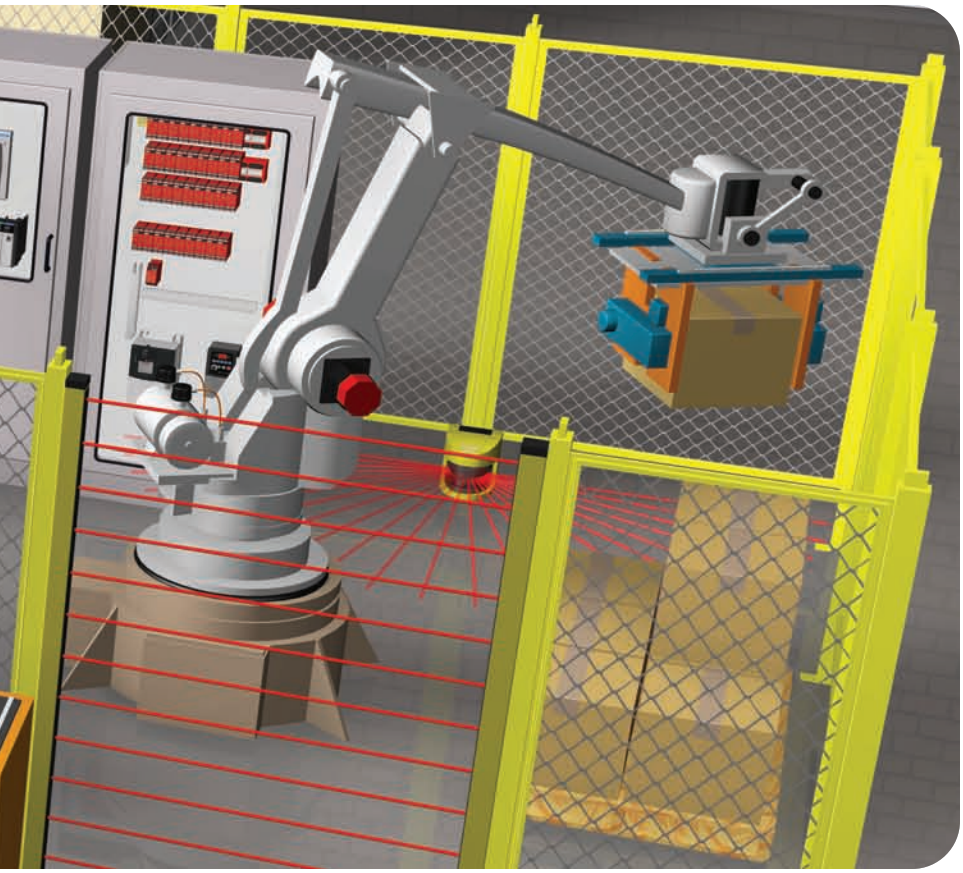
Allen-Bradley

Guardmaster®

Safety Products



- Principles, Standards, & Implementation
- Presence Sensing Safety Devices
- Safety Switches
- Operator Interface
- Logic
- Power
- Connection Systems
- Applied Safety Solutions
- Safety Applications









LISTEN. THINK. SOLVE.®

New in this Catalog

Presense Sensing Safety Devices



GuardShield™
Micro 400
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GuardShield™
Safe 4
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SafeZone™
Singlezone/Multizone
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Safety Switches



SensaGuard™
Integrated Latch
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Magnetically Coded
Non-Contact Switch
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22 mm Compact
Metal Limit Switch
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Logic



MSR41 Micro 400
Controller
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MSR42 Muting
Light Curtain
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MSR45E
Expansion Relay
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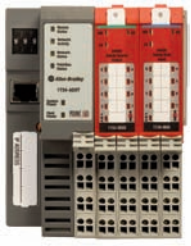
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PowerFlex® 753
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PowerFlex® 755
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Kinetix® 300
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Kinetix® 6200 &
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What Is Preferred Availability?

Products with Preferred Availability are our most commonly ordered items and are typically in factory stock. In this catalog, Preferred Availability products are indicated by ***bold*** *catalog numbers for your convenience.*

The latest Functional Safety Data and SISTEMA library for Rockwell Automation safeguarding products can be found at:
http://discover.rockwellautomation.com/Functional_Safety_DS

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Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The Illustrations, charts, sample programs and layout examples shown in this catalog are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Rockwell Automation does not assume responsibility or liability including intellectual property liability, for actual use based upon the examples shown in this publication.

Related Safety Information

The installer is responsible for the safety of the entire installed control system and for meeting all applicable laws, codes, and safety requirements.



ATTENTION: As the installer of this control system, you must be knowledgeable of other applicable standards pertaining to safety recommendations related to:
- Machine Construction
- General Electrical
- Machine Guarding
- Point of Operation guards, safety light curtains, mechanical guards, and two-hand controls, and safety monitoring relays

In addition to local laws and codes, you are responsible for the safety recommendations detailed in all applicable national and international codes and standards including:
- National Electric Code
- National Regulations Implementing European Directives
- OSHA Regulations
- ANSI Standards
- ISO and IEC Standards
- NFPA
- CSA

Terms and Conditions

For applicable "Terms and Conditions of Sale" please see page G-4.

IMPORTANT

Rockwell Automation reserves the right to make revisions to the material contained in this catalog and specifically disclaims all liability for any incidental or consequential damages resulting from the furnishing, performance or use of this material.

Application Considerations

Selection of Equipment—Because of the variety of uses for the products described in this catalog, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts and layout examples shown in this catalog are intended solely for purposes of example. Because there are many variables and requirements associated with any particular installation, Rockwell Automation does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Rockwell Automation Publication SGI-1.1, "Safety Guidelines for the Application, Installation and Maintenance of Solid-state Control" (available from your local Rockwell Automation Sales Office) describes some important differences between solid-state equipment and electromechanical devices which should be taken into consideration when applying products such as those described in this catalog.

Service and Installation Conditions—Unless otherwise noted, the products described in this catalog are designed to meet "usual service and installation conditions" as defined in NEMA (National Electrical Manufacturers Association) Standards Publication–Part ICS 1-108. Open style devices must be provided with environmental protection by proper mounting in enclosures designed for specific application conditions.

See page G-7 and page G-11 of this section for information on enclosures and an explanation of the degrees of protection provided by the different types, based on NEMA Standards Publication 250 and IEC Publication 529, as applicable.

Performance Data—Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of accelerated testing at elevated stress levels, and the user should correlate it to actual application requirements. Actual performance is subject to Rockwell Automation WARRANTY and LIMIT OF LIABILITY (see page G-4).

Metric Conversion Factors

From	To	Multiply by
Length		
Inches (in.)	Millimeters (mm)	25.4
Inches (in.)	Centimeters (cm)	25.4
Feet (ft)	Meters (m)	0.305
Yards (yd)	Meters (m)	0.914
Millimeters (mm)	Inches (in.)	0.0394
Centimeters (cm)	Inches (in.)	0.394
Meters (m)	Feet (ft)	3.28
Meters (m)	Yards (yd)	1.09
Area		
Square inches ($in.^2$)	Square millimeters (mm^2)	645.0
Square inches ($in.^2$)	Square centimeters (cm^2)	6.45
Square feet (ft^2)	Square meters (m^2)	0.0929
Square yards (yd^2)	Square meters (m^2)	0.836
Square millimeters (mm^2)	Square inches ($in.^2$)	0.00155
Square centimeters (cm^2)	Square inches ($in.^2$)	0.155
Square meters (m^2)	Square feet (ft^2)	10.8
Square meters (m^2)	Square yards (yd^2)	1.20
Weight		
Ounces (oz)	Grams (g)	28.3
Pounds (lb)	Kilograms (kg)	0.454
Grams (g)	Ounces (oz)	0.0353
Kilograms (kg)	Pounds (lb)	2.20
Volume		
Cubic inches ($in.^3$)	Cubic centimeters (cm^3)	16.4
Cubic feet (ft^3)	Cubic meters (m^3)	0.0283
Cubic inches ($in.^3$)	Litres (L)	0.0164
Cubic feet (ft^3)	Litres (L)	28.3
Gallons (Imp)	Litres (L)	4.55
Gallons (US)	Litres (L)	3.79
Cubic centimeters (cm^3)	Cubic inches ($in.^3$)	0.061
Cubic meters (m^3)	Cubic feet (ft^3)	35.3
Liters (L)	Cubic inches ($in.^3$)	61.0
Liters (L)	Cubic feet (ft^3)	0.0353
Liters (L)	Gallons (Imp)	0.220
Liters (L)	Gallons (US)	0.264
Pressure		
Pounds/square inch (psi)	Kilopascals (kPa)	6.89
Pounds/square inch (psi)	Bars (Bar)	0.0689
Kilopascals (kPa)	Pounds/square inch (psi)	0.145
Bars (Bar)	Pounds/square inch (psi)	14.5
Torque		
Pound inch (lb•in)	Newton meters (N•m)	0.113
Newton meters (N•m)	Pound inch (lb•in)	8.85
Temperature		
Degrees Fahrenheit (°F)	Degrees Celsius (°C)	Conversion Formula: 5/9 (°F – 32°F) = °C
Degrees Celsius (°C)	Degrees Fahrenheit (°F)	Conversion Formula: 9/5 (°C) + 32°F = °F

Terms and Conditions of Sale

These general terms and conditions of sale only apply to direct sales by the manufacturer or its affiliates. Sales by appointed distributors and other independent authorized resellers will be subject to terms and conditions of sale and may be separately established by each such distributor or reseller. Sales outside of North America, as well as sales of other Rockwell Automation products and services, also may be subject to separate or supplemental terms and conditions of sale. For further information, please consult a Rockwell Automation sales office or an Allen-Bradley distributor.

General—These general terms and conditions of sale (along with any directly associated written Seller specification or quotation) exclusively will govern the sale or licensing by Seller of all goods and services (including without limitation, hardware, firmware and software products, training, programming, maintenance, engineering, parts and repair services—collectively, the "Products") furnished hereunder. No addition or modification to these terms and conditions will be binding on Seller unless agreed to in writing signed by an authorized representative at Seller's headquarters. Seller objects to other terms and conditions that may be proposed by the customer not otherwise consistent with these or other terms and conditions set forth in Seller's written specification, quotation or order acknowledgment.

Payment Terms—Net thirty (30) days from date of invoice with ongoing approved credit as determined by Seller. Seller reserves the right to suspend any further performance under this agreement or otherwise in the event payment is not made when due. No payment by offset is permitted unless approved by Seller.

Delivery Terms—Delivery terms are Ex Works with respect to shipping costs, risk of loss and title transfer, except that title to all intellectual property rights associated with the Products (e.g., software and firmware) remains with Seller (or its suppliers and licensors), and such Products are made available or licensed only for use by the customer pursuant to this agreement or other Seller license agreement. Acknowledged shipping dates are approximate only and based on prompt receipt of all necessary information from the customer.

Warranty—

A. **Hardware:** Seller warrants for a period of one (1) year from the date of invoice from Seller or its appointed distributor, as the case may be, that hardware Products furnished hereunder will be of merchantable quality, free from defects in material, workmanship and design. Repaired or replacement Products provided under warranty are similarly warranted for a period of six (6) months from the date of shipment to Customer or the remainder of the original warranty term, whichever is longer.

B. **Software and Firmware:** Unless otherwise provided in a Seller or third party license agreement, Seller warrants for a period of one (1) year from the date of invoice from Seller or its appointed distributor, as the case may be, that standard software or firmware Products furnished hereunder, when used with Seller-specified hardware, will perform in accordance with published specifications prepared, approved, and issued by Seller's headquarters. Seller makes no representation or warranty, express or implied, that the operation of the software or firmware Products will be uninterrupted or error free, or that the functions contained therein will meet or satisfy the Customer's intended use or requirements. Software and firmware corrections are warranted for a period of three (3) months from the date of shipment to Customer or the remainder of the original warranty term, whichever is longer.

C. **Factory Repair and Field Exchange:** Seller warrants for a period of six (6) months from the date of invoice from Seller or its appointed distributor, as the case may be, that billable or non-warranty factory-repaired or field-exchanged hardware Products furnished hereunder will be free from defects in material and workmanship. Products furnished on an exchange basis may be new or reconditioned.

D. **Service:** Seller warrants that Products comprised of services, including engineering and custom application programming services, whether provided on a fixed cost or time and material basis, will be performed in accordance with generally accepted industry practices to the extent such services are subject to written acceptance criteria agreed to in advance by Seller. All other warranties relative to provided services are disclaimed.

E. **Customer Specifications:** Seller does not warrant and will not be liable for any design, materials or construction criteria furnished or specified by Customer and incorporated into the Products or for Products made by or source from other manufacturers or vendors specified by Customer. Any warranty applicable to such Customer-specified Products will be limited solely to the warranty, if any, extended by the original manufacturer or vendor other than Seller to the extent permissible thereunder.

F. **Remedies:** Satisfaction of the above warranties will be limited, at Seller's option, to the replacement, repair, re-performance or modification of, or issuance of a credit for the purchase price of the Products involved, and where applicable, only after the return of such Products with Seller's consent. Replacement Products may be new or reconditioned. Any warranty service (consisting of time, travel and expenses related to such services) performed other than at Seller's factory, will be at Customer's expense.

G. **General:** Warranty satisfaction is available only if (a) Seller is promptly notified in writing and (b) Seller's examination discloses, to its satisfaction, that any alleged defect has not been caused by misuse; neglect; improper installation, operation, maintenance, repair, alteration or modification; accident; or unusual deterioration or degradation of the Products or parts thereof due to physical environment or electrical or electromagnetic noise environment.

H. THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESSED, IMPLIED OR STATUTORY, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE, OR PERFORMANCE OR APPLICATION WARRANTIES, AND EXTEND ONLY TO CUSTOMERS PURCHASING FROM SELLER OR ITS APPOINTED DISTRIBUTOR.

Limit of Liability—IN NO EVENT WILL SELLER BE LIABLE FOR INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND. SELLER'S MAXIMUM CUMULATIVE LIABILITY RELATIVE TO ALL OTHER CLAIMS AND LIABILITIES, INCLUDING THAT WITH RESPECT TO DIRECT DAMAGES AND OBLIGATIONS UNDER ANY INDEMNITY, WHETHER OR NOT INSURED, WILL NOT EXCEED THE COST OF THE PRODUCTS GIVING RISE TO THE CLAIM OR LIABILITY. ANY ACTION AGAINST SELLER MUST BE BROUGHT WITHIN EIGHTEEN (18) MONTHS AFTER THE CAUSE OF ACTION ACCRUES. THESE DISCLAIMERS AND LIMITATIONS OF LIABILITY WILL APPLY REGARDLESS OF ANY OTHER CONTRARY PROVISION OF THE AGREEMENT AND REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT OR

OTHERWISE, AND FURTHER WILL EXTEND TO THE BENEFIT OF SELLER'S VENDORS, APPOINTED DISTRIBUTORS AND OTHER AUTHORIZED RESELLERS AS THIRD-PARTY BENEFICIARIES. EACH PROVISION IN THE AGREEMENT WHICH PROVIDES FOR A LIMITATION OF LIABILITY, DISCLAIMER OF WARRANTY OR CONDITION OR EXCLUSION OF DAMAGES IS SEVERABLE AND INDEPENDENT OF ANY OTHER PROVISION AND IS TO BE ENFORCED AS SUCH.

Intellectual Property—Seller will defend any suit or proceeding brought against the customer based on a claim that the design or construction of the Products sold or licensed hereunder by Seller infringe any United States or Canadian Patent, Copyright or Mask Work Registration, provided that the customer promptly notifies Seller of any such claim and resulting suit or proceeding in writing and further provided that, at Seller's expense, (a) the customer gives Seller the sole right to defend or control the defence of the suit or proceeding, including settlement, and (b) the customer provides all necessary information and assistance for that defence. Except for any consequential damages, Seller will pay all costs and damages finally awarded or agreed upon by Seller that are directly related to any such claim. In the event of a charge of infringement Seller's obligation under the Agreement will be fulfilled if Seller, at its option and expense, either (i) procures for the customer the right to continue using such Products; (ii) replaces the same with non-infringing Products; (iii) modifies the same so as to make them non-infringing; or (iv) accepts the return of any infringing Products and refunds their purchase price. Notwithstanding the foregoing, Seller will have no liability with respect to any claim of infringement to the extent based on a configuration or modification incorporated in the Products at the request of the customer, on any process application into which the Products are integrated by the customer, or on use of the Products in combination with other equipment or products not supplied by Seller. THIS PARAGRAPH SETS FORTH SELLER'S ENTIRE LIABILITY WITH RESPECT TO INTELLECTUAL PROPERTY AND INFRINGEMENT OF PATENTS BY ANY PRODUCTS (INCLUDING SOFTWARE PROGRAMS, EQUIPMENT OR PRODUCTS THEREOF) OR BY THEIR OPERATION, AND IS IN LIEU OF ALL WARRANTIES OR CONDITIONS RELATING TO INFRINGEMENT OR INTELLECTUAL PROPERTY, EITHER EXPRESS OR IMPLIED.

Licensed Software and Firmware—Products comprised of software or firmware may be subject to additional terms and conditions set forth in separate Seller's license agreements that will control to the extent necessary to resolve any conflict with the terms and conditions stated herein. Such Products will not be delivered or made available until the customer also agrees to the terms and conditions of such separate license agreements.

Packing and Marking—Customer-specified packing or marking may be subject to additional charges not otherwise included in the price of the Products.

Weights and Dimensions—Published weights and dimensions are estimates or approximate only and are not warranted.

Quotations—Written quotations are valid for 30 days from issue unless otherwise stated. Verbal quotations expire the same day they are made. All typographical and clerical errors are subject to correction.

Prices—Prices and other information shown in any Seller publication (including product catalogs and brochures) are subject to change without notice and confirmation by specific quotation. Such publications are not offers to sell and are maintained only as a source of general information. The customer will pay or reimburse Seller for all sales, use, excise or similar taxes. Products comprised of time and material services will be provided in accordance with Seller's published service rates (including applicable overtime and travel expenses) in effect as of the date such services are provided, unless otherwise confirmed by Seller's written quotation or order acknowledgment. Billable service time includes travel time to and from the job site and all time Seller's representatives are available for work and waiting (whether on or off the job site) to perform the services.

Changes—Customer-requested order changes, including those affecting the identity, scope and delivery of the Products, must be documented in writing and are subject to Seller's prior approval and adjustments in price, scheduling and other affected terms and conditions. In any event, Seller reserves the right to reject any change that it deems unsafe, technically inadvisable or inconsistent with established engineering or quality guidelines and standards, or incompatible with Seller's design or manufacturing capabilities.

Returns—All returns of Products will be subject to prior Seller approval. Non-warranty returns of unused and salable Products for credit will be subject to Seller's return policies in effect at the time, including applicable restocking charges and other conditions of return. Products returned under warranty must be properly packed and shipped to Seller-specified locations. Shipping containers must be clearly marked per Seller's instruction and shipped freight prepaid by the customer.

Order Cancellation—An order may be cancelled by the customer prior to shipment only by written notice and upon payment to Seller of reasonable cancellation and restocking charges, including reimbursement for direct costs, plus allowances for disruption. Cancellation charges associated with orders for custom Products or Products specifically manufactured to the customer's specification may equal the actual selling price of the Products. Seller has the right to cancel an order for cause at any time by written notice, and Seller will be entitled to cancellation and restocking charges as identified above. No termination by the customer for cause will be effective unless and until Seller has failed to correct such alleged cause within forty-five (45) days after receipt of the customer's written notice specifying such cause.

Force Majeure—Seller will not be liable for any loss, damage or delay arising out of its failure to perform hereunder due to causes beyond its reasonable control, including without limitation, acts of God or the customer, acts of civil or military authority, fires, strikes, floods, epidemics, quarantine restrictions, war, riots, delays in transportation, or transportation embargoes. In the event of any such delay, Seller's performance date(s) will be extended for that length of time as may be reasonably necessary to compensate for the delay.

Government Clauses and Contracts—No government contract regulations or clauses will apply to the Products or this agreement or act to bind Seller unless specifically agreed to by Seller in writing at Seller's headquarters. Products sold or licensed hereunder are not intended to be used, nor should they be used, in any nuclear-related application either as a "Basic Component" under 10 CFR 21 (United States NRC) or otherwise under similar nuclear laws and regulations of this or any other country.

Terms and Conditions of Sale

Export Control—Products and associated materials supplied or licensed under this agreement may be subject to various export laws and regulations. It is the responsibility of the exporter to comply with all such laws and regulations.

Disputes—The parties will attempt in good faith promptly to resolve any dispute arising out of this agreement by negotiations between representatives who have authority to settle the controversy. If unsuccessful, the parties further will attempt in good faith to settle the dispute by non-binding third-party mediation, with fees and expenses of such mediation apportioned equally to each side. Any dispute not so resolved by negotiation or mediation may then be submitted to a court of competent jurisdiction in accordance with the terms of this agreement. These procedures are the exclusive procedures for the resolution of all such disputes between the parties.

Governing Law—This agreement and all disputes arising thereunder will be governed by and interpreted in accordance with the internal laws of the state, province or other governmental jurisdiction in which Seller's principal place of business resides, but specifically excluding the provisions of the 1980 UN Convention on Contracts for the International Sales of Goods.

Assignment—This agreement may not be assigned by either party without the written consent of the other, however, consent will not be required for internal transfers and assignments as between Seller and its parent corporations, subsidiaries or affiliates as part of a consolidation, merger or other form of corporate reorganization.

Language—The parties acknowledge that they have required that this agreement be drawn up in English. Les parties reconnaissent avoir exigé la rédaction en anglais du Contrat. In the event of a conflict between the English and other language versions of this agreement, the English version will prevail.

ATTENTION: Servicing energized Industrial Control Equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of controlled equipment. Recommended practice is to disconnect and lockout control equipment from power sources, and release stored energy, if present. Refer to **National Fire Protection Association Standard No. NFPA70E, Part II and (as applicable) OSHA rules for Control of Hazardous Energy Sources (Lockout/Tagout) and OSHA Electrical Safety Related Work Practices** for safety related work practices, including procedural requirements for lockout/tagout, and appropriate work practices, personnel qualifications and training requirements where it is not feasible to de-energize and lockout or tagout electric circuits and equipment before working on or near exposed circuit parts.

Periodic Inspection—Industrial control equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. An initial inspection within three to four months after installation is suggested. See National Electrical Manufacturers Association (NEMA) Standard No. ICS 1.3, Preventive Maintenance of Industrial Control and Systems Equipment, for general guidelines for setting-up a periodic maintenance program. We suggest that a periodic maintenance program is set up. Some specific guidelines for Allen-Bradley products are listed below.

Contamination—If inspection reveals that dust, dirt, moisture or other contamination has reached the control equipment, the cause must be eliminated. This could indicate an incorrectly selected or ineffective enclosure, unsealed enclosure openings (conduit or other) or incorrect operating procedures. Replace any improperly selected enclosure with one that is suitable for the environmental conditions—refer to NEMA Standard No. 250, Enclosures for Electrical Equipment for enclosure type descriptions and test criteria. Replace any damaged or embrittled elastomer seals and repair or replace any other damaged or malfunctioning parts (e.g., hinges, fasteners, etc.). Dirty, wet or contaminated control devices must be replaced unless they can be cleaned effectively by vacuuming or wiping. Compressed air is not recommended for cleaning because it may displace dirt, dust, or debris into other parts or equipment, or damage delicate parts.

Cooling Devices—Inspect blowers and fans used for forced air cooling. Replace any that have bent, chipped, or missing blades, or if the shaft does not turn freely. Apply power momentarily to check operation. If unit does not operate, check and replace wiring, fuse, or blower or fan motor as appropriate. Clean or change air filters as recommended in the product manual. Also, clean fins of heat exchangers so convection cooling is not impaired.

Hazardous Location Enclosures—



ATTENTION: Explosion hazard. Always disconnect power before opening enclosures in hazardous locations. Close and secure such enclosures before re-applying power.

Location Enclosures—NEMA Types 7 & 9 enclosures require careful handling so machined flanges do not get damaged. For removable covers, remove the cover and set aside with machined surface up. For hinged covers, open the cover fully and restrain in the full open position if necessary. Clean and examine the flanges on both the body and cover before re-assemble. If there are scratches, nicks, grooves or rust on the mating surfaces, replace the body or cover as necessary. Examine all bolts and replace any that have damaged threads. Also check mating threads for damage and replace enclosure if necessary. Covers and bodies of some enclosures are manufactured as matched sets (not interchangeable). The manufacturer should be consulted before replacing a cover or body unless it is specified by the manufacturer as interchangeable.

Operating Mechanisms—Check for proper functioning and freedom from sticking or binding. Replace any broken, deformed or badly worn parts or assemblies according to individual product renewal parts lists. Check for, and re-tighten securely, any loose fasteners. Lubricate if specified in individual product instructions.

Note: Allen-Bradley magnetic starters, contactors and relays are designed to operate without lubrication—**do not** lubricate these devices because oil or grease on the pole faces (mating surfaces) of the operating magnet may cause the device to stick in the "ON" mode. Some parts of other devices are factory-lubricated—if lubrication during use or maintenance of these devices is needed, it will be specified in their individual instructions. If in doubt, consult your local Allen-Bradley Sales Office for information.

Contacts—Check contacts for excessive wear and dirt accumulations. Vacuum or wipe contacts with a soft cloth if necessary to remove dirt. Contacts are not harmed by discoloration and slight pitting. Contacts should never be filed, as dressing only shortens contact life. Contact spray cleaners **should not be** used as their residue on magnet pole faces or in operating mechanisms may cause sticking, and on contacts can interfere with electrical continuity. Contacts should only be replaced after silver has become badly worn. Always replace contacts in complete sets to avoid misalignment and uneven contact pressure.

Vacuum Contactors—Contacts of vacuum contactors are not visible, so contact wear must be checked indirectly. Vacuum bottles should be replaced when:

The estimated number of operations equals one million, or

The contact life line indicator shows need for replacement, or

The vacuum bottle integrity tests show need for replacement.

Replace all vacuum bottles in the contactor at the same time to avoid misalignment and uneven contact wear. If the vacuum bottles do not require replacement, check and adjust overtravel to the value listed on the maintenance instructions.

Terminals—Loose connections in power circuits can cause overheating that can lead to equipment malfunction or failure. Loose connections in control circuits can cause control malfunctions. Loose bonding or grounding connections can increase hazards of electrical shock and contribute to electromagnetic interference (EMI). Check the tightness of all terminals and bus bar connections and tighten **securely** any loose connections. Replace any parts or wiring damaged by overheating, and any broken wires or bonding straps.

Arc Hoods—Check for cracks, breaks, or deep erosion. Arc hoods and arc chutes should be replaced if damaged or deeply eroded.

Coils—If a coil exhibits evidence of overheating (cracked, melted or burned insulation), it must be replaced. In that event, check for and correct overvoltage or undervoltage conditions, which can cause coil failure. Be sure to clean any residue of melted coil insulation from other parts of the device or replace such parts.

Batteries—Replace batteries periodically as specified in product manual or if a battery shows signs of electrolyte leakage. Use tools to handle batteries that have leaked electrolyte; most electrolytes are corrosive and can cause burns. Dispose of the old battery in accordance with instructions supplied with the new battery or as specified in the manual for the product.

Pilot Lights—Replace any burned out lamps or damaged lenses.

Photoelectric Switches—The lenses of photoelectric switches require periodic cleaning with a soft dry cloth. Reflective devices used in conjunction with photoelectric switches also require periodic cleaning. Do not use solvents or cleaning agents on the lenses or reflectors. Replace any damaged lenses and reflectors.

Solid-State Devices



ATTENTION: Use of other than factory-recommended test equipment for solid-state controls may result in damage to the control or test equipment or unintended actuation of the controlled equipment. Refer to paragraph titled HIGH-VOLTAGE TESTING.

Solid-state devices require little more than a periodic visual inspection. Discolored, charred or burned components may indicate the need to replace the component or circuit board. Necessary replacements should be made only at the PC board or plug-in component level. Printed circuit boards should be inspected to determine whether they are properly seated in the edge board connectors. Board locking tabs should also be in place. Solid-state devices must also be protected from contamination, and cooling provisions must be maintained—refer to paragraphs titled CONTAMINATION and COOLING DEVICES on previous page. Solvents should not be used on printed circuit boards.

High-Voltage Testing—High-voltage insulation resistance (IR) and dielectric-withstanding voltage (DWV) tests should not be used to check solid-state control equipment. When measuring IR or DWV of electrical equipment such as transformers or motors, a solid-state device used for control or monitoring must be disconnected before performing the test. Even though no damage is readily apparent after an IR or DWV test, the solid-state devices are degraded and repeated application of high voltage can lead to failure.

Locking and Interlocking Devices—Check these devices for proper working condition and capability of performing their intended functions. Make any necessary replacements only with Allen-Bradley renewal parts or kits. Adjust or repair only in accordance with Allen-Bradley instructions.

Maintenance After a Fault Condition—Opening of the short circuit protective device (such as fuses or circuit breakers) in a properly coordinated motor branch circuit is an indication of a fault condition in excess of operating overload. Such conditions can cause damage to control equipment. **Before restoring power**, the fault condition must be corrected and any necessary repairs or replacements must be made to restore the control equipment to good working order. Refer to NEMA Standards Publication No. ICS 2, Part ICS2 302 for procedures.

Replacements—Use only replacement parts and devices recommended by Allen-Bradley to maintain the integrity of the equipment. Make sure the parts are properly matched to the model, series and revision level of the equipment.

Final Check Out—After maintenance or repair of industrial controls, always test the control system for proper functioning under controlled conditions that avoid hazards in the event of a control malfunction.

For additional information, refer to NEMA ICS 1.3, PREVENTIVE MAINTENANCE OF INDUSTRIAL CONTROL AND SYSTEMS EQUIPMENT, published by the National Electrical Manufacturers Association, and NFPA70B, ELECTRICAL EQUIPMENT MAINTENANCE, published by the National Fire Protection Association.

Degree of Protection

IEC Publication 60259 describes standard Degrees of Protection that enclosures of a product are designed to provide when properly installed.

Summary

The publication defines degrees of protection with respect to:

- Persons
- Equipment within the enclosure
- Ingress of water

It does **not** define:

- Protection against risk of explosion
- Environmental protection (e.g. against humidity, corrosive atmospheres or fluids, fungus or the ingress of vermin)

Note: The IEC test requirements for Degrees of Protection against liquid ingress refer only to water. Those products in this catalog, which have a high degree of protection against ingress of liquid, in most cases include Nitrile seals. These have good resistance to a wide range of oils, coolants and cutting fluids. However, some of the available lubricants, hydraulic fluids and solvents can cause severe deterioration of Nitrile and other polymers. Some of the products listed are available with seals of Viton® or other materials for improved resistance to such liquids. For specific advice on this subject refer to your local Rockwell Automation sales office.

IEC Enclosure Classification

The degree of protection is indicated by two letters (IP) and two numerals. International Standard IEC 529 contains descriptions and associated test requirements that define the degree of protection each numeral specifies. The table on this page indicates the general degree of protection—refer to the **Abridged Descriptions of IEC Enclosure Test Requirements** starting below. **For complete test requirements refer to IEC 60259.**

Abridged Descriptions of IEC Enclosure Test Requirements

(Refer to IEC 60259 for complete test specifications—e.g., test apparatus configuration; tolerances; etc. For Metric Conversion factors—see page G-3.)

Tests for Protection Against Access to Hazardous Parts (first characteristic numeral)

The first characteristic numeral of the IP number indicates compliance with the following tests for the degree of protection against access to hazardous parts. It also indicates compliance with tests as shown in the next section for the degree of protection against solid foreign objects.

The protection against access to hazardous parts is satisfactory if adequate clearance is kept between the specified access probe and hazardous parts. For voltage less than 1000V AC and 1500V DC, the access probe must not touch the hazardous live parts. For voltage exceeding 1000V AC and 1500V DC, the equipment must be capable of withstanding specified dielectric tests with the access probe in the most unfavorable position.

First Numeral*	Second Numeral*
Protection of persons against access to hazardous parts and protection against penetration of solid foreign objects.	Protection against ingress of water under test conditions specified in IEC 60259.
0 Non-protected	0 Non-protected
1 Back of hand; objects greater than 50 mm in diameter	2 Vertically falling drops of water
3 Finger; objects greater than 12.5 mm in diameter	4 Vertically falling drops of water with enclosure tilted 15°
5 Tools or objects greater than 2.5 mm in diameter	6 Spraying water
7 Tools or objects greater than 1.0 mm in diameter	8 Splashing water
9 Dust-protected (dust may enter during specified test but must not interfere with operation of the equipment or impair safety)	10 Water jets
11 Dusttight (no dust observable inside enclosure at end of test)	12 Powerful water jets
	13 Temporary submersion
	14 Continuous submersion
Example: IP41 describes an enclosure that is designed to protect against the entry of tools or objects greater than 1 mm in diameter and to protect against vertically dripping water under specified test conditions.	
Note: All first numerals and second numerals up to and including characteristic numeral 6, imply compliance also with the requirements for all lower characteristic numerals in their respective series (first or second). Second numerals 7 and 8 do not imply suitability for exposure to water jets (second characteristic numeral 5 or 6) unless dual coded; e.g., **IP_5/ IP_7**.	

* The IEC standard permits use of certain supplementary letters with the characteristic numerals. If such letters are used, refer to IEC 60259 for the explanation.

IP0_ —No test required.

IP1_—A rigid sphere 50 mm in diameter shall not completely pass through any opening. Force = 50 N.

IP2_—A jointed test finger 80 mm long and 12 mm in diameter may penetrate to its 80 mm length, but shall have adequate clearance as specified above, from hazardous live parts, in every possible position of the test finger as both joints are bent through an angle up to 90°. Force = 10 N.

IP3_—A test rod 2.5 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified in table above). Force = 3 N.

IP4_—A test wire 1 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified in table above). Force = 1 N.

IP5_ —A test wire 1 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified in table above). Force = 1 N.

IP6_—A test wire 1 mm in diameter shall not penetrate and adequate clearance shall be kept from hazardous live parts (as specified in the table above). Force = 1 N.

Tests for Protection Against Solid Foreign Objects (first characteristic numeral)

For first numerals **1, 2, 3,** and **4** the protection against solid foreign objects is satisfactory if the full diameter of the specified probe does not pass through any opening. Note that for first numerals **3** and **4** the probes are intended to simulate foreign objects which may be spherical. Where shape of the entry path leaves any doubt about ingress or a spherical object capable of motion, it may be necessary to examine drawings or to provide special access for the object probe. For first numerals **5** and **6** see test descriptions below for acceptance criteria.

IP0_—No test required.

IP1_—The full diameter of a rigid sphere 50 mm in diameter must not pass through any opening at a test force of 50 N.

IP2_—The full diameter of a rigid sphere 12.5 mm in diameter must not pass through any opening at a test force of 30 N.

IP3_—A rigid steel rod 2.5 mm in diameter must not pass through any opening at a test force of 3 N.

IP4_—A rigid steel wire 1 mm in diameter must not pass through any opening at a test force of 1 N.

IP5_—The test specimen is supported inside a specified dust chamber where talcum powder, able to pass through a square-meshed sieve with wire diameter 50 mm and width between wires 75 mm, is kept in suspension.

Enclosures for equipment subject to thermal cycling effects (category 1) are vacuum pumped to a reduced internal pressure relative to the surrounding atmosphere: maximum depression = 2 kPa; maximum extraction rate = 60 volumes per hour. If extraction rate of 40 to 60 volumes/hr. is obtained, test is continued until 80 volumes have been drawn through or 8 hr. has elapsed. If extraction rate is less than 40 volumes/hr. at 20 kPa depression, test time = 8 hr.

Enclosures for equipment not subject to thermal cycling effects **and** designated category 2 in the relevant product standard are tested for 8 hr. without vacuum pumping.

Protection is satisfactory if talcum powder has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the equipment or impair safety; and no dust has been deposited where it could lead to tracking along creepage distances.

IP6_—All enclosures are tested as category 1, as specified above for **IP5**_. The protection is satisfactory if no deposit of dust is observable inside the enclosure at the end of the test.

Tests for Protection Against Water (second characteristic numeral)

The second characteristic numeral of the IP number indicates compliance with the following tests for the degree of protection against water. For numerals **1** through **7**, the protection is satisfactory if any water that has entered does not interfere with satisfactory operation, does not reach live parts not designed to operate when wet, and does not accumulate near a cable entry or enter the cable. For second numeral **8** the protection is satisfactory if no water has entered the enclosure.

IP_0—No test required.

IP_1—Water is dripped onto the enclosure from a "drip box" having spouts spaced on a 20 mm square pattern, at a "rainfall" rate of 1 mm/min. The enclosure is placed in its normal operating position under the drip box. Test time = 10 min.

IP_2—Water is dripped onto the enclosure from a "drip box" having spouts spaced on a 20 mm square pattern, at a "rainfall" rate of 3 mm/min. The enclosure is placed in 4 fixed positions tilted 15° from its normal operating position, under the drip box. Test time = 2.5 min. for each position of tilt.

IP_3—Water is sprayed onto all sides of the enclosure over an arc of 60° from vertical, using an oscillating tube device with spray holes 50 mm apart (or a hand-held nozzle for larger enclosures). Flow rate, oscillating tube device = 0.07 l/min. per hole x number of holes; for hand-held nozzle = 10 l/min. Test time, oscillating tube = 10 min.; for hand-held nozzle = 1 min./m2 of enclosure surface area, 5 min. minimum.

IP_4—Same as test for **IP_3** except spray covers an arc of 180° from vertical.

IP_5—Enclosure is sprayed from all practicable directions with a stream of water at 12.5 l/min. from a 6.3 mm nozzle from a distance of 2.5 to 3 m. Test time = 1 min./m^2 of enclosure surface area to be sprayed, 3 min. minimum.

IP_6—Enclosure is sprayed from all practicable directions with a stream of water at 100 l/min. from a 12.5 mm nozzle from a distance of 2.5 to 3 m. Test time = 1 min./m^2 of enclosure surface area to be sprayed, 3 min. minimum.

IP_7—Enclosure is immersed in water in its service position for 30 min. Lowest point of enclosures less than 850 mm tall = 1000 mm below surface of water. Highest point of enclosures more than 850 mm tall = 150 mm below surface of water.

IP_8—Test conditions are subject to agreement between manufacturer and user, but shall be at least as severe as those for **IP_7**.

Specify the Correct Enclosure for Your Motor Controls

Type 1
General Purpose Surface Mounting



Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment in locations where unusual service conditions do not exist. The enclosures are designed to meet the rod entry and rust-resistance design tests. Enclosure is sheet steel, treated to resist corrosion.

Type 1
Flush Mounting

Type 1 Flush mounting enclosures for installation in machine frames and plaster wall. These enclosures are for similar applications and are designed to meet the same tests as Type 1 surface mounting.

Type 3
Rainproof Dusttight

Type 3 enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain and sleet; and to be undamaged by the formation of ice on the enclosure. They are designed to meet rain ✶, external icing ❄, dust, and rust-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 3R
Rainproof

Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain, and to be undamaged by the formation of ice on the enclosure. They are designed to meet rod entry, rain ‡ external icing ❄, and rust-resistance design tests. They are not intended to provide protection against conditions such as dust, internal condensation, or internal icing.

Type 4
Watertight



Type 4 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure. They are designed to meet hosedown, dust, and external icing tests ❄. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 4X
Non-Metallic, Corrosion-Resistant



Type 4X enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure. They are designed to meet the hosedown, dust, external icing ❄, and corrosion-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 6P
For Prolonged Submersion at a Limited Depth

Type 6P enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against the entry of water during prolonged submersion at a limited depth; and to be undamaged by the formation of ice on the enclosure. They are designed to meet air pressure, external icing ✶, hosedown and corrosion-resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Type 7
For Hazardous Gas Locations



Type 7 enclosures are for indoor use in locations classified as Class I, Groups C or D, as defined in the U.S. National Electrical Code. Type 7 enclosures are designed to be capable of withstanding the pressures resulting from an internal explosion of specified gases, and contain such an explosion sufficiently that an explosive gas-air mixture existing in the atmosphere surrounding the enclosure will not be ignited. Enclosed heat generating devices are designed not to cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in the surrounding atmosphere. Enclosures are designed to meet explosion, hydrostatic, and temperature design tests. Finish is a special corrosion-resistant, gray enamel.

Type 9
For Hazardous Dust Locations



Type 9 enclosures are intended for indoor use in locations classified as Class II, Groups E, F, or G, as defined in the U.S. National Electrical Code. Type 9 enclosures are designed to be capable of preventing the entrance of dust. Enclosed heat generating devices are designed not to cause external surfaces to reach temperatures capable of igniting or discolouring dust on the enclosure or igniting dust-air mixtures in the surrounding atmosphere. Enclosures are designed to meet dust penetration and temperature design tests, and aging of gaskets. The outside finish is a special corrosion-resistant gray enamel.

Type 12
Dusttight Industrial Use



Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids. They are designed to meet drip ❄, dust, and rust-resistance tests. They are not intended to provide protection against conditions such as internal condensation.

Type 13
Oiltight



Type 13 enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant. They are designed to meet oil exclusion and rust-resistance design tests. They are not intended to provide protection against conditions such as internal condensation.

✶ Evaluation criteria: No water has entered enclosure during specified test.
❄ Evaluation criteria: Undamaged after ice buildup during specified test has melted. (**Note:** Not required to be operable while ice-laden.)
‡ Evaluation criteria: No water shall have reached live parts, insulation or mechanisms.

NEMA Enclosures

ENCLOSURES:
Refer to the brief descriptions below for the various types of enclosures offered by Rockwell Automation. For definitions, descriptions and test criteria, see National Electrical Manufactures Association (NEMA) Standards Publication No. 250. Also see individual product listings within this Rockwell Automation catalog for available enclosure types and for any additional information relating to these descriptions.

NOTE: Enclosures do not normally protect devices against conditions such as condensation, icing, corrosion or contamination that may occur within the enclosure or enter via the conduit or unsealed openings. Users must make adequate provisions to safeguard against such conditions and satisfy themselves that the equipment is properly protected.

Selection Criteria

Enclosures for Non-Hazardous Locations

For a Degree of Protection Against:	Designed to Meet Tests No. ✶	Type							
		For Indoor Use			For Outdoor Use		Indoor or Outdoor		
		1	12	13	3R	3	4	4X	6P
Incidental contact with enclosed equipment	6.2	✓	✓	✓	✓	✓	✓	✓	✓
Falling dirt	6.2	✓	✓	✓	✓	✓	✓	✓	✓
Rust	6.8	✓	✓	✓	✓	✓	✓	✓	✓
Circulating dust, lint, fibres and flyings❄	6.5.1.2 (2)		✓	✓		✓	✓	✓	✓
Windblown dust	6.5.1.1 (2)					✓	✓	✓	✓
Falling liquids and light splashing	6.3.2.2		✓	✓		✓	✓	✓	✓
Rain (Test evaluated per 6.4.2.1)	6.4.2.1				✓	✓	✓	✓	✓
Rain (Test evaluated per 6.4.2.2)	6.4.2.2					✓	✓	✓	✓
Snow and sleet	6.6.2.2				✓	✓	✓	✓	✓
Hosedown and splashing water	6.7						✓	✓	✓
Occasional prolonged submersion	6.11 (2)								✓
Oil and coolant seepage	6.3.2.2		✓	✓					
Oil or coolant spraying and splashing	6.12			✓					
Corrosive agents	6.9				✓	✓	✓	✓	✓

✶ See page G-13 for abridged description of NEMA enclosure test requirements. Refer to NEMA Standards Publication No. 250 for complete test specifications.
❄ Non-hazardous materials, not Class III ignitable or combustible.

Enclosures for Hazardous Locations (Division 1 or 2)♣

For a Degree of Protection Against Atmospheres Typically Containing:➢	Designed to Meet Tests‡	Class (National Electrical Code)	7, Class I Group				9, Class II Group		
			A	B	C	D	E	F	G
Acetylene	Explosion Test Hydrostatic Test Temperature Test	I	✓						
Hydrogen, Manufactured Gas			✓	✓					
Diethyl Ether, Ethylene, Hydrogen Sulfide					✓				
Acetone, Butane, Gasoline, Propane, Toluene					✓	✓			
Metal dusts and other combustible dusts with resistivity of less than 10^5 Ω-cm	Dust Penetration Test Temperature Test with Dust Blanket	II					✓		
Carbon black, charcoal, coal or coke dusts with resistivity between 10^2…10^8 Ω-cm								✓	
Combustible dusts with resistivity of 10^5 Ω-cm or greater									✓
Fibers, flyings	§	III							✓

♣ For indoor locations only, unless cataloged with additional NEMA Type enclosure number(s) suitable for outdoor use as shown in the table on this page. Some control devices (if so listed in the catalog) are suitable for Division 2 hazardous location use in enclosures for nonhazardous locations. For explanation of CLASSES, DIVISIONS and GROUPS, refer to the National Electrical Code.
➢ For listing of additional materials and information noting the properties of liquids, gases and solids, refer to NFPA 497M-1991, Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations.
‡ See abridged description of test requirements on page G-13. For complete requirements, refer to UL Standard 698, compliance with which is required by NEMA enclosure standards.
§ UL 698 does not include test requirements for Class III. Products that meet Class II, Group G requirements are acceptable for Class III.

Abridged Description of NEMA Enclosure Test Requirements

6.2 **Rod Entry Test**—A 3.18 mm (0.125 in.) diameter rod must not be able to enter enclosure except at locations where nearest live part is more than 102 mm (4 in.) from an opening — such opening shall not permit a 13 mm (0.5 in.) diameter rod to enter.

6.3 **Drip Test**—Water is dripped onto enclosure for 30 minutes from an overhead pan having uniformly spaced spouts, one every 12,900 mm^2 (20 $in.^2$) of pan area, each spout having a drip rate of 20 drops per minute.

Evaluation 6.3.2.2: No water shall have entered enclosure.

6.4 **Rain Test**—Entire top and all exposed sides are sprayed with water at a pressure of 0.35 kg/cm^2 (5 psi) from nozzles for one hour at a rate to cause water to rise 457 mm (18 in.) in a straight-sided pan beneath the enclosure.

Evaluation 6.4.2.1: No water shall have reached live parts, insulation or mechanisms.

Evaluation 6.4.2.2: No water shall have entered enclosure.

6.5.1.1 (2) **Outdoor Dust Test (Alternate Method)**—Enclosure and external mechanisms are subjected to a stream of water at 170.5 liters (45 gallons) per minute from a 25.4 mm (1 in.) diameter nozzle, directed at all joints from all angles from a distance of 3…3.7 m (10…12 ft). Test time is 48 seconds times the test length (height + width + depth of enclosure in feet), or a minimum of 5 minutes. No water shall enter enclosure.

6.5.1.2 (2) **Indoor Dust Test (Alternate Method)**—Atomized water at a pressure of 2.11 kg/cm^2 (30 psi) is sprayed on all seams, joints and external operating mechanisms from a distance of 305…381 mm (12…15 in.) at a rate of 11 liters (3 gallons) per hour. No less than 142 gms (5 oz) of water per linear foot of test length (height + length + depth of enclosure) is applied. No water shall enter enclosure.

6.6 **External Icing Test**—Water is sprayed on enclosure for one hour in a cold room +2°C (36°F); then room temperature is lowered to approximately –5°C (–23°F) and water spray is controlled so as to cause ice to build up at a rate of 6.4 mm (0.25 in.) per hour until 19 mm (0.75 in.) thick ice has formed on top surface of a 25.4 mm (1 in.) diameter metal test bar, then temperature is maintained at –5°C (–23°F) for 3 hours.

Evaluation 6.6.2.2: Equipment shall be undamaged after ice has melted (external mechanisms not required to be operable while ice-laden).

6.7 **Hosedown Test**—Enclosure and external mechanisms are subjected to a stream of water at 246 liters (65 gallons) per minute from a 25.4 mm (1 in.) diameter nozzle, directed at all joints from all angles from a distance of 3…3.7 m (10 to 12 ft). Test time is 48 seconds times the test length [height + width + depth] of enclosure in meters (feet), or a minimum of 5 seconds. No water shall enter enclosure.

6.8 **Rust Resistance Test (Applicable Only to Enclosures Incorporating External Ferrous Parts)**—Enclosure is subjected to a salt spray (fog) for 24 hours, using water with five parts by weight of salt (NaCl), at 35°C (95°F), then rinsed and dried. There shall be no rust except where protection is impractical (e.g., machined mating surfaces, sliding surfaces of hinges, shafts, etc.).

6.9 **Corrosion Protection**—Sheet steel enclosures are evaluated per Underwriter's Laboratories (UL) 50, Part 13 (test for equivalent protection as G-90 commercial zinc coated sheet steel). Other materials per Underwriter's Laboratories (UL) 508, 6.9 or 6.10.

6.11 (2) **Air Pressure Test (Alternate Method)**—Enclosure is submerged in water at a pressure equal to water depth of 2 m (6 ft), for 24 hours. No water shall enter enclosure.

6.12 **Oil Exclusion Test**—Enclosure is subjected to a stream of test liquid for 30 minutes from a 9.5 mm (0.375 in.) diameter nozzle at 7.57 liters (2 gallons) a minute. Water with 0.1% wetting agent is directed from all angles from a distance of 305…457 mm (12…18 in.), while any externally operated device is operated at 30 operations per minute. No test liquid shall enter the enclosure.

Abridged Description of UL Standard 698 Test Requirements

Explosion Test—During a series of tests in which gas-air mixtures of the specific gas, over its range of explosive concentrations, are ignited inside the enclosure, the enclosure shall prevent the passage of flame and sparks capable of igniting a similar gas-air mixture surrounding the enclosure. In addition, there shall be no mechanical damage to enclosed electrical mechanisms or the enclosure.

Hydrostatic Test—The enclosure shall withstand for one minute a hydrostatic test based on the maximum internal explosion pressure developed during the explosion tests, as follows: cast metal, four times the explosion pressure without rupture or permanent deformation; fabricated steel, twice the explosion pressure without permanent deformation and three times the explosion pressure without rupture. Exception: Hydrostatic tests may be omitted if calculations show safety factor of 5:1 for cast metal and 4:1 for fabricated steel.

Temperature Test—The enclosed device is subjected to a temperature test to determine maximum temperature at any point on the external surface. The device must be marked with a temperature code based on the result only if the temperature exceeds +100°C (+212°F).

Dust Penetration Test—The device is operated at full rated load until equilibrium temperatures are attained, then allowed to cool to ambient (room) temperature, through six heating and cooling cycles covering at least 30 hours, while continuously exposed to circulating dust of specified properties in a test chamber. No dust shall enter the enclosure.

Temperature Test with Dust Blanket—This test is conducted as described for the Dust Penetration test except that the re-circulating dust nozzles are positioned so that the dust is not blown directly on the device under test. The device is operated at full rated load (and under abnormal conditions for equipment subject to overloading) until equilibrium temperatures are attained. Dust in contact with the enclosure shall not ignite or discolour from heat, and the exterior temperatures based on +40°C (+104°F) ambient shall not exceed:

Group	Normal Operation	Abnormal Operation
E	+200°C (+392°F)	+200°C (+392°F)
F	+150°C (+302°F)	+200°C (+392°F)
G	+120°C (+248°F)	+165°C (+329°F)

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Regulations

EU Directives and Legislation

The purpose of this section is to act as a guide for anyone concerned with machine safety especially guarding and protective systems in the European Union. It is intended for designers and users of industrial equipment.

In order to promote the concept of an open market within the European Economic Area (EEA) (which comprises all EU Member States plus three other countries) all member states are obliged to enact legislation that defines essential safety requirements for machinery and its use.

Machinery that does not meet these requirements cannot be supplied into or within EEA countries.

There are several European Directives that can apply to the safety of industrial machinery and equipment but the two that are of the most direct relevance are:

1. The Machinery Directive
2. The Use of Work Equipment by Workers at Work Directive

These two Directives are directly related as the Essential Health and Safety Requirements (EHSRs) from the Machinery Directive can be used to confirm the safety of equipment in the Use of Work Equipment Directive.

This section deals with aspects of both directives and it is strongly recommended that anyone concerned with the design, supply, purchase or use of industrial equipment within or into the EEA and also certain other European countries should familiarize themselves with their requirements. Most suppliers and users of machinery will simply not be allowed to supply or operate machinery in these countries unless they conform to these directives.

There are other European Directives that may have relevance to machinery. Most of them are fairly specialized in their application and are therefore left outside the scope of this section but it is important to note that, where relevant, their requirements must also be met. Examples are: The EMC Directive 2004/108/EC and the ATEX Directive 94/9/EC.

The EU Machinery Directive

The Machinery Directive covers the supply of new machinery and other equipment including safety components. It is an offense to supply machinery within the EU unless the provisions and requirements of the Directive are met.

The broadest definition of “machinery” given within the Directive is a follows: an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application.

Detailed information and guidance on the definition and all other aspects of the Machinery Directive can be found at the official EU website:

http://ec.europa.eu/enterprise/sectors/mechanical/machinery/index_en.htm

The current Machinery Directive (2006/42/EC) replaced the former version (98/37/EC) at the end of 2009. It clarifies and amends but does not introduce any radical changes to its Essential Health and Safety Requirements (EHSRs). It does introduce some changes to take account of changes in technology and methods. It extends its scope to cover some extra types of equipment (e.g. construction site hoists). There is now an explicit requirement for a risk assessment for the determination of which EHSRs are applicable and there are changes made to the conformity assessment procedures for Annex IV equipment.

The key provisions of the original Directive (98/37/EC) came into force for machinery on January 1, 1995 and for Safety Components on January 1, 1997.

The provisions of the current Directive (2006/42/EC) became applicable on December 29, 2009. It is the responsibility of the manufacturer or his authorized representative to ensure that equipment supplied is in conformity with the Directive. This includes:



Figure 1: CE Marking Affixed to Machine

- Ensuring that the applicable EHSRs contained in Annex I of the Directive are fulfilled
- A technical file is prepared
- Appropriate conformity assessment is carried out
- An “EC Declaration of Conformity” is given
- CE Marking is affixed where applicable
- Instructions for safe use are provided

Essential Health and Safety Requirements

Annex 1 of the Directive gives a list of Essential Health and Safety Requirements (referred to as EHSRs) to which machinery must comply where relevant. The purpose of this list is to ensure that the machinery is safe and is designed and constructed so that it can be used, adjusted and maintained throughout all phases of its life without putting persons at risk. The following text provides a quick overview of some typical requirements but it is important to consider all of the EHSRs given in Annex 1.

A risk assessment must be carried out to determine which EHSRs are applicable to the equipment under consideration.

The EHSRs in Annex 1 provides a hierarchy of measures for eliminating the risk:

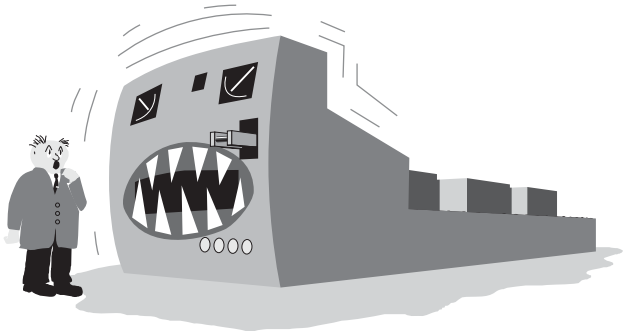


Figure 2: Machine Must Meet EHSRs

(1) Inherently Safe Design—Where possible the design itself will prevent any hazards.

Where this is not possible **(2) Additional Protective Measures**, e.g., Guards with interlocked access points, non-material barriers such as light curtains, sensing mats etc., should be used.

Any residual risk which cannot be dealt with by the above methods must be contained by **(3) Personal Protective Equipment and/or Training**. The machine supplier must specify what is appropriate.

Suitable materials should be used for construction and operation. Adequate lighting and handling facilities should be provided. Controls and control systems must be safe and reliable. Machines must not be capable of starting up unexpectedly and should usually have one or more emergency stop devices fitted. Consideration

must be given to complex installations where processes upstream or downstream can affect the safety of a machine. Failure of a power supply or control circuit must not lead to a dangerous situation. Machines must be stable and capable of withstanding foreseeable stresses. They must have no exposed edges or surfaces likely to cause injury.

Guards or protection devices must be used to protect risks such as moving parts. These must be of robust construction and difficult to bypass. Fixed guards must be mounted by methods that can only be removed with tools. Movable guards should be interlocked. Adjustable guards should be readily adjustable without the use of tools.

Electrical and other energy supply hazards must be prevented. There must be minimal risk of injury from temperature, explosion, noise, vibration, dust, gases or radiation. There must be proper provisions for maintenance and servicing. Sufficient indication and warning devices must be provided. Machinery shall be provided with instructions for safe installation, use, adjustment etc.

The Machinery Directive—Conformity Assessment and Standards

A harmonized European (EN) Standard that is listed in the Official Journal of the European Union (OJ) under the Machinery Directive, and whose date of cessation of presumption of conformity has not expired, confers a presumption of conformity with certain of the EHSRs. (Many recent standards listed in the OJ include a cross-reference identifying the EHSRs that is covered by the standard).

Therefore, where equipment complies with such current harmonized European standards, the task of demonstrating conformity with the EHSRs is greatly simplified, and the manufacturer also benefits from the increased legal certainty. These standards are not legally required, however, their use is strongly recommended since proving conformity by alternative methods can be an extremely complex issue. These standards support the Machinery Directive and are produced by CEN (the European Committee for Standardization) in cooperation with ISO, and CENELEC (the European Committee for Electrotechnical Standardization) in cooperation with IEC.

A thorough, documented risk assessment must be conducted to ensure that all potential machine hazards are addressed. It is the responsibility of the machine manufacturer to ensure that all EHSRs are satisfied, even those that are not addressed by harmonized EN Standards.

Technical File

The manufacturer or his authorized representative must prepare a Technical File to provide evidence of conformity with the EHSRs. This file should include all relevant information such as test results, drawings, specifications, etc.

It is not essential that all the information is permanently available as hard copy but it must be possible to make the entire Technical File available for inspection on request from a competent authority (a body appointed by an EU country to monitor the conformity of machinery).

At the minimum, the following documentation must be included in a Technical File:

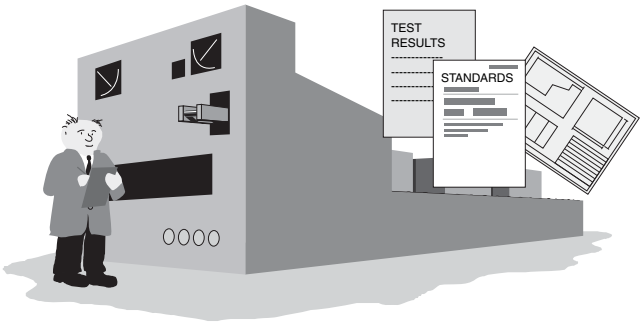


Figure 3: Document Assessment Results

1. Overall drawings of the equipment including control circuit drawings.
2. Detailed drawings, calculation notes, test results, etc. required for checking the conformity of the machinery with the EHSRs.
3. Risk assessment documentation, including a list of the essential health and safety requirements which apply to the machinery and a description of the protective measures implemented.
4. A list of the standards and other technical specifications used, indicating the essential health and safety requirements covered.
5. A description of methods adopted to eliminate hazards presented by the machinery.
6. If relevant, any technical reports or certificates obtained from a test facility or other body.
7. If conformity is declared with a Harmonized European Standard, any technical report giving test results for it.
8. A copy of the instructions for the machinery.
9. Where appropriate, the declaration of incorporation for included partly completed machinery and the relevant assembly instructions for such machinery.
10. Where appropriate, copies of the EC declaration of conformity of machinery or other products incorporated into the machinery.
11. A copy of the EC declaration of conformity.

For series manufacture, details of internal measures (quality systems, for example) to ensure all machinery produced remains in conformity:

- The manufacturer must carry out necessary research or tests on components, fittings or the completed machinery to determine whether by its design and construction it is capable of being erected and put into service safely.
- The technical file need not exist as a permanent single file, but it must be possible to assemble it to make it available in a reasonable time. It must be available for ten years following production of the last unit.

The technical file does not need to include detailed plans or any other specific information regarding sub-assemblies used for the manufacture of the machinery, unless they are essential to verify conformity with the EHSRs.

Conformity Assessment

Certain types of equipment are subject to special measures. This equipment is listed in Annex IV of the Directive and includes dangerous machines such as some woodworking machines, presses, injection molding machines, underground equipment, vehicle servicing lifts, etc.

Annex IV also includes certain safety components such as Protective devices designed to detect the presence of persons (e.g. light curtains) and logic units for ensuring safety functions.



Figure 4: Conformity Assessments

For Annex IV machines that are not in full conformity with the relevant Harmonized European Standards the manufacturer or his authorized representative must apply one of the following procedures:

1. **EC Type Examination**. A Technical File must be prepared and an example of the machine must submitted to a notified body (test house) for EC type examination. If it passes, the machine will be given an EC type examination certificate. The validity of the certificate must be reviewed every five years with the Notified Body.
2. **Full Quality Assurance**. A Technical File must be prepared and the manufacturer must operate an approved quality system for design, manufacture, final inspection and testing. The quality system must ensure conformity of the machinery with the provisions of this Directive. The quality system must be periodically audited by a Notified Body.

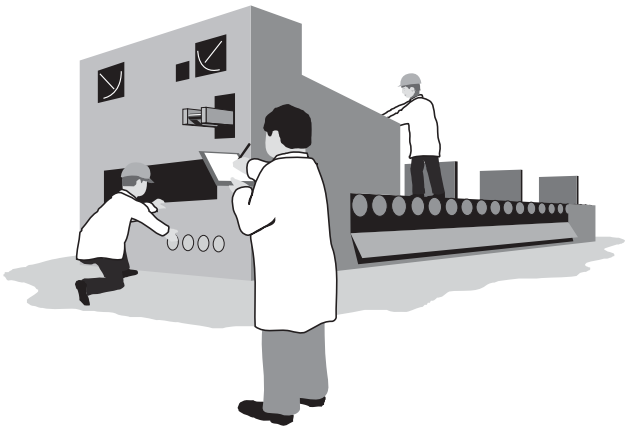


Figure 5: Notified Body Examinations

For machines that are not included in Annex IV or machines that are included in Annex IV but are in full conformity with the relevant Harmonized European Standards, the manufacturer or his authorized representative also has the option prepare the Technical and self assess and declare the conformity of the equipment. There must be internal checks to ensure that the manufactured equipment remains in conformity.

Notified Bodies

A network of notified bodies that communicate with each other and work to common criteria exists throughout the EU. Notified Bodies are appointed by governments (not by industry) and details of organizations with notified body status can be obtained from: *http://ec.europa.eu/enterprise/sectors/mechanical/machinery/index_en.htm*

EC Declaration of Conformity Procedure

The CE Marking must be applied to all machines supplied. The machines should also be supplied with an EC Declaration of Conformity.

CE

Figure 6: CE Mark

The CE Mark indicates that the machine conforms to all applicable European Directives and that the appropriate conformity assessment procedures have been completed. It is an offense to apply the CE Mark for the Machinery Directive unless the machine satisfies the relevant EHSRs.

The EC Declaration of Conformity must contain the following information:

- Business name and full address of the manufacturer and, where appropriate, the authorized representative;
- Name and address of the person authorized to compile the technical file, who must be established in the Community (in the case of a manufacturer outside the EU this may be the "Authorized Representative") ;
- Description and identification of the machinery, including generic denomination, function, model, type, serial number and commercial name;
- A sentence expressly declaring that the machinery fulfills all the relevant provisions of this Directive and where appropriate, a similar sentence declaring the conformity with other Directives and/or relevant provisions with which the machinery complies;
- Where appropriate, a reference to the harmonized standards used;
- Where appropriate, the reference to other technical standards and specifications used;
- (For an Annex IV machines) where appropriate, the name, address and identification number of the notified body which carried out the EC type-examination referred to in Annex IX and the number of the EC type-examination certificate;
- (For an Annex IV machines) where appropriate, the name, address and identification number of the notified body which approved the full quality assurance system referred to in Annex X;
- The place and date of the declaration;
- The identity and signature of the person empowered to draw up the declaration on behalf of the manufacturer or the authorized representative.

EC Declaration of Incorporation for Partly Completed Machinery

Where the equipment is supplied for assembly with other items to form a complete machine at a later date, a DECLARATION OF INCORPORATION should be issued with it. The CE mark should not be applied. The declaration should state that the equipment must not be put into service until the machine into which it has been incorporated has been declared in conformity. A Technical File must be prepared and the partly completed machinery must be supplied with information containing a description of the conditions which must be met with a view to correct incorporation in the final machinery, so as not to compromise safety.

This option is not available for equipment which can function independently or which modifies the function of a machine.

The Declaration of Incorporation must contain the following information:

- Business name and full address of the manufacturer of the partly completed machinery and, where appropriate, the authorized representative;
- Name and address of the person authorized to compile the relevant technical documentation, who must be established in the Community (in the case of a manufacturer outside the EU this may be the "Authorized Representative");
- Description and identification of the partly completed machinery including generic denomination, function, model, type, serial number and commercial name;
- A sentence declaring which essential requirements of this Directive are applied and fulfilled and that the relevant technical documentation is compiled in accordance with part B of Annex VII, and, where appropriate, a sentence declaring the conformity of the partly completed machinery with other relevant Directives;
- An undertaking to transmit, in response to a reasoned request by the national authorities, relevant information on the partly completed machinery. This shall include the method of transmission and shall be without prejudice to the intellectual property rights of the manufacturer of the partly completed machinery;
- A statement that the partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate;
- The place and date of the declaration;
- The identity and signature of the person empowered to draw up the declaration on behalf of the manufacturer or the authorized representative.

Machinery Supplied from Outside the EU—Authorized Representatives

If a manufacturer based outside the EU (or EEA) exports machinery into the EU they will need to appoint an Authorized Representative.

An Authorized Representative means any natural or legal person established in the European Community who has received a written mandate from the manufacturer to perform on his behalf all or part of the obligations and formalities connected with the Machinery Directive.

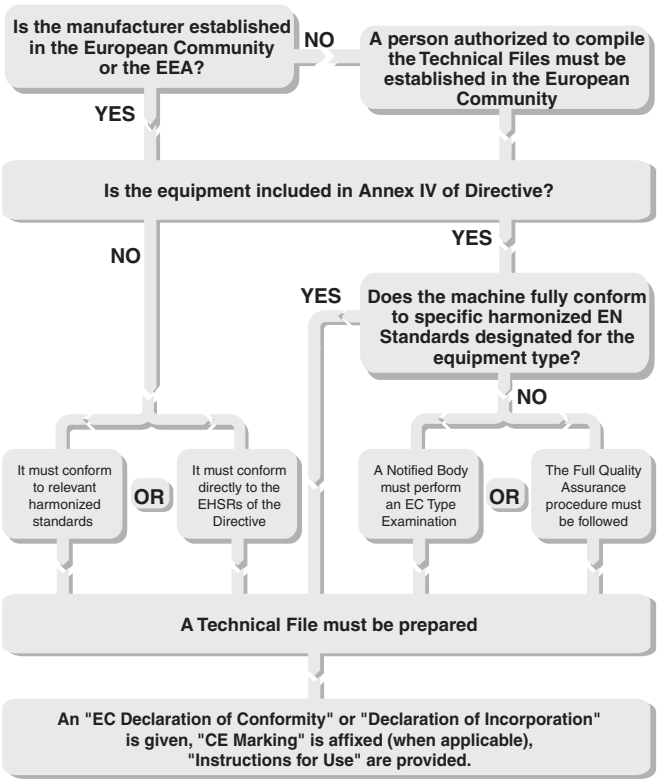


Figure 7: Overview of Procedures for the Machinery Directive

It is important to study the Directive (2006/42/EC) for full details.

The EU Use of Work Equipment Directive (U.W.E. Directive)

Whereas the Machinery Directive is aimed at suppliers, this Directive (89/655/EEC as amended by 95/63/EC, 2001/45/EC and 2007/30/EC) is aimed at users of machinery. It covers all industrial sectors and it places general duties on employers together with minimum requirements for the safety of work equipment. All EU countries are enacting their own forms of legislation to implement this Directive.

For example it is implementation in the UK under the name of The Provision and Use of Work Equipment Regulations (often abbreviated to P.U.W.E.R.). The form of implementation may vary between countries but the effect of the Directive is retained.

The articles of the Directive give details of which types of equipment and workplaces are covered by the Directive.

They also place general duties on employers such as instituting safe systems of working and providing suitable and safe equipment that must be properly maintained. Machine operators must be given proper information and training for the safe use of the machine.

New machinery (and second hand machinery from outside the EU) provided after January 1, 1993 should satisfy any relevant product directives, e.g., The Machinery Directive (subject to transitional arrangements). Second hand equipment from within the EU provided for the first time in the workplace must immediately provide minimum requirements given in an annex of the U.W.E. Directive.

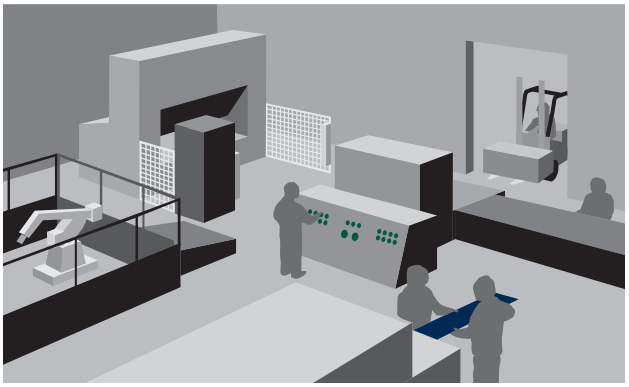


Figure 8: Directive Covers Use of Equipment

Note: Existing or second-hand machinery which is significantly overhauled or modified will be classified as new equipment, so the work carried out on it must ensure compliance with the Machinery Directive (even if it is for a company's own use).

Suitability of work equipment is an important requirement of the directive and it highlights the employer's responsibility to carry out a proper process of risk assessment.

It is a requirement that machinery must be properly maintained. This will normally mean that there must be a routine and planned preventive maintenance schedule. It is recommended that a log is compiled and kept up to date. This is especially important in cases where the maintenance and inspection of equipment contributes to the continuing safety integrity of a protective device or system.

The Annex of the U.W.E. Directive gives general minimum requirements applicable to work equipment.

If the equipment conforms to relevant product directives, e.g., The Machinery Directive, they will automatically comply with the corresponding machine design requirements given in the minimum requirements of the Annex.

Member states are allowed to issue legislation regarding the use of work equipment that goes beyond the minimum requirements of the U.W.E. Directive.

Detailed information on the Use of Work Equipment Directive can be found at the official EU website:
http://europa.eu/legislation_summaries/employment_and_social_policy/health_hygiene_safety_at_work/c11116_en.htm

U.S. Regulations

This section introduces some of the industrial machine guarding safety regulations in the U.S. This is only a starting point; readers must further investigate the requirements for their specific applications and take measures to ensure that their designs, uses and maintenance procedures and practices meet their own needs as well as national and local codes and regulations.

There are many organizations that promote industrial safety in the United States. These include:

1. Corporations, which use established requirements as well as establish their own internal requirements;
2. The Occupational Safety and Health Administration (OSHA);
3. Industrial organizations like the National Fire Protection Association (NFPA), the Robotics Industries Association (RIA), the Association of Manufacturing Technology (AMT) and the suppliers of safety products and solutions such as Rockwell Automation.

Occupational Safety and Health Administration

In the United States, one of the main drivers of industrial safety is the Occupational Safety and Health Administration (OSHA). OSHA was established in 1970 by an Act of the U.S. Congress. The purpose of this act is to provide safe and healthful working conditions and to preserve human resources. The act authorizes the Secretary of Labor to set mandatory occupational safety and health standards applicable to businesses affecting interstate commerce. This Act shall apply with respect to employment performed in a workplace in a State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, the Trust Territory of the Pacific Islands, Wake Island, Outer Continental Shelf Lands defined in the Outer Continental Shelf Lands Act, Johnston Island, and the Canal Zone.

Article 5 of the Act sets the basic requirements. Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees; and shall comply with occupational safety and health standards promulgated under this Act.

Article 5 also states that each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

The OSHA Act places the responsibility on both the employer and the employee. This is quite divergent from Machinery Directive, which requires suppliers to place machines on the market that are free from hazards. In the U.S., a supplier can sell a machine without any safeguarding. The user must add the safeguarding to make the machine safe. Although this was a common practice when the Act was approved, the trend is for suppliers to provide machines with the safeguarding, as designing safety into a machine is far more cost effective than adding the safeguarding after the machine is designed and built. Standards are now attempting to get the supplier and user to communicate requirements for safeguarding so that machines are made not only safe but more productive.

The Secretary of Labor has the authority to promulgate as an occupational safety or health standard any national consensus standard, and any established Federal standard, unless the promulgation of such a standard would not result in improved safety or health for specifically designated employees.

OSHA accomplishes this task by publishing regulations in Title 29 of the Code of Federal Regulation (29 CFR). Standards pertaining to industrial machinery are published by OSHA in Part 1910 of 29 CFR. They are freely available on the OSAH website at www.osha.gov. Unlike most standards, which are voluntary, the OSHA standards are laws.

Some of the important parts as they pertain to machine safety are as follows:

A General
B Adoption and Extension of Established Federal Standards
C General Safety and Health Provisions
H Hazardous Materials
I Personal Protective Equipment
J General Environmental Controls—includes Lockout/Tagout
O Machinery and Machine Guarding
R Special Industries
S Electrical

Some OSHA standards reference voluntary standards. The legal effect of incorporation by reference is that the material is treated as if it were published in full in the Federal Register. When a national consensus standard is incorporated by reference in one of the subparts, that standard is considered the law. For example, NFPA 70, a voluntary standard known as the US National Electric Code, is referenced in Subpart S. This makes the requirements in the NFPA70 standard mandatory.

The 29 CFR 1910.147, in Subpart J, covers the control of hazardous energy. This is commonly known as the Lockout/Tagout standard. The equivalent voluntary standard is ANSI Z244.1. Essentially, this standard requires power to the machine to be locked out when undergoing service or maintenance. The purpose is to prevent the unexpected energization or startup of the machine which would result in injury to employees.

Employers must establish a program and utilize procedures for affixing appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start up or release of stored energy in order to prevent injury to employees.

Minor tool changes and adjustments, and other minor servicing activities, which take place during normal production operations, are not covered by this standard if they are routine, repetitive, and integral to the use of the equipment for production, provided that the work is performed using alternative measures which provide effective protection. Alternative measures are safeguarding devices like light curtains, safety mats, gate interlocks and other similar devices connected to a safety system. The challenge to the machine designer and user is to determine what is “minor” and what is “routine, repetitive and integral.”

Subpart O covers “Machinery and Machine Guarding.” This subpart lists the general requirements for all machines as well as requirements for some specific machines. When OSHA was formed in 1970, it adopted many existing ANSI standards. For example B11.1 for mechanical power presses was adopted as 1910.217.

The 1910.212 is the general OSHA standard for machines. It states that one or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by the point of operation, ingoing nip points, rotating parts, flying chips and sparks. Guards shall be affixed to the machine where possible and secured elsewhere if for any reason attachment to the machine is not possible. The guard shall be such that it does not offer an accident hazard in itself.

The “point of operation” is the area on a machine where work is actually performed upon the material being processed. The point of operation of a machine, whose operation exposes an employee to injury, shall be guarded. The guarding device shall be in conformity with any appropriate standards or, in the absence of applicable specific standards, shall be so designed and constructed as to prevent the operator from having any part of his body in the danger zone during the operating cycle.

Subpart S (1910.399) states the OSHA electrical requirements. An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this Subpart S if it is accepted, certified, listed, labeled, or otherwise determined to be safe by a nationally recognized testing laboratory (NRTL).

What is Equipment? A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electrical installation.

What is “Listed”? Equipment is “listed” if it is of a kind mentioned in a list which, (a) is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment, and (b) states such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

As of August 2009, the following companies are recognized by OSHA as NRTLs:
Canadian Standards Association (CSA)
Communication Certification Laboratory, Inc. (CCL)
Curtis-Straus LLC (CSL)
FM Approvals LLC (FM)
Intertek Testing Services NA, Inc. (ITSNA)
MET Laboratories, Inc. (MET)
NSF International (NSF)
National Technical Systems, Inc. (NTS)
SGS U.S. Testing Company, Inc. (SGSUS)
Southwest Research Institute (SWRI)
TÜV America, Inc. (TÜVAM)
TÜV Product Services GmbH (TÜVPSG)
TÜV Rheinland of North America, Inc. (TÜV)
Underwriters Laboratories Inc. (UL)
Wyle Laboratories, Inc. (WL)

Some states have adopted their own local OSHAs. Twenty-four states, Puerto Rico and the Virgin Islands have OSHA-approved State Plans and have adopted their own standards and enforcement policies. For the most part, these States adopt standards that are identical to Federal OSHA. However, some States have adopted different standards applicable to this topic or may have different enforcement policies.

Employers must report incident history to OSHA. OSHA compiles incident rates and transmits the information to local offices, and uses this information to prioritize inspections. The key inspection drivers are:

- Imminent Danger
- Catastrophes and Fatalities
- Employee Complaints
- High Hazardous Industries
- Local Planned Inspections
- Follow-up Inspections
- National and Local Focus Programs

Violations of OSHA standards can result in fines. The schedule of fines is:

- Serious: up to $7000 per violation
- Other than Serious: discretionary but not more than $7000
- Repeat: up to $70,000 per violation
- Willful: up to $70,000 per violation
- Violations resulting in death: further penalties
- Failure to abate: $7000/day

The table below shows the top 14 OSHA citations from October 2004 to September 2005.

Standard	Description
1910.147	The control of hazardous energy (lockout/tagout)
1910.1200	Hazard communication
1910.212	General requirements for all machines
1910.134	Respiratory protection
1910.305	Wiring methods, components, and equipment for general use
1910.178	Powered industrial trucks
1910.219	Mechanical power transmission
1910.303	General requirements
1910.213	Woodworking machinery
19102.215	Abrasive wheel machinery
19102.132	General requirements
1910.217	Mechanical power presses
1910.095	Occupational noise exposure
1910.023	Guarding floor and wall openings and holes

Table 1

Canada Regulations

In Canada, Industrial Safety is governed at the Provincial level. Each province has its own regulations that are maintained and enforced. For example, Ontario established the Occupational Health and Safety Act, which sets out the rights and duties of all parties in the workplace. Its main purpose is to protect workers against health and safety hazards on the job. The Act establishes procedures for dealing with workplace hazards, and it provides for enforcement of the law where compliance has not been achieved voluntarily.

Within the Act there is regulation 851, Section 7 that defines the Pre-Start Health and Safety review. This review is a requirement within Ontario for any new, rebuilt or modified piece of machinery and a report needs to be generated by a professional engineer.

Standards

This section provides a list of some of the typical international and national standards that are relevant to machinery safety. It is not intended to form an exhaustive list but rather to give an insight on what machinery safety issues are the subject of standardization.

This section should be read in conjunction with the Regulation section.

The countries of the world are working towards global harmonization of standards. This is especially evident in the area of machine safety. Global safety standards for machinery are governed by two organizations: ISO and IEC. Regional and country standards are still in existence and continue to support local requirements but in many countries there has been a move toward using the international standards produced by ISO and IEC.

For example, the EN (European Norm) standards are used throughout the EEA countries. All new EN standards are aligned with, and in most cases have identical text with ISO and IEC standards.

IEC covers electrotechnical issues and ISO covers all other issues. Most industrialized countries are members of IEC and ISO. Machinery safety standards are written by working groups comprised of experts from many of the world's industrialized counties.

In most countries standards can be regarded as voluntary whereas regulations are legally mandatory. However standards are usually used as the practical interpretation of the regulations. Therefore the worlds of standards and regulations are closely interlinked.

ISO (International Organization for Standardization)

ISO is a non-governmental organization comprised of the national standards bodies of most of the countries of the world (157 countries at the time of this printing). A Central Secretariat, located in Geneva, Switzerland, coordinates the system. ISO generates standards for designing, manufacturing and using machinery more efficiently, safer and cleaner. The standards also make trade between countries easier and fairer.

ISO standards can be identified by the three letters ISO.

The ISO machine standards are organized in the same fashion as the EN standards, three levels: Type A, B and C (see the later section on EN Harmonized European Standards).

For more information, visit the ISO website: *www.iso.org*

IEC (International Electrotechnical Commission)

The IEC prepares and publishes international standards for electrical, electronic and related technologies. Through its members, the IEC promotes international cooperation on all questions of electrotechnical standardization and related matters, such as the assessment of conformity to electrotechnical standards.

For more information, visit the IEC website: *www.iec/ch*.

EN Harmonized European Standards

These standards are common to all EEA countries and are produced by the European Standardization Organizations CEN and CENELEC. Their use is voluntary but designing and manufacturing equipment to them is the most direct way of demonstrating compliance with the EHSRs of the Machinery Directive.

They are divided into 3 types: A, B and C standards.

Type A. STANDARDS: Cover aspects applicable to all types of machines.

Type B. STANDARDS: Subdivided into 2 groups.

Type B1 STANDARDS: Cover particular safety and ergonomic aspects of machinery.

Type B2 STANDARDS: Cover safety components and protective devices.

Type C. STANDARDS: Cover specific types or groups of machines.

It is important to note that complying with a C Standard gives automatic presumption of conformity with the EHSRs. In the absence of a suitable C Standard, A and B Standards can be used as part or full proof of EHSR conformity by pointing to compliance with relevant sections.

Agreements have been reached for cooperation between CEN/CENELEC and bodies such as ISO and IEC. This should ultimately result in common worldwide standards. In most cases an EN Standard has a counterpart in IEC or ISO. In general the two texts will be the same and any regional differences will be given in the forward of the standard.

This section lists some of the EN, ISO, IEC and other national and regional Standards relevant to machinery safety. Where an EN standard is shown in brackets it is identical or very closely aligned with the ISO or IEC standard. For a complete list of EN Machinery Safety standards go to:
http://ec.europa.eu/enterprise/sectors/mechanical/machinery/index_en.htm

ISO and EN Standards (Type A)

EN ISO 12100

Safety of machinery. Basic concepts, general principles for design. Pts 1 & 2

This is an A standard which outlines all the basic principles including risk assessment, guarding, interlocking, emergency stops, trip devices, safety distances, etc. It references to other standards that provide greater levels of detail.

In the near future it is likely that EN ISO 12100 and EN ISO 14121 will be combined into one standard.

EN ISO 14121

Principles for risk assessment.

This principle outlines the fundamentals of assessing the risks during the life of the machinery. It summarizes methods for hazard analysis and risk estimation.

An ISO Technical Report: ISO/TR 14121-2 is also available. It gives practical guidance and examples of methods for risk assessment.

ISO and EN Standards (Type B)

EN ISO 11161

Safety of Integrated Manufacturing Systems—Basic Requirements.

This standard was published in its revised form in 2007. It was significantly updated making it very useful for contemporary integrated machinery.

EN ISO 13849-1:2008 Safety related parts of control systems—Pt 1: General principles for design

This standard is the result of the significant revision of the old EN 954-1 (which is due for withdrawal at the end of 2011). It introduced many new aspects for Functional Safety of control systems. The term “PL” (Performance Level) is used to describe the level of integrity of a system or a subsystem.

It is available as an alternative to IEC/EN 62061 (see later). Note that EN ISO 13849-1 covers all technologies of control system whereas IEC/EN 62061 only covers electrical technology.

EN ISO 13849-1 is intended to provide a direct transition path from the categories of the previous EN 954-1. It has a relatively simple methodology compared to IEC/EN 62061 but this is at the expense of some constraints and restrictions. Either the revised ISO/EN 13849-1 or IEC/EN 62061 can be applied to machinery electrical safety related systems and the user should choose whichever one is best suited to their needs but EN ISO 13849-1 is often preferred when transitioning from Categories.

Note: Recent to the time of publication of this text, CEN (European Committee for Standardisation) announced that the final date for presumption of conformity of EN 954-1 will be extended to the end of 2011 to facilitate transition to the later standards. This replaces the original date of December 29, 2009.

For the latest information on the use and status of EN 954-1 visit: *http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx*. In the meantime it is advised that the extension of the transition period is used to move over to the use of the later standards (EN ISO 13849-1 or IEC/EN 62061) in a timely manner.

EN ISO 13849-2

Safety related parts of control systems—Pt 2: Validation

This standard provides details for validation of safety related parts of control systems. It has annexes that give details safety components, principles and fault exclusion.

EN ISO 13850

Emergency Stop devices, functional aspects—Principles for design.

Provides design principles and requirements.

ISO 13851 (EN 574)

Two-hand control devices—Functional aspects—Principles for design.

Provides requirements and guidance on the design and selection of two-hand control devices, including the prevention of defeat and the avoidance of faults.

EN ISO 13857

Safety distances to prevent danger zones being reached by the upper and lower limbs.

Provides data for calculation of safe aperture sizes and positioning for guards, etc.

ISO 13854 (EN 349)

Minimum distances to avoid crushing parts of the human body.

Provides data for calculation of safe gaps between moving parts, etc.

ISO 13855 (EN 999)

The positioning of protective equipment in respect to approach speeds of parts of the human body.

Provides methods for designers to calculate the minimum safety distances from a hazard for specific safety devices, in particular for electrosensitive devices (e.g., light curtains), pressure sensitive mats/floors and two-hand controls. It contains a principle for the positioning of safety devices based on approach speed and machine stopping time that can reasonably be extrapolated to cover interlocked guard doors without guard locking.

ISO 13856-1 (EN 1760-1)

Pressure Sensitive Safety Devices—Pt 1: Mats & Floors.

Provides requirements and test procedures.

ISO 13856-2 (EN 1760-2)

Pressure Sensitive Safety Devices—Pt 2: Edges & Bars.

Provides requirements and test procedures

ISO 14118 (EN 1037)

Prevention of unexpected start-up—Isolation and energy dissipation

Defines measures aimed at isolating machines from power supplies and dissipating stored energy to prevent unexpected machine startup and allow safe intervention with machinery.

ISO 14119 (EN 1088)

Interlocking devices associated with guards—Principles for design and selection.

Provides principles for the design and selection of interlocking devices associated with guards.

In order to verify mechanical switches it refers to IEC 60947-5-1—Low voltage switch gear—Pt 5: Control circuit devices and switching elements—Section 1: Electromechanical control circuit devices.

In order to verify non-mechanical switches it refers to IEC 60947-5-3—Particular requirements for proximity devices with defined behavior under fault conditions.

ISO 14120 (EN 953)

General Requirements for the Design and Construction of Guards.

Provides definitions, descriptions and design requirements for fixed and movable guards.

ISO and EN Standards (Type C)

There is a large range of Type C Standards that cover specific types of machinery. For example:

EN ISO 10218-1

Industrial robots

EN 415-4

Safety of packaging machines. Palletizers and depalletizers.

IEC and EN Standards

IEC/EN 60204-1

Electrical equipment of machines—Pt 1 General requirements.

This is a very important standard that outlines recommendations for safety related aspects of wiring and electrical equipment on machines. A significantly revised version was published in 2006. This revision removed the former preference for electromechanical safety circuits.

IEC/EN 61508

Functional safety of electrical, electronic and programmable electronic safety-related systems.

This standard is important because it contains the requirements and provisions that are necessary for the design of complex electronic and programmable systems and subsystems. The standard is generic so it is not restricted to the machinery sector. It is a lengthy and complex document comprising seven parts. Within the machinery sector, its use is mostly for the design of complex devices such as safety PLCs. For system level design and integration aspects for machinery the sector specific standards such as IEC/EN 62061 or EN ISO 13849-1 are probably the most suitable. IEC 61508 has mapped out the approach for a new generation of sector and product specific standards that is now emerging. It introduced the term SIL (safety integrity level) and gives a hierarchy of 4 SILs which are applied to a safety function. SIL 1 is the lowest and SIL 4 is the highest. SIL 4 is not usually applicable to the machinery sector because it is intended to be related to very high risk levels more associated with sectors such as petrochemical or nuclear.

IEC 62061 (EN 62061)

Functional safety of safety related electrical, electronic and programmable electronic control systems.

This standard is one of the new generations of standards that use the term SIL (safety integrity level). It is the machinery specific implementation of IEC/EN 61508. It specifies requirements and makes recommendations for the design, integration and validation of electrical safety related control systems for machines. This standard provides an alternative approach to EN ISO 13849-1 and is intended to be useful for the increasingly complex safety functionality required for today's current and future machinery For less complex safety functionality EN ISO 13849-1 may be easier to implement. The use of these standards requires the availability of data such as PFH_D (probability of dangerous failure per hour) or MTTFd (mean time to dangerous failure).

IEC 61496 (EN 61496)

Electro-sensitive protective equipment Pt 1: General requirements and tests.

General requirements and tests.

Pt 2: Particular requirements for equipment using active optoelectronic protective devices.

Part 1 gives requirements and test procedures for the control and monitoring aspects for electrosensitive protective equipment. Subsequent parts deal with aspects particular to the sensing side of the system. Part 2 gives particular requirements for safety light curtains.

IEC 61800-5-2 (EN 61800-5-2)

Functional safety of power drive systems.

This standard deals with drives that have safety functionality.

US Standards

OSHA Standards

Where possible, OSHA promulgates national consensus standards or established Federal standards as safety standards. The mandatory provisions (e.g., the word shall implies mandatory) of the standards, incorporated by reference, have the same force and effects as the standards listed in Part 1910. For example, the national consensus standard NFPA 70 is listed as a reference document in Appendix A of Subpart S-Electrical of Part 1910 of 29 CFR. NFPA 70 is a voluntary standard, which was developed by the National Fire Protection Association (NFPA). NFPA 70 is also known as the National Electric Code (NEC). By incorporation, all the mandatory requirements in the NEC are mandatory by OSHA.

The following is a list of some of the OSHA standards relevant to machinery safety,

1910 Subpart O - Machinery and Machine Guarding

1910.211 - Definitions.

1910.212 - General requirements for all machines.

1910.213 - Woodworking machinery requirements.

1910.214 - Cooperage machinery. [Reserved]

1910.215 - Abrasive wheel machinery.

1910.216 - Mills and calendars in the rubber and plastics industries.

1910.217 - Mechanical power presses.

1910.217 App A - Mandatory requirements for certification/ validation of safety systems for presence sensing device initiation of mechanical power presses

1910.217 App B - Nonmandatory guidelines for certification/ validation of safety systems for presence sensing device initiation of mechanical power presses

1910.217 App C - Mandatory requirements for OSHA recognition of third-party validation organizations for the PSDI standard

1910.217 App D - Nonmandatory supplementary information

1910.218 - Forging machines.

1910.219 - Mechanical power

1910.255 - Resistance welding.

1910 Subpart R - Special Industries

1910.261 - Pulp, paper, and paperboard mills.

1910.262 - Textiles.

1910.263 - Bakery equipment.

1910.264 - Laundry machinery and operations.

1910.265 - Sawmills.

1910.266 - Logging operations.

ANSI Standards

The American National Standards Institute (ANSI) serves as the administrator and coordinator of the United States private sector voluntary standardization system. It is a private, nonprofit, membership organization supported by a diverse constituency of private and public sector organizations.

ANSI, itself, does not develop standards; it facilitates the development of standards by establishing consensus among qualified groups. ANSI also ensures that the guiding principles of consensus, due process and openness are followed by the qualified groups. Below is a partial list of industrial safety standards that can be obtained by contacting ANSI.

These standards are categorized as either application standards or construction standards. Application standards define how to apply a safeguarding to machinery. Examples include ANSI B11.1, which provides information on the use of machine guarding on power presses, and ANSI/RIA R15.06, which outlines safeguarding use for robot guarding.

National Fire Protection Association

The National Fire Protection Association (NFPA) was organized in 1896. Its mission is to reduce the burden of fire on the quality of life by advocating scientifically based consensus codes and standards, research and education for fire and related safety issues. The NFPA sponsors many standards to help accomplish its mission. Two very important standards related to industrial safety and safe-guarding are the National Electric Code (NEC) and Electrical Standard for Industrial Machinery.

The National Fire Protection Association has acted as sponsor of the NEC since 1911. The original code document was developed in 1897 as a result of the united efforts of various insurance, electrical, architectural, and allied interests. The NEC has since been updated numerous times; it is revised about every three years. Article 670 of the NEC covers some details on industrial machinery and refers the reader to the Electrical Standard for Industrial Machinery, NFPA 79.

NFPA 79 applies to electrical/electronic equipment, apparatus, or systems of industrial machines operating from a nominal voltage of 600 volts or less. The purpose of NFPA 79 is to provide detailed information for the application of electrical/electronic equipment, apparatus, or systems supplied as part of industrial machines that will promote safety to life and property. NFPA 79, which was officially adopted by ANSI in 1962, is very similar in content to the standard IEC 60204-1.

Machines, which are not covered by specific OSHA standards, are required to be free of recognized hazards which may cause death or serious injuries. These machines must be designed and maintained to meet or exceed the requirements of applicable industry standards. NFPA 79 is a standard that would apply to machines not specifically covered by OSHA standards.

ANSI/NFPA 70

US National Electrical Code

ANSI/NFPA 70E

Electrical Safety Requirements for Employee Workplaces

ANSI/NFPA 79

Electrical Standard for Industrial Machinery

Association for Manufacturing Technology

ANSI B11.1

Machine Tools - Mechanical Power Presses - Safety Requirements for Construction, Care, and Use

ANSI B11.2

Machine Tools - Hydraulic Power Presses, Safety Requirements for Construction, Care, and Use

ANSI B11.3

Power Press Brakes, Safety Requirements for the Construction, Care, and Use

ANSI B11.4

Machine Tools - Shears - Safety Requirements for Construction, Care, and Use

ANSI B11.5

Machine Tools - Iron Workers - Safety Requirements for Construction, Care, and Use

ANSI B11.6

Lathes, Safety Requirements for the Construction, Care, and Use

ANSI B11.7

Machine Tools - Cold Headers and Cold Formers, Safety Requirements for Construction, Care, and Use

ANSI B11.8

Drilling, Milling, and Boring Machines, Safety Requirements for the Construction, Care, and Use

ANSI B11.9

Grinding Machines, Safety Requirements for the Construction, Care, and Use

ANSI B11.10

Metal Sawing Machines, Safety Requirements for Construction, Care, and Use

ANSI B11.11

Gear Cutting Machines, Safety Requirements for the Construction, Care, and Use

ANSI B11.12

Machine Tools - Roll-Forming and Roll-Bending Machines - Safety Requirements for the Construction, Care, and Use

ANSI B11.13

Machine Tools - Single- and Multiple-Spindle Automatic Bar and Chucking Machines - Safety Requirements for Construction, Care and Use

ANSI B11.14

Machine Tools - Coil-Slitting Machines Safety Requirements for Construction, Care, and Use – Withdrawn and rolled into B11.18

ANSI B11.15

Pipe, Tube, and Shape Bending Machines, Safety Requirements for Construction, Care, and Use

ANSI B11.16

Metal Powder Compacting Presses, Safety Requirements for Construction, Care, and Use

ANSI B11.17

Machine Tools - Horizontal Hydraulic Extrusion Presses - Safety Requirements for Construction, Care, and Use

ANSI B11.18

Machine Tools - Machines and Machinery Systems for Processing Strip, Sheet, or Plate from Coiled Configuration - Safety Requirements for Construction, Care, and Use

ANSI B11.19

Machine Tools - Safeguarding When Referenced by Other B11 Machine Tool Safety Standards-Performance Criteria for the Design, Construction, Care and Operation

ANSI B11.20

Machine Tools - Manufacturing Systems/Cells – Safety Requirements for Construction, Care, and Use

ANSI B11.21

Machine Tools - Machine Tools Using Lasers for Processing Materials - Safety Requirements for Design, Construction, Care, and Use

ANSI B11.TR3

Risk assessment and risk reduction – A guide to estimate, evaluate and reduce risks associated with machine tools

ANSI B11.TR4

This technical report covers the application of programmable controllers to safety applications.

ANSI B11.TR6

This technical report, currently in development, will provide circuit examples of safety functions to accommodate various levels of risk Reduction.

ANSI ISO 12100

Safety of machinery. Basic concepts, general principles for design. Pts -1 and -2

The standard ISO 12100 has been adopted in the US by AMT as an identical ANSI standard. ISO 12100 is a globally applicable top level basic principles standard that forms the framework for most of the ISO, IEC and EN machinery safety standards. It provides a risk assessment approach as opposed to a prescriptive and restrictive approach. The aim is to avoid cost and trade barrier problems caused by a multiplicity of different national standards covering the same subject in different ways.

Robot Industries Association

ANSI RIA R15.06

Safety Requirements for Industrial Robots and Robot Systems

ANSI RIA R15.06

Safety Requirements for Industrial Robots and Robot Systems

Packaging Machinery Manufacturer's Institute

ANSI PMMI B155.1

Safety Requirements for Packaging Machinery and Packaging-Related Converting Machinery

The packaging standard was recently revised to incorporate risk assessment and risk reduction.

American Society of Safety Engineers

Z224.1

Control of Hazardous Energy, Lockout/Tag out and Alternative Methods

This standard is similar to OSHA 1910.147. It provides a method (risk assessment) to determine the appropriate alternative method when energy cannot be locked out.

Society of Plastics Industry

ANSI B151.1

Horizontal Injection Molding Machines – Safety Requirements for Manufacture, Care and Use

ANSI B151.15

Extrusion Blow Molding Machines – Safety Requirements

ANSI B151.21

Injection Blow Molding Machines - Safety Requirements

ANSI B151.26

Plastics Machinery - Dynamic Reaction - Injection Molding Machines - Safety Requirements for the Manufacture, Care and Use

ANSI B151.27

Plastics Machinery - Robots used with Horizontal Injection Molding Machines - Safety Requirements for the Integration, Care and Use

ANSI B151.28

Plastics Machinery - Machines to Cut, Slit, of Buff Plastic Foams - Safety Requirements for the Manufacture, Care and Use

Canada Standards

CSA Standards reflect a national consensus of producers and users – including manufactures, consumers, retailers, unions and professional organizations, and government agencies. The standards are used widely by industry and commerce and often adopted by municipal, provincial, and federal governments in their regulations, particularly in the fields of health, safety, building and construction, and the environment.

Individuals, companies, and associations across Canada indicate their support for CSA's standards development by volunteering their time and skills to CSA Committee work and supporting the Association's objectives through sustaining memberships. The more than 7000 committee volunteers and the 2000 sustaining memberships together form CSA's total membership.

The Standards Council of Canada is the coordinating body of the National Standards system, a federation of independent, autonomous organizations working towards the further development and improvement of voluntary standardization in the national interest.

CSA Z432-04

Safeguarding of Machinery

CSA Z434-03

Industrial Robots and Robot Systems - General Safety Requirements

CSA Z460-05

Control of hazardous energy – Lockout and other methods

CSA Z142-02

Code for Power Press Operation: Health, Safety, and Guarding Requirements

Australia Standards

Most of these standards are closely aligned with the equivalent ISO/IEC/EN standards

Standards Australia Limited
286 Sussex Street,
Sydney,
NSW 2001
Phone: +61 2 8206 6000
Email: mail@standards.org.au
Website: www.standards.org.au

To purchase copies of standards:

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AS 4024.1-2006

Safeguarding of machinery. Part 1: General principles

AS 4024.1101-2006 Terminology – General

AS 4024.1201-2006 Basic terminology and methodology

AS 4024.1202-2006 Technical principles

AS 4024.1301-2006 Principles of risk assessment

AS 4024.1302-2006 Reduction of risks to health and safety from hazardous substances emitted by machinery

AS 4024.1401-2006 Design principles – Terminology and general principles

AS 4024.1501-2006 Design of safety related parts of control systems – General principles

AS 4024.1502-2006 Design of safety related parts of control systems – Validation

AS 4024.1601-2006 General requirements for the design and construction of fixed and movable guards

AS 4024.1602-2006 Principles for the design and selection of interlocks

AS 4024.1603-2006 Prevention of unexpected start-up

AS 4024.1604-2006 Emergency stop – Principles for design

AS 4024.1701-2006 Basic human body measurements for technological design

AS 4024.1702-2006 Principles for determining the dimensions required for openings for whole body access to machinery

AS 4024.1703-2006 Principles for determining the dimensions required for access openings

AS 4024.1704-2006 Anthropometric data

AS 4024.1801-2006 Safety distances – Upper limbs

AS 4024.1802-2006 Safety distances – Lower limbs

AS 4024.1803-2006 Minimum gaps to prevent crushing of parts of the human body

AS 4024.1901-2006 General principles for human interaction with displays and control actuators

AS 4024.1902-2006 Displays

AS 4024.1903-2006 Control actuators

AS 4024.1904-2006 Requirements for visual, auditory and tactile signs

AS 4024.1905-2006 Requirements for marking

AS 4024.1906-2006 Requirements for the location and operation of actuators

AS 4024.1907-2006 System of auditory and visual danger and information signals

AS4024.2-1998

Safeguarding of machinery. Part 2: Installation and commissioning requirements for electro-sensitive systems—Optoelectronic devices

The basis of this standard is IEC 61496-1 and -2. Part 2 covers the installation and commissioning of light curtains specifically related to machinery safety.

AS 4024.3-1998

Safeguarding of machinery. Part 3: Manufacturing and testing requirements for electro-sensitive systems— Optoelectronic devices

The basis of this standard is IEC 61496-1 and -2. Part 3 covers the manufacturing and testing of light curtains specifically related to machinery safety.

AS4024.4-1998

Safeguarding of machinery. Part 4: Installation and commissioning requirements for electro-sensitive systems—Pressure-sensitive devices

The basis of this standard is EN 1760-1 and EN 1760-2. Part 4 covers the installation and commissioning of mats, floors, edges and bars that are used with machinery, regardless of the energy used.

AS 4024.5-1998

Safeguarding of machinery. Part 5: Manufacturing and testing requirements for electro-sensitive systems— Pressure-sensitive devices

The basis of this standard is EN1760-1 and EN1760-2. Part 5 covers the manufacturing and testing mats, floors, edges and bars that are used with machinery, regardless of the energy used.

Safety Strategy

From a purely functional point of view the more efficiently a machine performs its task of processing material then the better it is. But, in order for a machine to be viable it must also be safe. Indeed safety must be regarded as a prime consideration.

In order to devise a proper safety strategy there must be two key steps, which work together as shown in Figure 9.

Risk Assessment based on a clear understanding of the machine limits and functions and the tasks that may be required to be performed at the machine throughout its life.

Risk Reduction is then performed if necessary and safety measures are selected based on the information derived from the risk assessment stage.

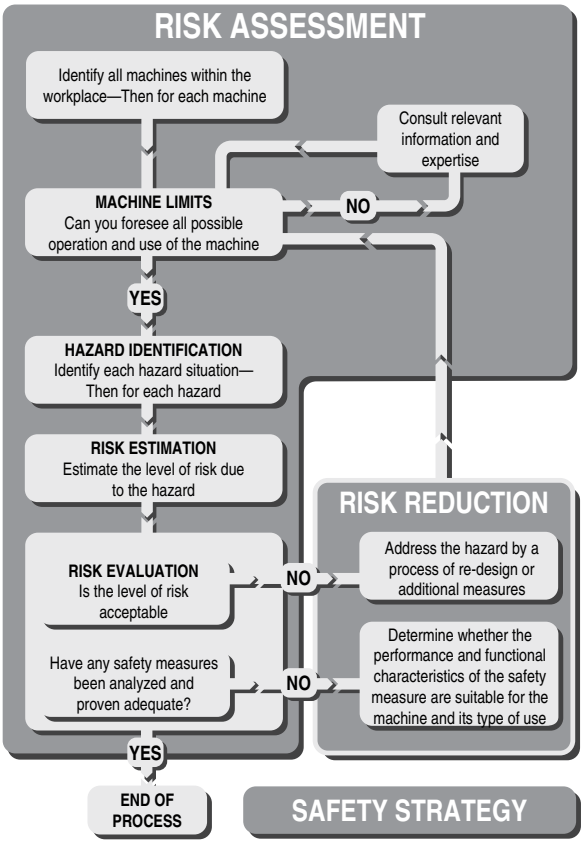


Figure 9: Safety Strategy

The manner in which this is done is the basis of the Safety Strategy for the machine.

We need a checklist to follow and ensure that all aspects are considered, and that the overriding principle does not become lost in the detail. The whole process should be documented. Not only will this ensure a more thorough job, but it will also make the results available for checking by other parties.

This section applies both to machine manufacturers and to machine users. The manufacturer needs to ensure that his machine is capable of being used safely. The risk assessment should be started at the machine design phase and it should take account of all the foreseeable tasks that will need to be performed on the machine. This task based approach at the early iterations of the risk assessment is very important. For example, there may be a regular need for adjustment of moving parts at the machine. At the design phase it should be possible to design in measures that will allow this process to be carried out safely. If it is missed at the early stage it may be difficult or impossible to implement at later stage. The result could be that the adjustment of moving parts still has to be performed but must be done in a manner that is either unsafe or inefficient (or both). A machine on which all tasks have been taken account of during the risk assessment will be a safer machine and a more efficient machine.

The user (or employer) needs to ensure that the machines in their working environment are safe. Even if a machine has been declared safe by the manufacturer, the machine user should still perform a risk assessment to determine whether the equipment is safe in their environment. Machines are often used in circumstances unforeseen by the manufacturer. For example, a milling machine used in a school workshop will need additional considerations to one that is used in an industrial tool room.

It should also be remembered that if a user company acquires two or more independent machines and integrates them into one process they are the manufacturer of the resulting combined machine.

So now let us consider the essential steps on the route to a proper safety strategy. The following can be applied to an existing factory installation or a single new machine.

Risk Assessment

It is wrong to regard risk assessment as a burden. It is a helpful process that provides vital information and empowers the user or designer to take logical decisions about ways of achieving safety.

There are various standards that cover this subject. ISO 14121: “Principles for risk assessment” and ISO 12100: “Safety of machinery—Basic principles” contain the most globally applied guidance.

Which ever technique is used to carry out a risk assessment, a cross functional team of people will usually produce a result with wider coverage and better balance than one individual.

Risk assessment is an iterative process; it will be performed at different stages of the machine life cycle. The information available will vary according to the stage of the life cycle. For example, a risk assessment conducted by a machine builder will have access to every detail of the machine mechanisms and construction materials but probably only an approximate assumption of the machine’s ultimate working environment. A risk assessment conducted by the machine user would not necessarily have access to the in-depth technical details but will have access to every detail of the machines working environment. Ideally the output of one iteration will be the input for the next iteration.

Machine Limit Determination

This involves collecting and analyzing information regarding the parts, mechanisms and functions of a machine. It will also be necessary to consider all the types of human task interaction with the machine and the environment in which the machine will operate. The objective is to get a clear understanding of the machine and its usage.

Where separate machines are linked together, either mechanically or by control systems, they should be considered as a single machine, unless they are “zoned” by appropriate protective measures.

It is important to consider all limits and stages of the life of a machine including installation, commissioning, maintenance, decommissioning, correct use and operation as well as the consequences of reasonably foreseeable misuse or malfunction.

Task and Hazard Identification

All the hazards at the machine must be identified and listed in terms of their nature and location. Types of hazard include crushing, shearing, entanglement, part ejection, fumes, radiation, toxic substances, heat, noise, etc.

The results of the task analysis should be compared with the results of the hazard identification. This will show where there is a possibility for the convergence of a hazard and a person i.e. a hazardous situation. All the hazardous situations should be listed. It may be possible that the same hazard could produce different type of hazardous situation depending on the nature of the person or the task. For example, the presence of a highly skilled and trained maintenance technician may have different implications than the presence of an unskilled cleaner who has no knowledge of the machine. In this situation if each case is listed and addressed separately it may be possible to justify different protective measures for the maintenance technician than the ones for the cleaner. If the cases are not listed and addressed separately then the worst case should be used and the maintenance and the cleaner will both be covered by the same protective measure.

Sometimes it will be necessary to carry out a general risk assessment on an existing machine that already has protective measures fitted (e.g., a machine with dangerous moving parts protected by an interlocked guard door). The dangerous moving parts are a potential hazard that may become an actual hazard in the event of failure of the interlocking system. Unless that interlock system has already been validated (e.g., by risk assessment or design to an appropriate standard), its presence should not be taken into account.

Risk Estimation

This is one of the most fundamental aspects of risk assessment. There are many ways of tackling this subject and the following pages illustrate the basic principles.

Any machinery that has potential for hazardous situations presents a risk of a hazardous event (i.e. of harm). The greater the amount of risk, the more important it becomes to do something about it. At one hazard the risk could be so small that we can tolerate and accept it but at another hazard the risk could be so large that we need to go to extreme measures to protect against it. Therefore in order to make a decision on "if and what to do about the risk," we need to be able to quantify it.

Risk is often thought of solely in terms of the severity of injury at an accident. Both the severity of potential harm AND the probability of its occurrence have to be taken into account in order to estimate the amount of risk present.

The suggestion for risk estimation given on the following pages is not advocated as the definitive method as individual circumstances may dictate a different approach. IT IS INTENDED ONLY AS A GENERAL GUIDELINE TO ENCOURAGE A METHODICAL AND DOCUMENTED STRUCTURE.

The point system used has not been calibrated for any particular type of application therefore is not necessarily suitable for any specific application. ISO TR (Technical Report) 14121-2 "Risk assessment – Practical guidance and examples of methods" provides practical guidance and some shows different methods for quantification of risk.

The following factors are taken into account:

- THE SEVERITY OF POTENTIAL INJURY.
- THE PROBABILITY OF ITS OCCURRENCE.

The probability of occurrence includes two factors:

- FREQUENCY OF EXPOSURE.
- PROBABILITY OF INJURY.

Dealing with each factor independently we will assign values to each of these factors.

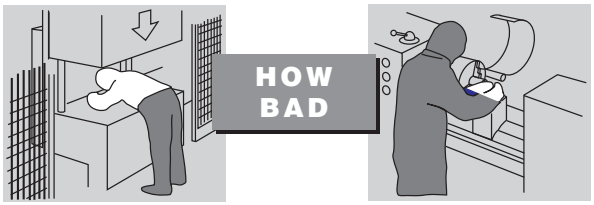
Make use of any data and expertise available to you. You are dealing with all stages of machine life, so to avoid too much complexity base your decisions on the worst case for each factor.

It is also important to retain common sense. Decisions need to take account of what is feasible, realistic and plausible. This is where a cross functional team approach is valuable.

Remember, for the purposes of this exercise you should usually not take account of any existing protective system. If this risk estimation shows that a protective system is required there are some methodologies as shown later in this chapter that can be used to determine the characteristics required.

1. Severity of potential injury

For this consideration we are presuming that the accident or incident has occurred, perhaps as a result of the hazards shown in Figure 10. Careful study of the hazard will reveal what is the most severe injury possible.



In this example most severe injury would be "fatal."

In this example the probable most severe injury would be "serious," with the possibility of bruising, breakage, finger amputation or injury from ejected chuck key, etc.

Figure 10: Potential Injury

Remember: For this consideration we are presuming that an injury is inevitable and we are only concerned with its severity. You should assume that the operator is exposed to the hazardous motion or process.

The severity of injury should be assessed as:

- **FATAL:** Death
- **MAJOR**: (Normally irreversible) Permanent disability, loss of sight, limb amputation, respiratory damage, etc.
- **SERIOUS**: (Normally reversible) Loss of consciousness, burns, breakages, etc.
- **MINOR**: Bruising, cuts, light abrasions, etc.

Each description could be assigned a points value (shown in Figure 11).

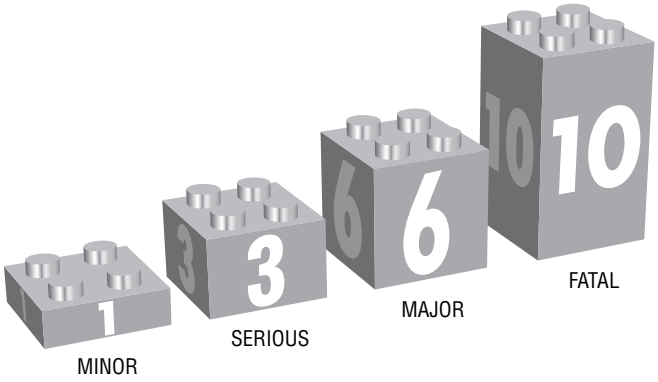


Figure 11: Points Assigned to Severity

2. Frequency of exposure

Frequency of exposure answers the question of how often is the operator or the maintenance person exposed to the hazard (Figure 12).

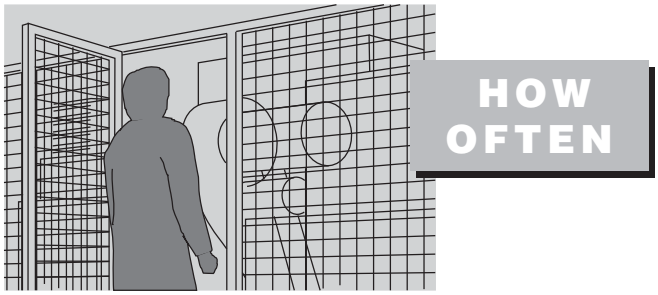


Figure 12: Frequency of Exposure

The frequency of exposure to hazard can be classified as:

- **FREQUENT**: Several times per day
- **OCCASIONAL**: Daily
- **SELDOM**: Weekly or less

Each description could be assigned a points value (shown in Figure 13).

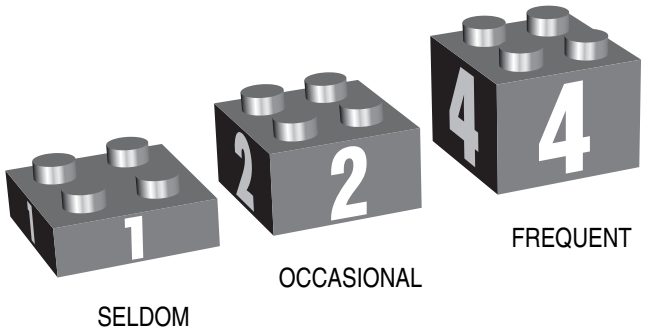
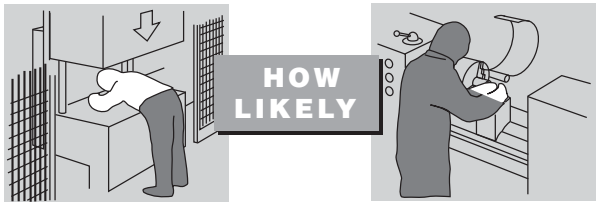


Figure 13: Points Assigned to Frequency of Exposure

3. Probability of injury

You should assume that the operator is exposed to the hazardous motion or process (Figure 14).



In this example the probability of injury could be rated as "certain" because of the amount of body in the hazard area and the speed of machine operation.

In this example the probability of injury may be rated as "possible" as there is minimal contact between the hazard and the operator. There may be time to withdraw from the danger.

Figure 14: How Likely

By considering the manner in which the operator is involved with the machine and other factors (speed of start up, for example) the probability of injury can be classified as:

- Unlikely
- Probable
- Possible
- Certain

Each description could be assigned a points value shown in Figure 15.

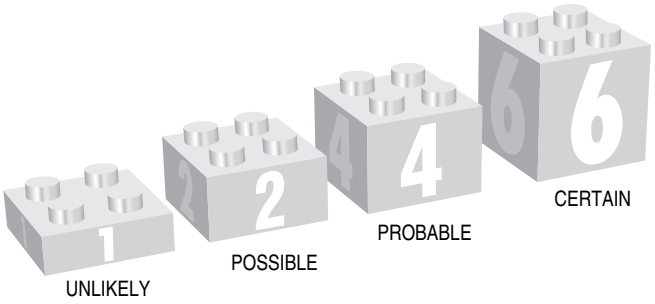


Figure 15: Points Assigned to Probability of Injury

All headings are assigned a value and they are now added together to give an initial estimate. Figure 16 shows the sum of the three components adds up to a value of 13. But we must consider a few more factors.

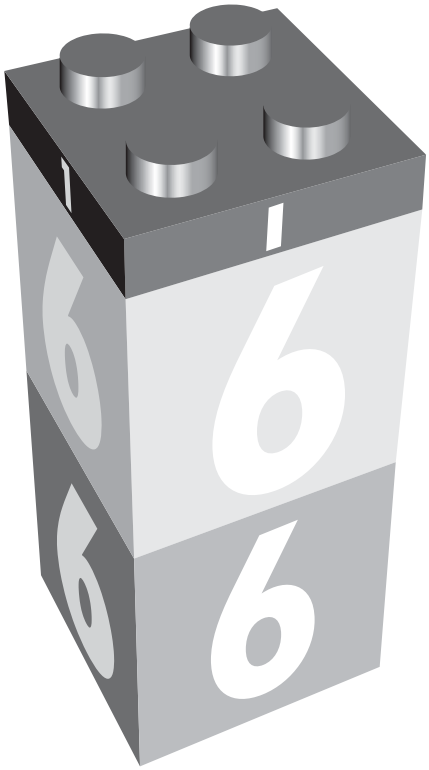


Figure 16: Initial Estimate

(**Note**: This is not based necessarily on the previous example pictures.)

The next step is to adjust the initial estimate by considering additional factors such as those shown in Table 2. Often they can only be properly considered when the machine is installed in its permanent location.

Typical Factor	Suggested Action
More than one person exposed to the hazard	Multiply the severity by the number of people
Protracted time in the danger zone without complete power isolation	If time spent per access is more than 15 minutes, add 1 point to the frequency factor.
Operator is unskilled or untrained	Add 2 points to the total.
Very long intervals (e.g., one year) between accesses. (There may be progressive and undetected failures particularly in monitoring systems.)	Add points equivalent to the maximum frequency factor.

Table 2: Additional Considerations for Risk Estimate

The results of any additional factors are then added to the previous total as shown in Figure 17.

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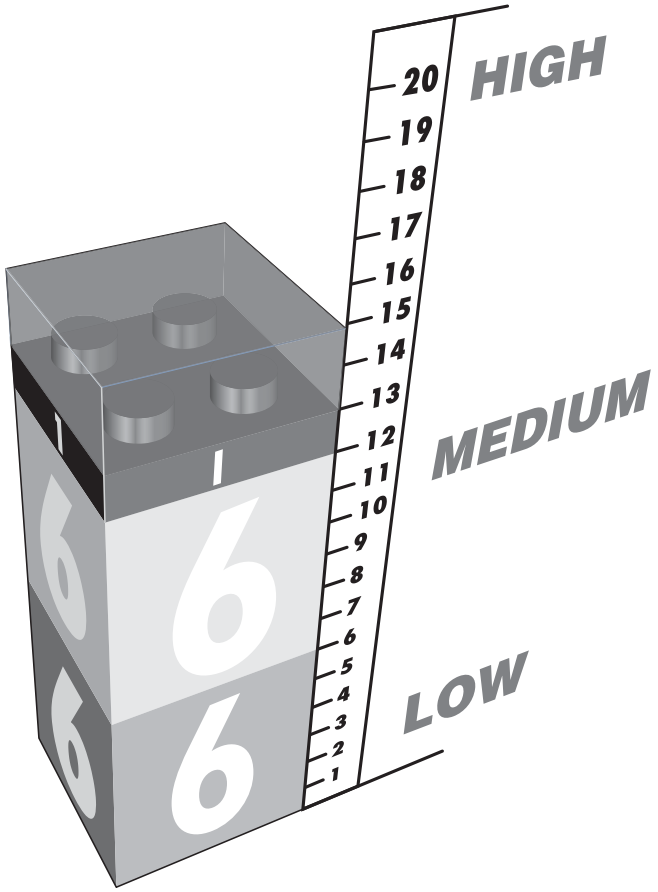


Figure 17: Final Value with Adjustments

Risk Reduction

Now we must consider each machine and its respective risks in turn and take measures to address all of its hazards.

The chart shown in Figure 18 is a suggestion for part of a documented process of accounting for all safety aspects of the machinery being used. It acts as a guide for machinery users, but machine manufacturers or suppliers can also use the same principle to confirm that all equipment has been evaluated. It will also act as an index to more detailed reports on risk assessment.

It shows that where a machine carries the CE Mark it simplifies the process as the machine hazards have already been evaluated by the manufacturer and that all the necessary measures have been taken. Even with CE Marked equipment there may still be hazards due to the nature of its application or material being processed which the manufacturer did not foresee.

Hierarchy of Measures for Risk Reduction

There are three basic methods to be considered and used in the following order:

1. Eliminate or reduce risks as far as possible (inherently safe machinery design and construction).
2. Install the necessary protective systems and measures (e.g. interlocked guards, light curtains etc) in relation to risks that cannot be eliminated by design.
3. Inform users of the residual risks due to any shortcomings of the protection measures adopted, indicate whether any particular training is required and specify any need to provide personal protection equipment.

Each measure from the hierarchy should be considered starting from the top and used where possible. This will usually result in the use of a combination of measures.

Company - MAYKIT WRIGHT LTD
Facility - Tool room - East Factory.
Date - 8/29/95
Operator profile - skilled.

Equipment Identity & Date	Directive Conformity	Risk Assessment Report Number	Accident History	Notes	Hazard Identity	Hazard Type	Action Required	Implemented and Inspected - Reference
Bloggs center lathe. Serial no. 8390726 Installed 1978	None claimed	RA302	None	Electrical equipment complies with BS EN 60204 E-Stops fitted (replaced 1989)	Chuck rotation with guard open	Mechanical Entanglement Cutting	Fit guard interlock switch	11/25/94 J Kershaw Report no 9567
					Cutting fluid	Toxic	Change to non toxic type	11/30/94 J Kershaw Report no 9714
					Swarf cleaning	Cutting	Supply gloves	11/30/94 J Kershaw Report no 9715
Bloggs turret head milling m/c Serial no 17304294 Manuf 1995 Installed May 95	M/c Dir. EMC Dir	RA416	None		Movement of bed (towards wall)	Crushing	Move machine to give enough clearance	4/13/95 J Kershaw Report no 10064

Figure 18: Risk Assessment Matrix

Inherently Safe Design

At the machine design phase it will be possible to avoid many of the possible hazards simply by careful consideration of factors such as materials, access requirements, hot surfaces, transmission methods, trap points, voltage levels, etc.

For example, if access is not required to a dangerous area, the solution is to safeguard it within the body of the machine or by some type of fixed enclosing guard.

Protective Systems and Measures

If access is required, then life becomes a little more difficult. It will be necessary to ensure that access can only be gained while the machine is safe. Protective measures such as interlocked guard doors and/or trip systems will be required. The choice of protective device or system should be heavily influenced by the operating characteristics of the machine. This is extremely important as a system that impairs machine efficiency will render itself liable to unauthorized removal or bypassing.

The safety of the machine in this case will depend on the proper application and correct operation of the protective system even under fault conditions.

The correct operation of the system must now be considered. Within each type there is likely to be a choice of technologies with varying degrees of performance of fault monitoring, detection or prevention.

In an ideal world every protective system would be perfect with absolutely no possibility of failing to a dangerous condition. In the real world, however, we are constrained by the current limits of knowledge and materials. Another very real constraint is cost. Based on these factors it becomes obvious that a sense of proportion is required. Common sense tells us that it would be ridiculous to insist that the integrity of a safety system on a machine that may, at the worst case, cause mild bruising to be the same as that required to keep a jumbo jet in the air. The consequences of failure are drastically different and therefore we need to have some way of relating the extent of the protective measures to the level of risk obtained at the risk estimation stage.

Whichever type of protective device is chosen it must be remembered that a “safety related system” may contain many elements including the protective device, wiring, power switching device and sometimes parts of the machine’s operational control system. All these elements of the system (including guards, mounting, wiring etc.) should have suitable performance characteristics relevant to their design principle and technology. IEC/EN 62061 and EN ISO 13849-1 classify hierarchical levels of performance for safety related parts of control systems and they provide risk assessment methods in their annexes to determine the integrity requirements for a protective system.

ISO 13849-1:2006 provides an enhanced risk graph in its Annex A. This graph is shown in Figure 19.

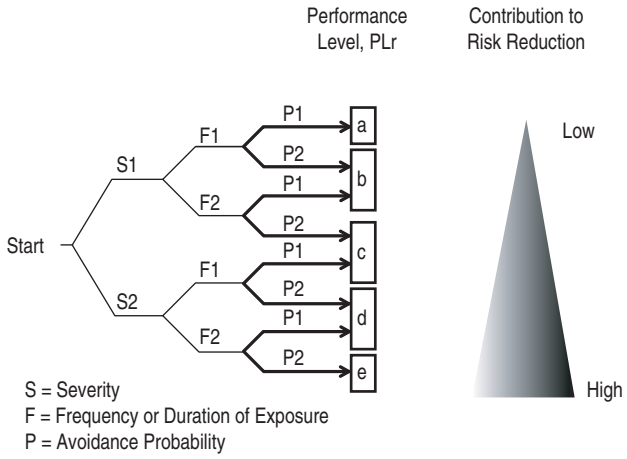


Figure 19: Risk Graph for Determining the Required Performance Level for a Safety Function—from ISO 13849-1:2006

IEC 62061 also provides a method in its Annex A, it takes the form shown in Figure 20.

The use of either of the above methods should provide equivalent results. Each method is intended to take account of the detailed content of the standard to which it belongs.

In both cases it is extremely important that the guidance provided in the text of the standard is used. The Risk Graph or Table must not be used in isolation or in an overly simplistic manner.

Evaluation

After the protective measure has been chosen and before it is implemented it is important to repeat the risk estimation. This is a procedure that is often missed. It may be that if we install a protective measure, the machine operator may feel that they are totally and completely protected against the original envisaged risk. Because they no longer have the original awareness of danger, they may intervene with the machine in a different way. They may be exposed to the hazard more often, or they may enter further into the machine for example. This means that if the protective measure fails they will be at a greater risk than envisaged before. This is the actual risk that we need to estimate. Therefore the risk estimation needs to be repeated taking into account any foreseeable changes in the way that people may intervene with the machine. The result of this activity is used to check whether the proposed protective measures are, in fact, suitable. For further information Annex A of IEC/EN 62061 is recommended.

Training, Personal Protective Equipment, etc.

It is important that operators have the necessary training in the safe working methods for a machine. This does not mean that the other measures can be omitted. It is not acceptable to merely tell an operator that they must not go near dangerous areas (as an alternative to guarding them).

It may also be necessary for the operator to use equipment such as special gloves, goggles, respirators, etc. The machinery designer should specify what sort of equipment is required. The use of personal protective equipment will not usually form the primary safeguarding method but will complement the measures shown above.

Risk assessment and safety measures

Document No.:
Part of:

Product:
Issued by:
Date:

☐ Pre risk assessment
☐ Intermediate risk assessment
☐ Follow up risk assessment

Black area = Safety measures required
Grey area = Safety measures recommended

Consequences	Severity Se	Class Cl 3 - 4	5 - 7	8 - 10	11 - 13	14 - 15	Frequency and duration, Fr		Probability of hzd. event, Pr		Avoidance Av	
Death, losing an eye or arm	4	SIL 2	SIL 2	SIL 2	SIL 3	SIL 3	<= 1 hour	5	Common	5		
Permanent, losing fingers	3		OM	SIL 1	SIL 2	SIL 3	> 1 h - <=day	5	Likely	4		
Reversible, medical attention	2			OM	SIL 1	SIL 2	>1day - <= 2wks	4	Possible	3	Impossible	5
Reversible, first aid	1				OM	SIL 1	> 2wks - <= 1 yr	3	Rarely	2	Possible	3
							> 1 yr	2	Negligible	1	Likely	1

Ser. No.	Hzd. No.	Hazard	Se	Fr	Pr	Av	Cl	Safety measure	Safe

Comments

Figure 20: Table for Determining the Required Safety Integrity Level for a Safety Function—from IEC 62061

Standards

Many standards and technical reports provide guidance on risk assessment. Some are written for wide applicability, and some are written for specific applications. The following is a list of standards that include information on risk assessment.

ANSI B11.TR3: Risk assessment and risk reduction—A guide to estimate, evaluate and reduce risks associated with machine tools

ANSI PMMI B155.1: Safety Requirements for Packaging Machinery and Packaging-Related Converting Machinery

ANSI RIA R15.06: Safety Requirements for Industrial Robots and Robot Systems

AS 4024.1301-2006: Principles of risk assessment

CSA Z432-04: Safeguarding of Machinery

CSA Z434-03: Industrial Robots and Robot Systems—General Safety Requirements

IEC/EN 61508: Functional safety of electrical, electronic and programmable electronic safety-related systems.

IEC/EN 62061: Safety of machinery—Functional safety of safety related electrical, electronic and programmable electronic control systems.

EN ISO 13849-1: Safety of machinery—Safety related parts of control systems

EN ISO 14121-1: Principles for risk assessment

ISO TR 14121-2: Risk assessment—Practical guidance and examples of methods

Protective Measures and Complementary Equipment

When the risk assessment shows that a machine or process carries a risk of injury, the hazard must be eliminated or contained. The manner in which this is achieved will depend on the nature of the machine and the hazard. Protective measures in conjunction with guarding either prevent access to a hazard or prevent dangerous motion at a hazard when access is available. Typical examples of protective measures are interlocked guards, light curtains, safety mats, two-hand controls and enabling switches.

Emergency stop devices and systems are associated with safety related control systems but they are not direct protective systems, they should only be regarded as complementary protective measures.

Preventing Access

Fixed Enclosing Guards

If the hazard is on a part of the machinery which does not require access, a guard should be permanently fixed to the machinery as shown in Figure 21. These types of guards must require tools for removal. The fixed guards must be able to 1) withstand their operating environment, 2) contain projectiles where necessary, and 3) not create hazards by having, for example, sharp edges. Fixed guards may have openings where the guard meets the machinery or openings due to the use of a wire mesh type enclosure.

Windows provide convenient ways to monitor machine performance, when access to that portion of the machine. Care must be taken in the selection of the material used, as chemical interactions with cutting fluids, ultra-violet rays and simple aging cause the window materials to degrade over time.

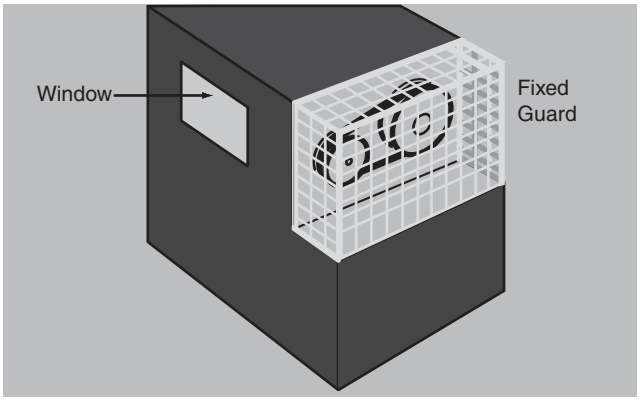


Figure 21: Fixed Guards

The size of the openings must prevent the operator from reaching the hazard. Table O-10 in U.S. OHSA 1910.217 (f) (4), ISO 13854, Table D-1 of ANSI B11.19, Table 3 in CSA Z432, and AS4024.1 provide guidance on the appropriate distance a specific opening must be from the hazard.

Detecting Access

Protective measures can be used to detect access to a hazard. When detection is selected as the method of risk reduction, the designer must understand that a complete safety system must be used; the safeguarding device, by itself, does not provide necessary risk reduction.

This safety system generally consists of three blocks: 1) an input device that senses the access to the hazard, 2) a logic device that process the signals from the sensing device, checks the status of the safety system and turns on or off output devices, and 3) an output device that controls the actuator (for example, a motor). Figure 22 shows the block diagram of a simple safety system.

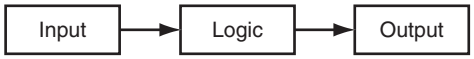


Figure 22: Simple Safety System Block Diagram

Detection Devices

Many alternative devices are available to detect the presence of a person entering or inside a hazard area. The best choice for a particular application is dependent on a number of factors.

- Frequency of access,
- Stopping time of hazard,
- Importance of completing the machine cycle, and
- Containment of projectiles, fluids, mists, vapors, etc.

Appropriately selected movable guards can be interlocked to provide protection against projectiles, fluids, mists and other types of hazards, and are often used when access to the hazard is infrequent. Interlocked guards can also be locked to prevent access while the machine is in the middle of the cycle and when the machine takes a long time to come to a stop.

Presence sensing devices, like light curtains, mats and scanners, provide quick and easy access to the hazard area and are often selected when operators must frequently access the hazard area. These types of devices do not provide protection against projectiles, mists, fluids, or other types of hazards.

The best choice of protective measure is a device or system that provides the maximum protection with the minimum hindrance to normal machine operation. All aspects of machine use must be considered, as experience shows that a system that is difficult to use is more liable to be removed or by-passed.

Presence Sensing Devices

When deciding how to protect a zone or area it is important to have a clear understanding of exactly what safety functions are required.

In general there will be at least two functions.

1. Switch off or disable power when a person enters the hazard area.
2. Prevent switching on or enabling of power when a person is in the hazard area.

At first thought these may seem to be one and the same thing but although they are obviously linked, and are often achieved by the same equipment, they are actually two separate functions. To achieve the first point we need to use some form of trip device. In other words a device which detects that a part of a person has gone beyond a certain point and gives a signal to trip off the power. If the person is then able to continue past this tripping point and their presence is no longer detected then the second point (preventing switching on) may not be achieved.

Figure 23 shows a full body access example with a vertically mounted light curtain as the trip device. Interlocked guard doors may also be regarded as a trip only device when there is nothing to prevent the door being closed after entry.

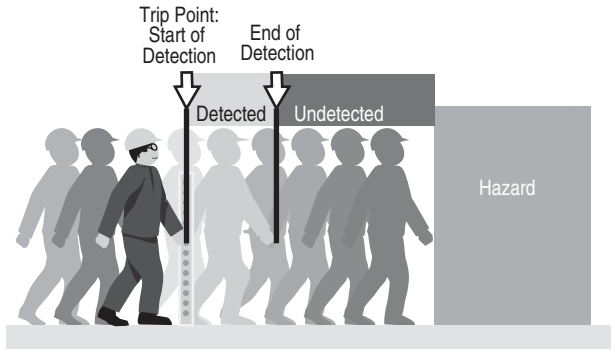


Figure 23: Full Body Access

If whole body access is not possible, so a person is not able to continue past the tripping point, their presence is always detected and the second point (preventing switching on) is achieved.

For partial body applications, as shown in Figure 24, the same types of devices perform tripping and presence sensing. The only difference being the type of application.

Presence sensing devices are used to detect the presence of people. The family of devices includes safety light curtains, single beam safety barriers, safety area scanners, safety mats and safety edges.

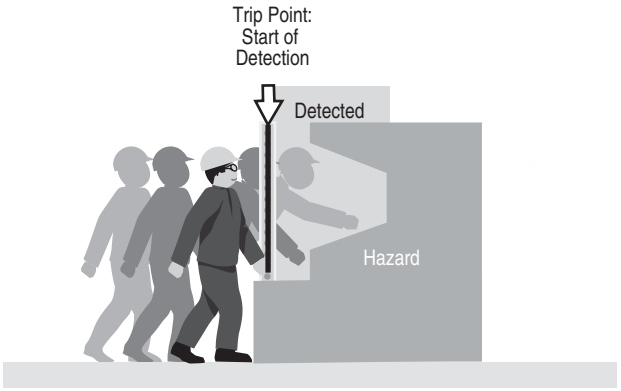


Figure 24: Partial Body Access

Safety Light Curtains

Safety light curtains are most simply described as photoelectric presence sensors specifically designed to protect personnel from injuries related to hazardous machine motion. Also known as AOPDs (Active Opto-electronic Protective Devices) or ESPE (Electro Sensitive Protective Equipment), light curtains offer optimal safety, yet they allow for greater productivity and are the more ergonomically sound solution when compared to mechanical guards. They are ideally suited for applications where personnel need frequent and easy access to a point of operation hazard.

Light curtains are designed and tested to meet IEC 61496-1 and -2. There is no harmonized EN version of part 2 so Annex IV of the European Machinery Directive requires third party certification of light curtains prior to placing them on the market in the European Community. Third parties test the light curtains to meet this international standard. Underwriter's Laboratory has adopted IEC 61496-1 as a U.S. national standard.

Operation

Safety light curtains consist of an emitter and receiver pair that creates a multi-beam barrier of infrared light in front of, or around, a hazardous area. The emitter is synchronized with the receiver by the photoelectric beam nearest one end of the housing. To eliminate susceptibility to false tripping attributed to ambient light and interference (crosstalk) from other opto-electronic devices, the LEDs in the emitter are pulsed at a specific rate (frequency modulated), with each LED pulsed sequentially so that an emitter can only affect the specific receiver associated with it. When all the beams have been checked, the scan starts over again. An example of a basic light curtain system is shown in Figure 25.

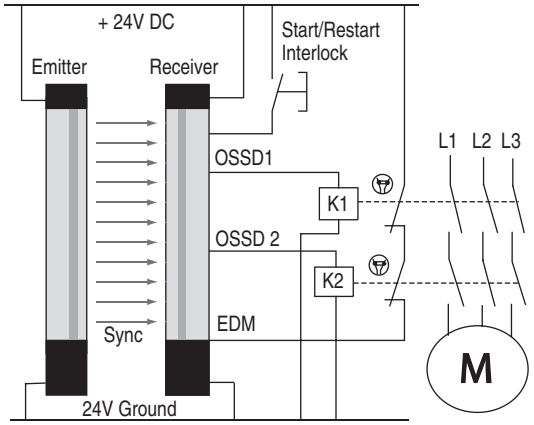


Figure 25: Basic Light Curtain Safety System

When any of the beams are blocked by intrusion into the sensing field, the light curtain control circuit turns its output signals off. The output signal must be used to turn the hazard off. Most light curtains have OSSD (Output Signal Switching Devices) outputs. The OSSDs are PNP type transistors with short circuit protection, overload protection and cross fault (channel to channel) detection. They can switch DC powered devices, like safety contactors and safety control relays, usually up to 500 mA.

Start/Restart Interlock: Light curtains are designed to interface directly with either low power machine actuators or logic devices like monitoring safety relays or programmable safety controllers. When switching machine actuators directly, the Start/Restart interlocking input of the light curtain must be used. This prevents the light curtain from re-initiating the hazard when the light curtain is initially powered or when the light curtain is cleared.

EDM: Light curtains also have an input that allows them to monitor the machine actuators. This is known as EDM (external device monitoring). After the light curtain is cleared, the light curtain determines if the external actuator is off before enabling any restart.

The emitter and receiver can also be interfaced to a control unit that provides the necessary logic, outputs, system diagnostics and additional functions (muting, blanking, PSDI) to suit the application.

The light curtain system must be able to send a stop signal to the machine even in the event of a component failure(s). Light curtains have two cross monitored outputs that are designed to change state when the safety light curtain sensing field is broken. If one of the outputs fails, the other output responds and sends a stop signal to the controlled machine and as part of the cross monitored system detects that the other output did not change state or respond. The light curtain would then go to a lock out condition, which prevents the machine from being operated until the safety light curtain is repaired. Resetting the safety light curtains or cycling power will not clear the lock out condition.

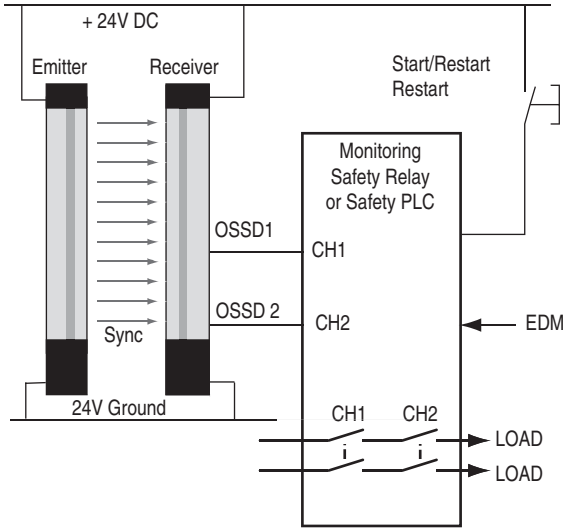


Figure 26: Light Curtain Interfacing with MSR or Safety PLC

Light curtains are often integrated into the safety system by connecting them to a monitoring safety relay (MSR) or safety PLC, as shown in Figure 26. In this case, the MSR or safety PLC handles the switching of the loads, the start/restart interlock and the external device monitoring. This approach is used for complex safety functions, and large load switching requirements. This also minimizes the wiring to the light curtain.

Resolution:

One of the important selection criteria for light curtain is its resolution. Resolution is the theoretical maximum size that an object must be to always trip the light curtain. Frequently used resolutions are 14 mm, which is commonly used for finger detection; 30 mm, which is commonly used for hand detection; and 50 mm, which is commonly used for ankle detection. Larger values are used for full body detection.

The resolution is one of the factors that determine how close the light curtain can be placed to the hazard. See the section on "Safety Distance Calculation" for more information.

Vertical Applications:

Light curtains are most often used in vertically mounted applications. The light curtains must be placed at such distance as to prevent the user from reaching the hazard before the hazard stops.

In reach-through applications, the breaking of the light curtain initiates a stop command to the hazard. While continuing to reach through, to load or unload parts for example, the operator is protected because some part of their body is blocking the light curtain and preventing a restart of the machine.

Fixed guards or additional safeguarding must prevent the operator from reaching over, under or around the light curtain. Figure 27 shows an example of a vertical application.

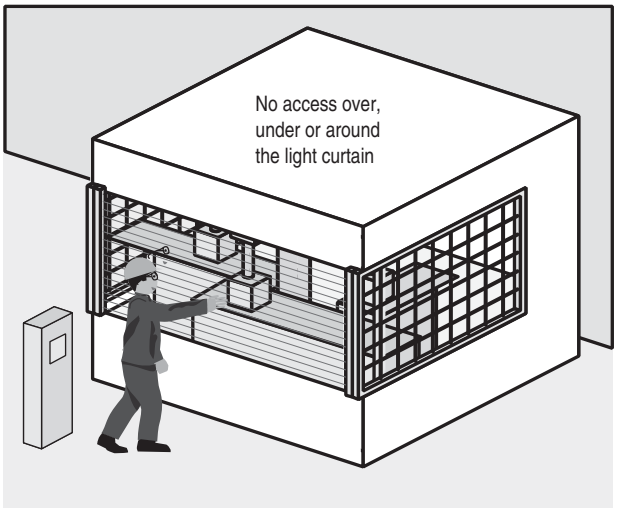


Figure 27: Vertical Application

Cascading

Cascading is a technique of connecting one set of light curtains directly to another set of light curtains like that shown in Figure 28. One set acts as the host, and the other set acts as a guest. A third light curtain can be added as the second guest. This approach saves cabling costs and input terminals at the logic device. The tradeoff is that the response time of the cascaded light curtains is increased as more beams have to be checked during each scan of the cascaded light curtain.

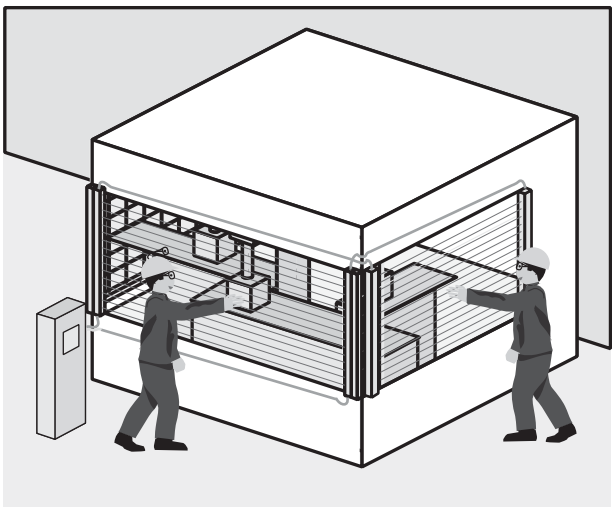


Figure 28: Cascaded Light Curtains

Fixed Blanking

Blanking allows portions of a light curtain's sensing field to be disabled to accommodate objects typically associated with the process. These objects must be ignored by the light curtain, while the light curtain still provides detection of the operator.

Figure 29 shows an example where the object is stationary. Mounting hardware, machine fixture, tooling, or conveyor are in the blanked portion of the light curtain. Known as monitored fixed blanking, this function requires that the object be in the specified area at all times. If any of the beams programmed as “blanked” are not blocked by the fixture or work piece, a stop signal is sent to the machine.

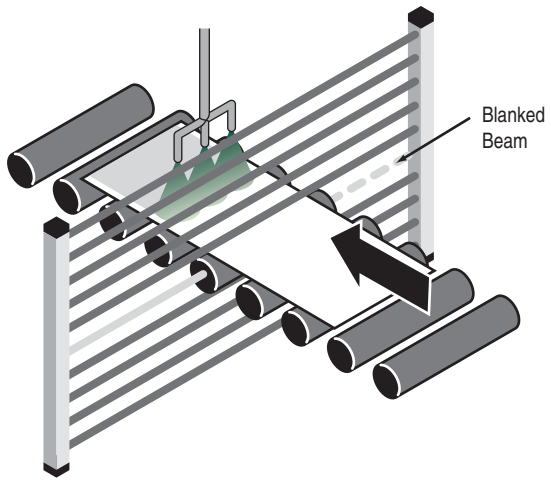


Figure 29: LIght Curtain Is Blanked Where Conveyor Is Fixed

Floating Blanking

Floating blanking allows an object such as feed stock to penetrate the sensing field at any point without stopping the machine. This is accomplished by disabling up to two light beams anywhere within the sensing field. Instead of creating a fixed window, the blanked beams move up and down, or “float,” as needed.

The number of beams that can be blanked depends on the resolution. Two beams can be blanked with a resolution of 14 mm, whereas only one beam can be blanked when a resolution of 30 mm is used. This restriction maintains a smaller opening to help prevent the operator from reaching through the blanked beams.

The beam(s) can be blocked anywhere in the sensing field except the sync beam without the system sending a stop signal to the protected machinery. A press brake, shown in Figure 30, provides a good example. As the ram moves down, the sheet metal bends and moves through the light curtain, breaking only one or two contiguous beams at a time.

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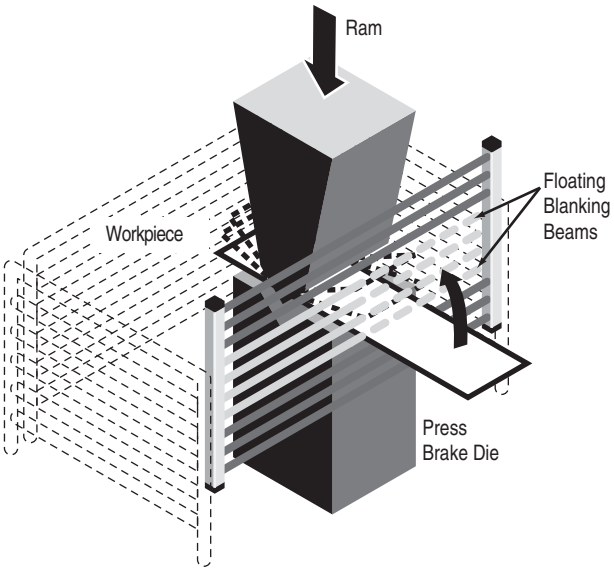


Figure 30: Floating Blanking

When using blanking, fixed or floating, the Safety Distance (the minimum distance the light curtain can be from the hazard such that an operator cannot reach the hazard before the machine stops) is affected. Since blanking increases the minimum object size that can be detected, the minimum safety distance must also increase based on the formula for calculating the minimum safety distance (see the Safety Distance Calculation section).

Horizontal Applications

After calculating the safety distance, the designer might find that the machine operator can fit in the space between the light curtain and the hazard. If this space exceeds 300 mm (12 in.), additional precautions must be considered. One solution is to mount a second light curtain in a horizontal position. These can be two independent sets of light curtains or a cascaded pair of light curtains. Another alternative is to mount a longer light curtain on an angle to the machine. These alternatives are shown in Figure 31. In either alternative, the light curtains must be located a safe distance away from the hazard.

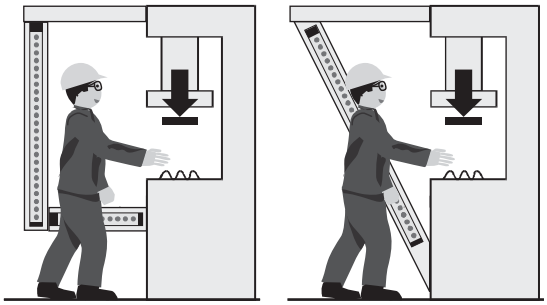


Figure 31: Alternative Solutions for Space between Light Curtain and Hazard

For longer safety distances or for area detection, light curtains can be mounted horizontally, as shown in Figure 32. The light curtains must not be mounted too close to the floor to prevent them from getting dirty, nor too high so as to allow someone to crawl under the light curtain. A distance of 300 mm (12 in.) off the floor is often used. Additionally, the light curtains must not be used as foot steps to gain access. The resolution of the light curtain must be selected to at least detect a person's ankle. No larger than 50 mm resolution is used for ankle detection. If the light curtain does not protect the whole cell, then a manual rest function must be used. The reset button must be located outside the cell with full view of the cell.

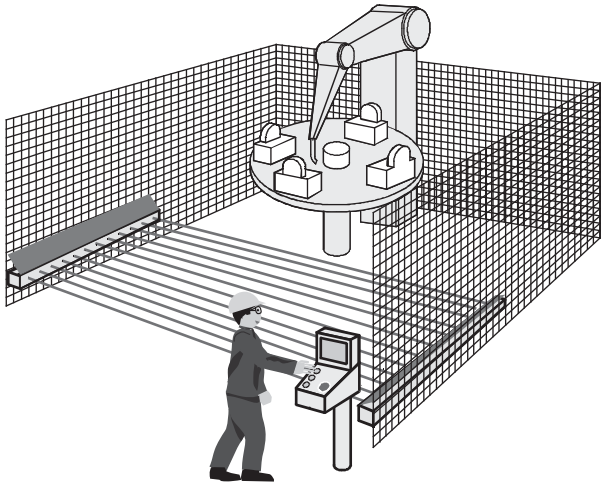


Figure 32: Horizontal Application of a Light Curtain

Perimeter or Area Access Control

Perimeter access control is often used to detect access along the outside edge of a hazard area. Light curtains used to detect perimeter access have resolutions that detect full bodies, as shown in Figure 33. This can be accomplished by a couple different ways. Multi-beam light curtains consisting of two or three beams or a single beam device that is reflected off mirrors to create a dual beam pattern are regularly used. In either case, the lowest beam should be 300 mm (12 in.) off the ground, and the highest beam should prevent a person from simply climbing over the light curtain.

Mirrors can be used to deflect the light beam around a cell. The distance the light curtain can cover is reduced due to the losses in the mirror reflections. Alignment of the light curtain is more difficult and a visible laser alignment tool is often needed during installation.

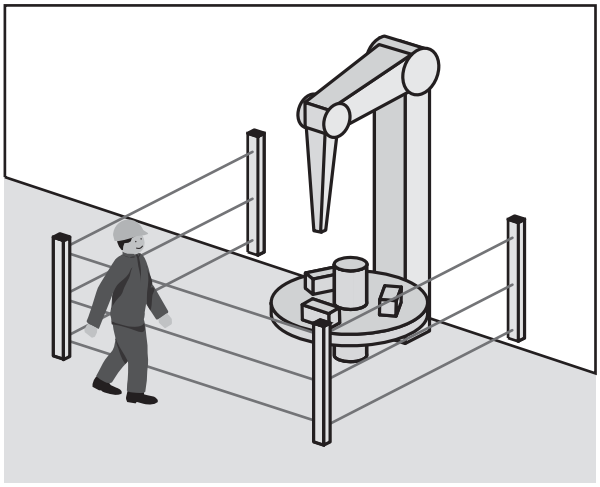


Figure 33: Mirrors Create Perimeter

Mirrors can be used to deflect the light beam around a cell. The distance the light curtain can cover is reduced due to the losses in the mirror reflections. Alignment of the light curtain is more difficult and a visible laser alignment tool is often needed during installation.

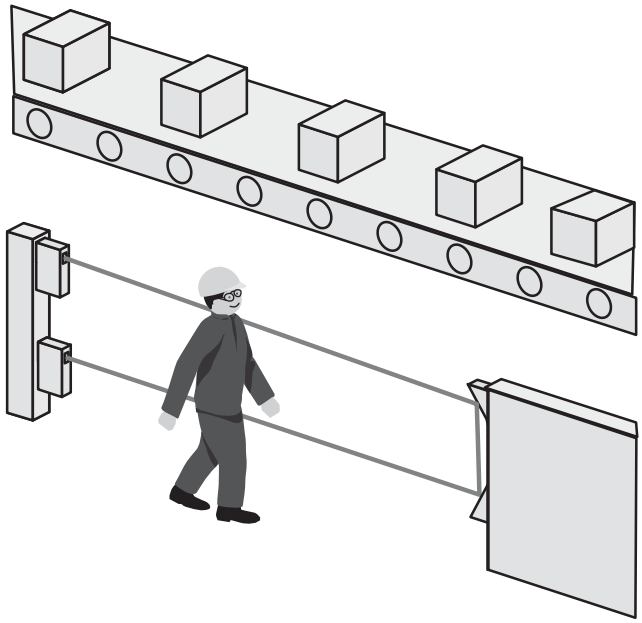


Figure 34: Single Beam Devices for Low Risk Applications

Some single beam devices have extensive (up to 275 feet) sensing distances. This allows a single beam device to create a protective barrier around hazardous machines. Since only a single or dual beam arrangement can be made, this approach is limited to low risk applications. The “Safety Distance Calculation” section (page) discussed beam placement and spacing to achieve adequate protective fields. Figure 34 shows an example of a single beam application. This approach is generally used in low risk applications, due to the larger beam spacing. Breakage of the beam is used to stop the hazardous machine motion.

Safety Laser Scanners

Safety laser scanners use a rotating mirror that deflects light pulses over an arc, creating a plane of detection. The location of the object is determined by the angle of rotation of the mirror. Using a “time-of-flight” technique of a reflected beam of invisible light, the scanner can also detect the distance the object is from the scanner. By taking the measured distance and the location of the object, the laser scanner determines the exact position of the object.

Laser scanners create two zones: 1) a warning zone and 2) a safety zone. The warning zone provides a signal that does not shut down the hazard and informs people that they are approaching the safety zone as shown in Figure 35. Objects entering or inside the safety zone cause the laser scanner to issue a stop command; the OSSD outputs turn off.

The shape and size of the protected area is configured by an accompanied software program and downloaded to the scanner. The safety distance calculation must be used to determine the appropriate size of the safety zone.

One advantage of the laser scanner over a horizontal light curtains or mats is the ability to reconfigure the area. Figure 35 shows an example of the warning field configured to ignore structural objects.

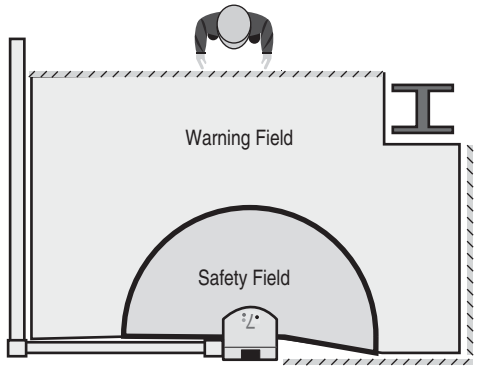


Figure 35: Warning Field Configured Around Structural Objects

Developments in laser scanner technology allow a single scanner to cover multiple zones. In Figure 36, the laser scanner allows operator access to one side (shown as Case 1) while the robot is busy on the other side (Case 2).

Older scanners have electro-mechanical outputs. Newer scanners adopt the same principles as light curtains and provide OSSD outputs with cross checking, external device monitoring and restart interlock for standalone use. The OSSD outputs can also be connected to logic devices when needed as part of a larger system.

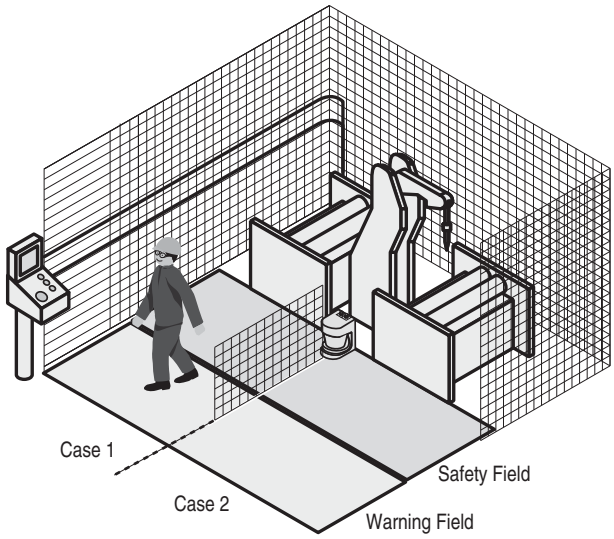


Figure 36: Multizone Application of Laser Scanner

Muting

Muting is characterized as the automatic, temporary suspension of a safety function. Sometimes the process requires that the machine stop when personnel enters the area, yet remain running when automatically-fed material enters. In such a case, a muting function is necessary. Muting is permitted during the non-hazardous portion of the machine cycle or must not expose people to a hazard.

Sensors are used to initiate the muting function. The sensors may be safety rated or non-safety rated. The types, number and location of muting sensors must be selected to meet the safety requirements determined by the risk assessment.

Figure 37 shows a typical conveyor material handling muting arrangement using two sensors. The sensors are arranged in an X pattern. Some logic units require a specific order in which the sensors are blocked. When order is important, the X pattern must be asymmetrical. For those logic units that use the sensor inputs as pairs, the X pattern can be symmetrical. Polarized, retroreflective photosensors are often used to prevent spurious reflections from falsely initiating the muting function, or causing nuisance trips. Other sensing technologies, such as inductive sensors and limit switches may also be use.

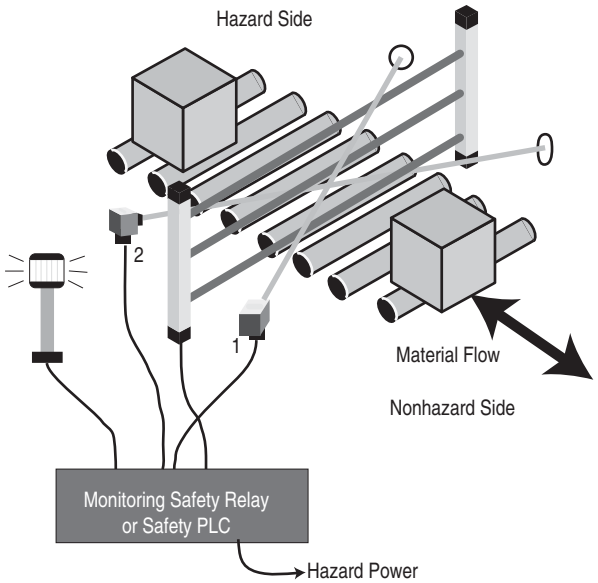


Figure 37: Conveyor 2 Sensor Muting

Another commonly applied approach is to use four sensors, as shown in Figure 38. Two sensors are mounted on the hazard side and two on the non hazard side. The sensors look directly across the conveyor. The shape and position of the object is less important in this approach. The length of the object is important as the object must block all four sensors.

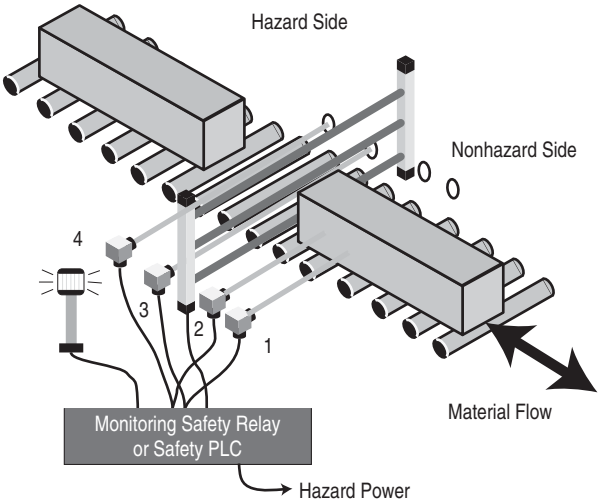


Figure 38: Conveyor 4 Sensor Muting

A common application is for a fork truck to access a conveyor. In order to mute the light curtain, the fork truck must be detected by sensors. The challenge is to locate the sensors so they detect the fork truck and not a person. Figure 39 shows an example of this application.

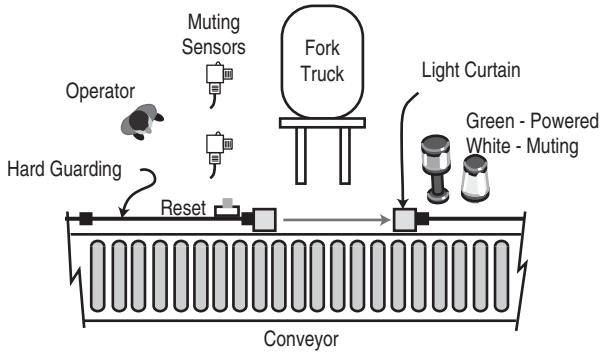


Figure 39: Fork Truck 2 Sensor Muting

Access to robot cells is also accomplished by muting. As shown in Figure 40, limit switches, located on the base of the robot, indicate the position of the robot. The safeguarding devices (the light curtains and safety mats) are muted when the robot is not in a hazardous position.

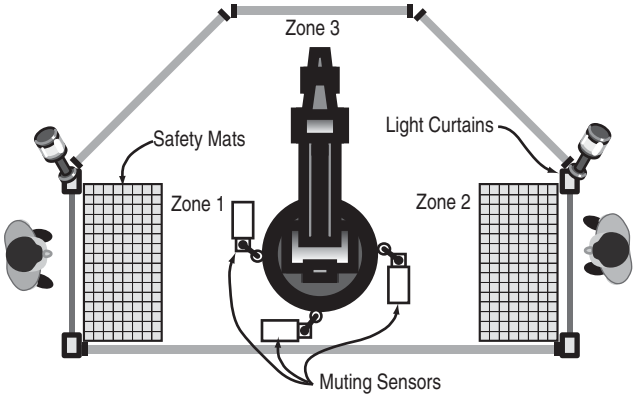


Figure 40: Muting of a Robot Cell

Presence Sensing Device Initiation (PSDI)

Also known as single break, double break, or stepping operating mode, PSDI involves the use of a light curtain not only as a safety device, but as the control for machine operation. PSDI initiates a machine cycle based on the number of times the sensing field is broken. For example, as an operator reaches toward the hazard to insert a work piece, breakage of the beams immediately stops the machine or prevents restart of the machine until the operator removes his hand from the area, at which time the machine automatically initiates its next cycle. This process can be accomplished by safety programmable logic devices or by monitoring relays specifically designed for this function.

Auto initiation allows the machine to start and stop based on the number of times the light curtain beams are broken and cleared. Illustrated in Figures 41 to 43 is an auto initiation double break mode (after initial start-up sequence).

In Step 1, the operator breaks the light curtain. The machine is stopped and the operator removes the processed material. The operator clears the light curtain, making the first break.

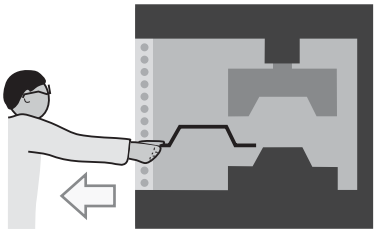


Figure 41: Step 1 of Double Break PSDI

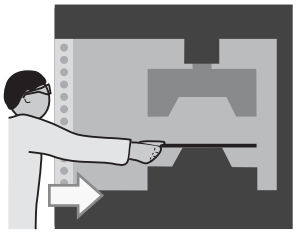


Figure 42: Step 2 of Double Break PSDI

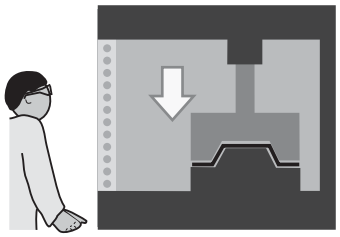


Figure 43: Step 3 of Double Break PSDI

In Step 2, the operator breaks the light curtain a second time and loads new material. The machine remains in stop mode.

In Step 3, the machine starts automatically after the second clearing of the light curtain.

Pressure Sensitive Safety Mats

These devices are used to provide guarding of a floor area around a machine, as shown in Figure 44. A matrix of interconnected mats is laid around the hazard area and pressure applied to the mat (e.g., an operator's footstep) will cause the mat controller unit to switch off power to the hazard.

There are a number of technologies used to create safety mats. One of the more popular technologies is using two parallel metal plates, as shown in Figure 45. The plates are separated by spacers. The metal plates and spacers are encapsulated in a nonconductive material with its surface designed to prevent slipping.

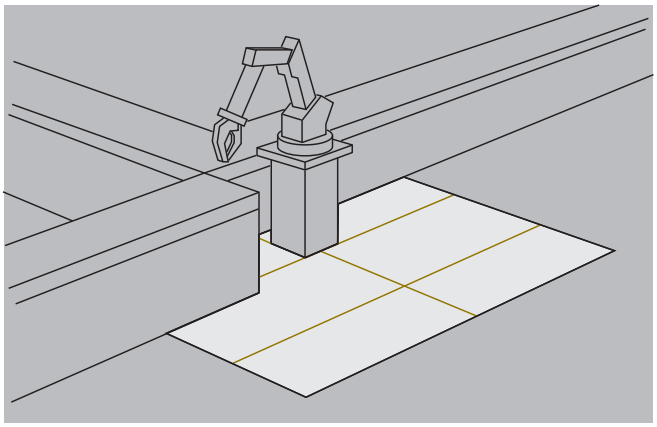


Figure 44: Safety Mats Surrounding a Robot

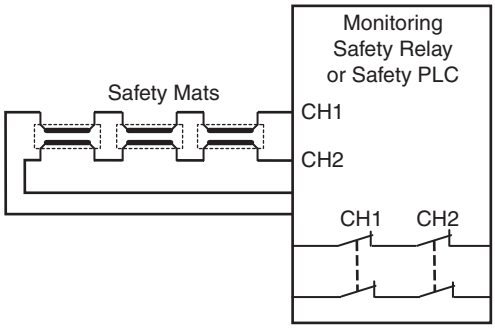


Figure 45: Safety Mat Interfacing

To ensure that the safety mat is available for use, an electrical current is passed through both plates. If an open-circuit wiring fault occurs, the safety system shuts down. To accommodate the parallel plates into a safety system, either two or four conductors are used. If two conductors are used, then a terminating resistor is used to differentiate the two plates. The more popular approach is to use four conductors. Two conductors, connected to the top plate are assigned one channel. Two conductors connected to the bottom plate are assigned to a second channel. When a person steps on the mat, the two plates create a short circuit from Channel 1 to Channel 2. The safety logic device must be designed to accommodate this short circuit. Figure 46 shows an example of how multiple 4-wire mats are connected in series to ensure the safety mats are available for use.

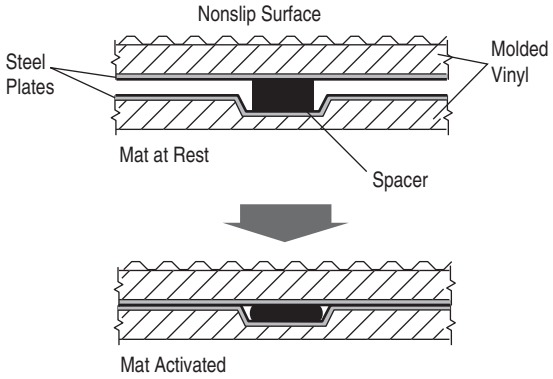


Figure 46: Typical Safety Mat Construction

Pressure sensitive mats are often used within an enclosed area containing several machines—flexible manufacturing or robotics cells, for example. When cell access is required (for setting or robot “teaching,” for example), they prevent dangerous motion if the operator strays from the safe area, or must get behind a piece of equipment, as shown in Figure 47.

The size and positioning of the mat must take the safety distance into account (see Safety Distance Calculation).

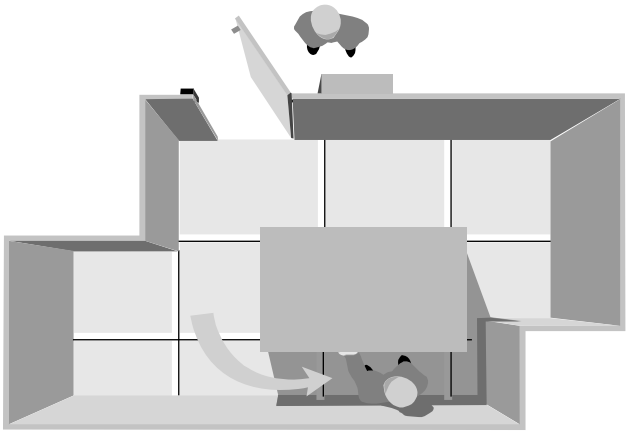


Figure 47: Safety Mat Detects Operator Behind Equipment

Pressure Sensitive Edges

These devices are flexible edging strips that can be mounted to the edge of a moving part, such as a machine table or powered door that poses a risk of a crushing or shearing, as shown in Figure 48.

If the moving part strikes the operator (or vice versa), the flexible sensitive edge is depressed and will initiate a command to switch off the hazard power source. Sensitive edges can also be used to guard machinery where there is a risk of operator entanglement. If an operator becomes caught in the machine, contact with the sensitive edge will shut down machine power.

There are a number of technologies used to create safety edges. One popular technology is to insert essentially what is a long switch inside the edge. This approach provides straight edges and generally uses the four-wire connection technique.



Figure 48: Edge on Machine Table and Powered Door

The Allen-Bradley Guardmaster Safedge uses conductive rubber, with two wires running the length of edge (Figure 49). At the end of the edge, a terminating resistor is used to complete the circuit. Depressing the rubber reduces the circuit resistance.

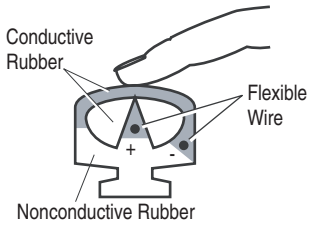


Figure 49: Conductive Rubber Safety Edge

Since a change in resistance must be detected, the monitoring safety relay must be designed to detect this change. An example wiring of this two-wire design with a terminating resistor is shown in Figure 50. One advantage of the conductive rubber technology is that it provides active corners.

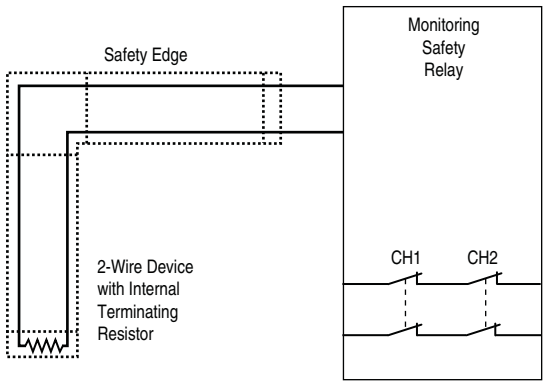


Figure 50: Conductive Rubber Safety Edge Circuit

Light curtains, scanners, floor mats and sensitive edges are classified as “trip devices.” They do not actually restrict access but only “sense” it. They rely entirely on their ability to both sense and switch for the provision of safety. In general they are only suitable on machinery which stops reasonably quickly after switching off the power source. Because an operator can walk or reach directly into the hazard area it is obviously necessary that the time taken for the motion to stop is less than that required for the operator to reach the hazard after tripping the device.

Safety Switches

When access to the machine is infrequent, movable (operable) guards are preferred. The guard is interlocked with the power source of the hazard in a manner which ensures that whenever the guard door is not closed the hazard power will be switched off. This approach involves the use of an interlocking switch fitted to the guard door. The control of the power source of the hazard is routed through the switch section of the unit. The power source is usually electrical but it could also be pneumatic or hydraulic. When guard door movement (opening) is detected the interlocking switch will initiate a command to isolate the hazard power supply either directly or via a power contactor (or valve).

Some interlocking switches also incorporate a locking device that locks the guard door closed and will not release it until the machine is in a safe condition. For the majority of applications the combination of a movable guard and an interlock switch with or without guard locking is the most reliable and cost effective solution.

Tongue Interlock Switches

Tongue operated interlocks require a tongue-shaped actuator to be inserted and removed from the switch. When the tongue is inserted, the internal safety contacts close and allow the machine to run. When the tongue is removed, the internal safety contacts open and send a stop command to the safety related parts of the control system. Tongue operated interlocks are versatile as they can be used on sliding, hinged or removable guards as shown in Figure 51.

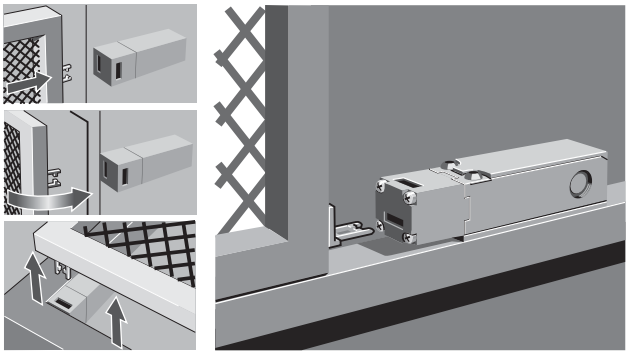


Figure 51: Tongues Interlocks on Sliding, Hinge or Removable Guards

Some of the latest functional safety standards focus on the need for complete fault tolerance as part of the requirements for device that is being used for high risk levels (e.g. SIL 3 or PLe). Because, in theory, mechanical tongue operated switches have single points of failure (e.g. the tongue actuator) even though they have two electrical switching channels. This means that non-contact switches may be preferred in these cases because they do not generally have the single mechanical failure points.

Tongue interlocks have three basic features that allow them to have a safety rating: defeatability, galvanic isolation, and direct opening action.

Defeatability

The security of an interlock switch is dependent on its ability to withstand attempts to "cheat" or defeat the mechanism. An interlock switch should be designed so that it cannot be defeated by simple tools or materials which may be readily available (like screwdrivers, coins, tape, or wire).

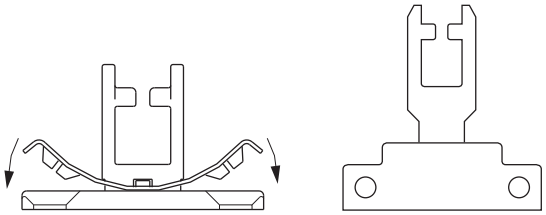


Figure 52: Tongue Shaped Actuators with Dimensional Features to Help Prevent Defeatability

This is accomplished by making the actuator a special shape, as shown in Figure 52. When maintenance is required on the machine, the interlocks may have to be bypassed. If this is done, other safeguarding methods for protection must be provided. Access to spare actuators must be controlled by management operating procedures. Some actuators, like the one on the left in Figure 52, have a spring that prevents the tongue from fully entering and operating the interlock switch unless it is correctly fixed to the guard.

In some circumstances personnel may be tempted to override the switch in some way. Information concerning the use of the machine, gathered at the risk assessment stage, will help to decide whether this is more likely or less likely to happen. The more likely it is to happen then the more difficult it should be to override the switch or system. The level of estimated risk should also be a factor at this stage. Switches are available with various levels of security ranging from resistance to impulsive tampering, to being virtually impossible to defeat.

It should be noted at this stage that if a high degree of security is required it is sometimes more practical to achieve this by the way in which it is mounted.

For example, if the switch is mounted as in Figure 53 with a covering track, there is no access to the switch with the guard door open. The nature of any "cheating" prevention measures taken at the installation will depend on the operating principle of the switch.

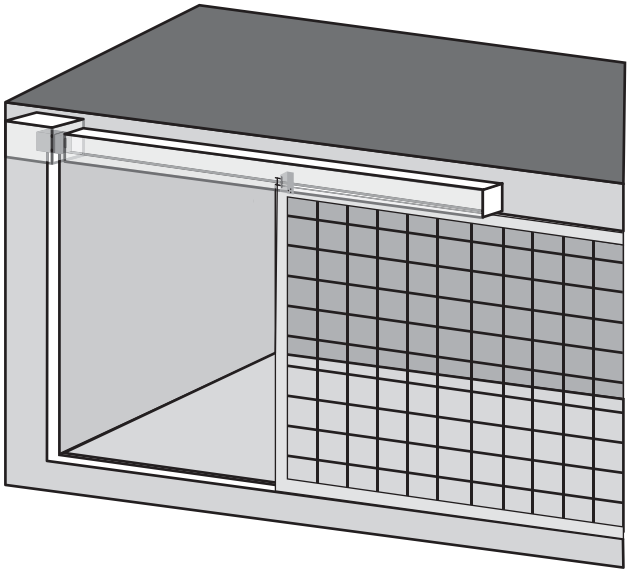


Figure 53: Switch and Actuator Hidden

Direct Opening Action

ISO 12100-2 explains that if a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements, these components are said to be connected in the positive mode. IEC 60947-5-1 uses the term Direct Opening Action and defines it as achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (for example not dependent upon springs). This standard provides a set of test that can be used to verify Direct Opening Action. Products that meet the requirements of Direct Opening Action display the symbol shown in Figure 54 on their enclosure.

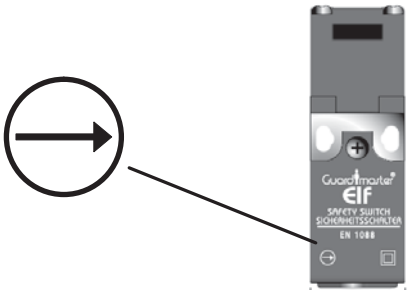


Figure 54: Symbol of Direct Opening Action

Figure 55 shows an example of positive mode operation giving forced disconnection of the contacts. The contacts are considered normally-closed (N.C.) when the actuator is inserted into the switch (i.e., guard closed). This closes an electrical circuit and allows current to flow through the circuit when the machine is allowed to run. The closed circuit approach allows for the detection of a broken wire which will initiate a stop function. These switches are typically designed with double break contacts. When the guard is opened, the tongue is removed from the operating head and rotates an internal cam. The cam drives the plunger which forces the spanner to open both contacts, breaking potentially welded contacts.

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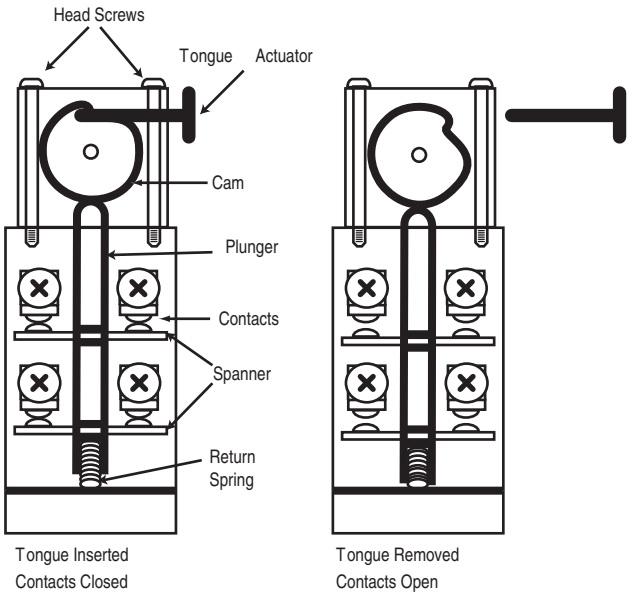


Figure 55: Double-Break with Direct Opening Action

Most tongue interlocks also have a set of normally-open (N.O.) contacts. These contacts typically close by the force of the return spring. If the spring breaks, proper contact operation cannot be performed with a high enough degree of reliability. Therefore, they are typically used to signal the machine control system that the guard is open.

Normally-open spring-return contacts can be used as a secondary channel in a safety system. This approach provides diversity to the safety system to help prevent common cause failures. The monitoring safety relay or safety PLC must be designed to accommodate this diverse N.O. + N.C. approach.

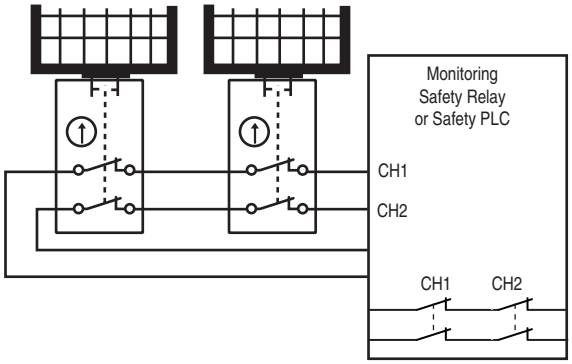


Figure 56: Daisy Chain of Multiple Two N.C. Interlocks

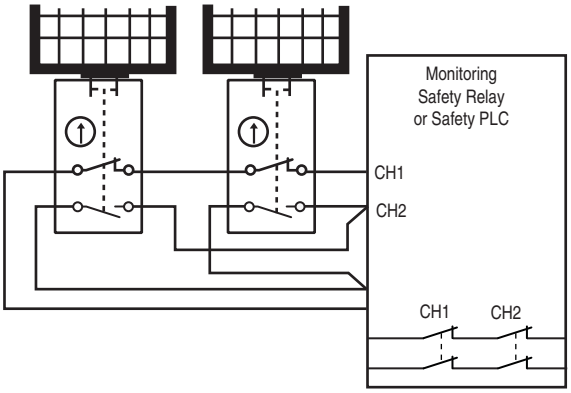


Figure 57: Multiple Interlocks with N.C. and N.O. Contacts

One advantage of using two normally closed contacts with interlocks is reduction in the wiring when multiple gates must be monitored. Figure 56 shows how multiple gates can be daisy chained. This may be practical for a small number of gates, but becomes more challenging to troubleshoot when too many gates are connected in series.

Where the risk assessment deems the use of diverse contacts, the N.C. contacts are connected in series and the N.O. contacts are connected in parallel. Figure 57 shows a basic schematic of this approach when multiple interlocks are monitored by a monitoring safety relay. The N.O. contacts in the Channel 2 circuit are connected in parallel.

Duplication (also referred to as Redundancy)

If components which are not inherently safe are used in the design, and they are critical to the safety function, then an acceptable level of safety may be provided by duplication of those components or systems. In case of failure of one component, the other one can still perform the function. It is usually necessary to provide monitoring to detect the first failure so that, for example, a dual channel system does not become degraded to a single channel without anybody being aware of it. Attention also must be given to the issue of common cause failures.

Protection must be provided against failure, which will cause all duplicated components (or channels) to fail at the same time Suitable measures may include using diverse technologies for each channel or ensuring an oriented failure mode.

Galvanic Isolation

Figure 58 shows contact blocks with two sets of contacts. A galvanic isolation barrier is required if it is possible for the contacts to touch each other back to back in the event of contact weld or sticking.

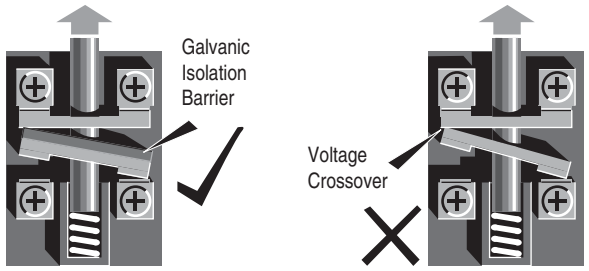


Figure 58: Galvanic Isolation of Contacts

Mechanical Stops

Interlock switches are not designed to withstand the stopping of a gate. The machine designer must provide an adequate stop while also providing enough travel for the actuator to fully insert into the switch (Figure 59).

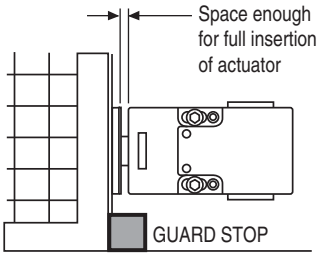


Figure 59: Mechanical Stops

The guard-mounted tongue needs to remain reasonably well aligned with the entry hole in the switch body. Over time, hinges may wear and guards may bend or twist. This adversely affects the alignment of the actuator to the head. The machine designer should consider metal bodied interfaces and flexible actuators, as shown in Figure 60.



Figure 60: Metal Interface with Flexible Actuator

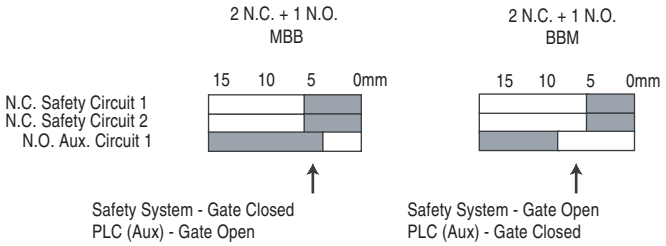


Figure 61: MBB and BBM Contacts—Conflicting Messages

Due to wear, damaged, or other changes to the guarding over time, pressure may be applied to the door forcing it open slightly. If the door moves between to the point where the change-over occurs, the safety system and machine control system will get conflicting messages, as shown in Figure 61.

Fixes for this include latching the door closed or using snap acting contacts. Selection of the appropriate tongue interlock involves many considerations: plastic or metal body, number of contacts, contact operation, size of guard, alignment of guard, movement of the guard, space available and washdown. Tongue operated switches can be difficult to clean thoroughly. Thus, food/beverage and pharmaceutical industries generally prefer non contact interlocks.

Guard Locking Switches

In some applications, locking the guard closed or delaying the opening of the guard is required. Devices suitable for this requirement are called guard locking interlock switches. They are suited to machines with run down characteristics but they can also provide a significant increase of protection level for most types of machines.

For most types of guard locking interlock switches, the unlocking action is conditional on the receipt of some form of electrical signal, for example an electrical voltage to energize a lock release solenoid. This principle of conditional release makes the solenoid controlled guard locking switch a very useful and adaptable device. Whereas with most devices the safety function is achieved by stopping the machine, guard locking switches also prevent access to the machine and prevent restart of the machine whenever the lock is released. Therefore these devices can perform two separate but inter-related safety functions: prevention of access and prevention of dangerous movement. This means that these switches are fundamentally important in the field of machinery safety. The following text describes some typical application based reasons why guard locking interlock switches are commonly used:

Protection of machine and people: In many situations tool or work piece damage can be caused or significant process disruption incurred if a machine is stopped suddenly at the wrong point in its operating sequence. A typical example of this would be the opening of an interlocked guard door of an automated machine tool in mid cycle. This situation can be avoided by using a solenoid controlled guard locking switch. If access through the guard door is required a lock release request signal is sent to the machine controller which will then wait for a properly sequenced stop before sending the release signal to the guard locking switch.

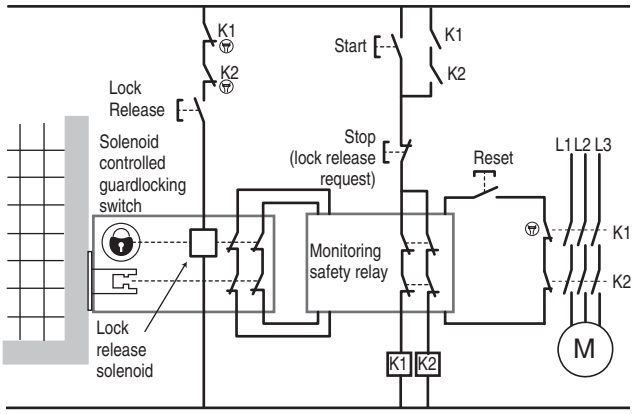


Figure 62: Simplified Basic Solenoid Guard Locking Switch Scheme

Figure 62 shows a very simplified schematic view of the principle. In practice, the start, stop and lock release functions of the push switches shown would typically be achieved by inputs and outputs of the machine's PLC. The PLC would accept a lock release request input at any point in the machine cycle but would only action a release command at the end of that cycle. The release command would be the equivalent of pressing the stop and lock release push switches.

When the lock is released and the guard door is opened, the switch contacts open causing the isolation of power to the hazard.

This type of approach can be further developed by using a key operated switch or button as the lock release request. In this way it can be possible to control not only when the guard can be opened but also who can open it.

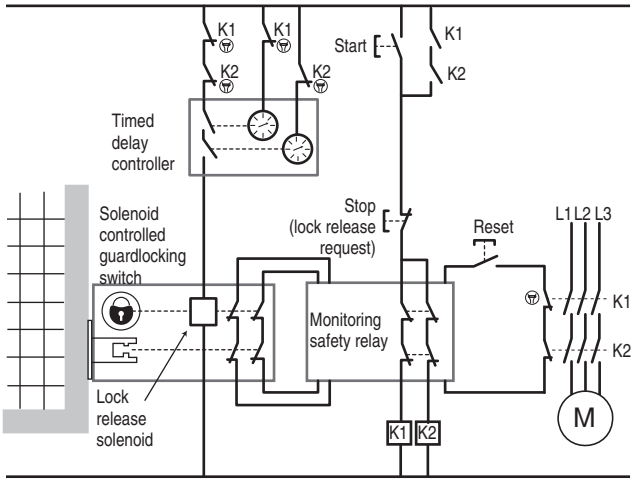


Figure 63: Timed Delay Controlled Solenoid Guard Locking Switch Scheme

Protection against machine run down: On many machines, removal of power to the motor or actuator will not necessarily cause a reliable and immediate stopping of the dangerous motion. This situation can be addressed by using a solenoid controlled guard locking switch with its release conditional on implementation of some form of delay that ensures that all dangerous motion has stopped before the lock is released.

Timed delay: The simplest method is to use a timed delay function configured so that the switch will not release the guard until the contactor is OFF and a preset time interval has elapsed. This is shown in Figure 63. The timed delay function can be provided by a Safety PLC or a dedicated controller. It is important that it is safety rated because failure that causes a shorter time delay than specified could result in exposure to dangerous moving parts.

The timed delay interval should be set at least to the worst case stopping time of the machine. This stopping time must be predictable, reliable and not dependant on braking methods that may degrade with use.

Stopped motion confirmation: It is also possible to make the lock release conditional on the confirmation that motion has stopped. The advantages with this approach are that even if the machine takes longer than expected to stop the lock will never be released too early. It also provides better efficiency than a timed delay because the lock is released as soon as the motion has stopped without having to always wait for the worst case stopping time. An example of this approach is shown in Figure 64.

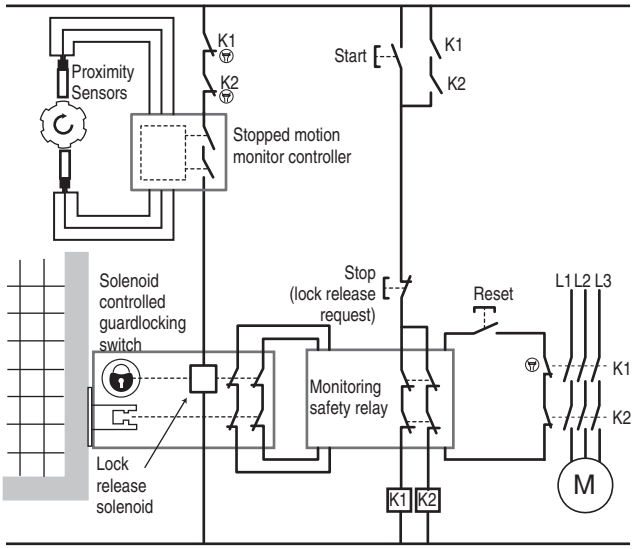


Figure 64: Simplified Stopped Motion Controlled Solenoid Guard Locking Switch Scheme

This stopped motion monitoring function must be safety rated and is usually achieved by one of the following methods:

Proximity sensors or shaft encoders combined with a dedicated controller or safety PLC.

Back EMF detection using a dedicated control unit.

Future generations of variable speed drives and motion control systems will also provide this functionality as safety rated.

Slow speed safety: For some types of machinery it may be necessary to have access to some moving parts in order to perform certain tasks such as maintenance, setting, feeding or threading. This type of activity is only considered if adequate safety can be provided by other measures. Typically these other measures will take the form of at least both of the following:

a) Access is only allowed under conditions of a safe slow speed

b) Any person with access to the moving parts must have personal local control for stopping, or prevention of starting, of the motion. The local control must override any other control signals.

This should be taken as a minimum. Whether this is acceptable or not will depend on risk assessment and relevant safety standards and regulations. However where it is found to be acceptable this type of safety functionality is often implemented using a solenoid controlled guard locking interlock switch in combination with a slow speed monitoring unit and a three position enabling device.

The safe slow speed monitoring unit constantly checks the speed of the moving parts via its input sensors and will only allow the sending of the lock release signal when the speed is not greater than its preset threshold value. After the lock has been released the slow speed unit continues to monitor the speed. If its preset threshold is exceeded while access is allowed, power to the motor will be switched off immediately. Also the safe slow speed can only continue while the enabling switch is held in the middle position (see Figure 70 for more information). It is clear that the guard locking switch, the safe slow speed unit and the enabling device must be connected to some form of safety rated logic solver in order implement the required functionality for both safety and production. In its most simple form this can simply be the way that the units are hardwired together, typically switchable via a manual mode selector switch. This switch is often key operated to restrict the safe slow speed access mode to authorized people. Greater operating efficiency and flexibility can be gained by using a configurable or programmable device for the logic solving function. This could be anything from modular configurable relay through to a Safety PLC.

This type of safe slow speed functionality is often required on complex integrated machinery systems where the equipment is divided into different operating zones each with different and interdependent operating modes. In these types of applications a Safety PLC or a dedicated configurable control unit such as the MSR57 is often a more suitable solution than individual relays and control units.

Most guard locking switches are adaptations of tongue interlocks. A solenoid is added to the interlock. The solenoid locks the actuator in place. There are two types of solenoid locking:

1. Power-to-unlock
2. Power-to-lock

Power-to-unlock devices require power to the solenoid to unlock the actuator. As long as power is applied to the solenoid, the door can be opened. With power removed from the actuator, the guard locks as soon as it is closed.

During a power loss, the gate remains closed and locked. If the guard locking device is used in full body access applications, a method of escape must be provided in case someone becomes locked in the hazard area. This is accomplished by providing a rotating lever, a pushbutton, or mechanical methods, as shown in Figure 65.

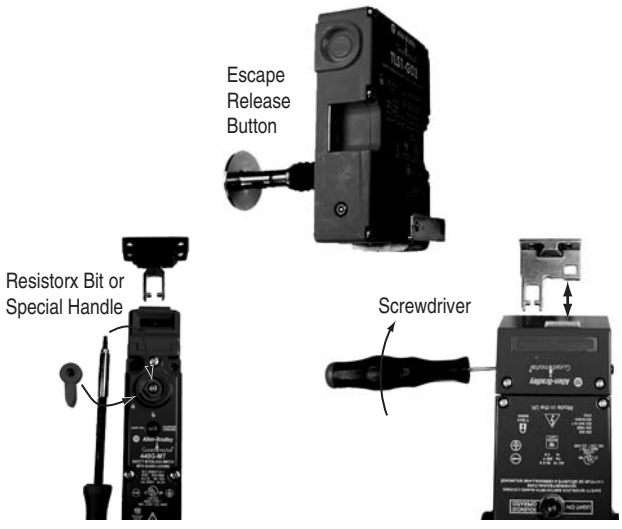


Figure 65: Escape Methods for Guard Locking

The power-to-lock requires power to the solenoid to lock the guard. A risk assessment must consider the potential hazardous situations that may arise if power is lost and the gate becomes unlocked while the machine is running down.

An important criterion when selecting guard locking interlocks is the holding force. How much force is required to hold the guard locked? When the door is manually operated, holding force can be minimal. Depending on where the guard locking switch is installed, operating leverage may suggest higher holding forces. Motorized doors may require higher holding forces.

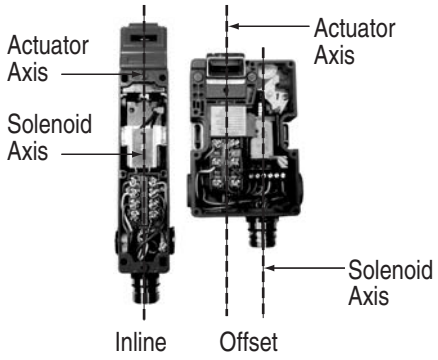


Figure 66: Inline and Offset Solenoid

Another important criterion for the selection process involves the relationship of the solenoid and the actuator. Two relationships exist: inline and offset, as shown in Figure 66. The solenoid is in the same axis as the actuator contacts or the solenoid is offset from the actuator contacts. The offset arrangement provides separate contacts that provide status of the solenoid.

The inline arrangement does not provide separate contacts for the solenoid. The inline arrangement is a little easier to apply. The offset arrangement provides more information on the operation of the switch. With the offset arrangement, the machine designer must ensure the solenoid status is monitored by the safety system. Selection of either arrangement is based on user preference.

A second type of guard locking device is manually operated and the guard can be opened at any time. A handle or knob that releases the guard lock also opens the control circuit contacts.

On a device such as the bolt switch, a time delay is imposed. The bolt which locks the guard in place operates the contacts and is withdrawn by turning the operating knob. The first few turns open the contacts but the locking bolt is not fully retracted until the knob is turned many more times (taking up to 20 seconds). These devices are simple to apply and they are extremely rugged and reliable. The time delay bolt switch is suitable mainly for sliding guards.

The stopping time of the hazard must be predictable and it must not be possible for the bolt to be withdrawn before the hazard has ceased. It must only be possible to extend the bolt into its locked position when the guard is fully closed. This means that it will be necessary to add stops to restrict the travel of the guard door, as shown in Figure 67.

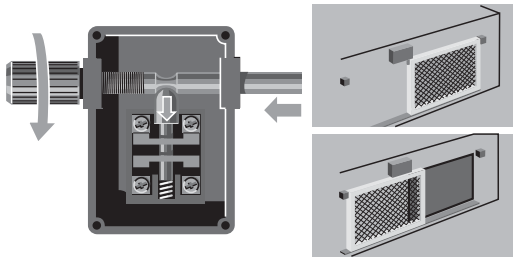


Figure 67: Sliding Bolt Interlock

Non-Contact Interlock Switches

Some of the latest functional safety standards focus on the need for complete fault tolerance as part of the requirements for device that is being used for high risk levels (e.g. SIL 3 or PLe). Because, in theory, mechanically actuated switches have single points of failure (e.g. the tongue actuator) even though they have two electrical switching channels. This means that dual channel non-contact switches may be preferred in these cases because they do not generally have the single mechanical failure points.

For non-contact interlocks, no physical contact (under normal conditions) takes place between the switch and actuator. Therefore positive mode operation cannot be used as the way of ensuring the switching action, and we need to use other methods to achieve equivalent performance.

Redundancy

Just as described in the section on tongue interlock switches, a high level of safety can be provided by non-contact devices designed with component duplication (or redundancy). In case of a failure of one component there is another one ready to perform the safety function and also a monitoring function to detect that first failure. In some cases it can be an advantage to design devices with components that have the same function but different failure mechanisms. This is referred to as diverse redundancy. A typical example is the use of one normally open contact and one normally closed contact.

Oriented Failure Mode

With simple devices we can use components with an oriented failure mode as explained in ISO 12100-2. This means using components in which the predominant failure mode is known in advance and always the same. The device is designed so that anything likely to cause a failure will also cause the device to switch off.

An example of a device using this technique is a magnetically actuated non-contact interlock switch. The contacts are connected with an internal non-reset overcurrent protection device. Any overcurrent situation in the circuit being switched will result in an open circuit at the protection device that is designed to operate at a current well below that which could endanger the safety-related contacts.

Due to the use of special components, the safety-critical fault likely to occur would be a welding of the reed contacts due to excessive current being applied to the switch as illustrated in Figure 68. This is prevented by the non-reset overcurrent protection device. There is a large margin of safety between the rating of this device and the reed contacts. Because it is non-reset, the switch should be protected by a suitably rated external fuse. The Allen-Bradley Guardmaster Ferrogard interlocks use this technique.

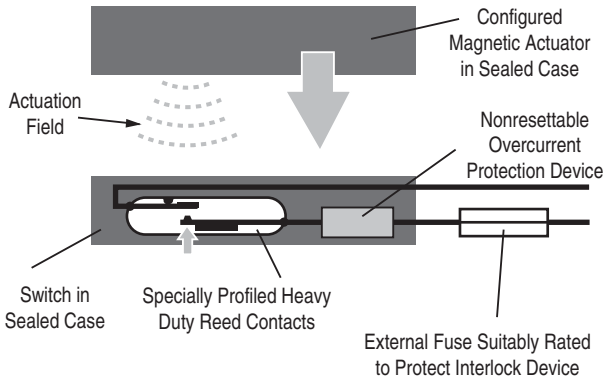


Figure 68: Simple Magnetic Operated Noncontact Interlock

Non-contact devices are designed with smooth enclosures and are fully sealed, making them ideal for food and beverage applications as they have no dirt traps and can be pressure cleaned. They are extremely easy to apply and have a considerable operating tolerance so they can accept some guard wear or distortion and still function properly.

One important consideration when applying non-contact switches is their sensing range and tolerance to misalignment. Each product family has an operating curve showing sensing range and tolerance to misalignment, as shown in Figure 69.

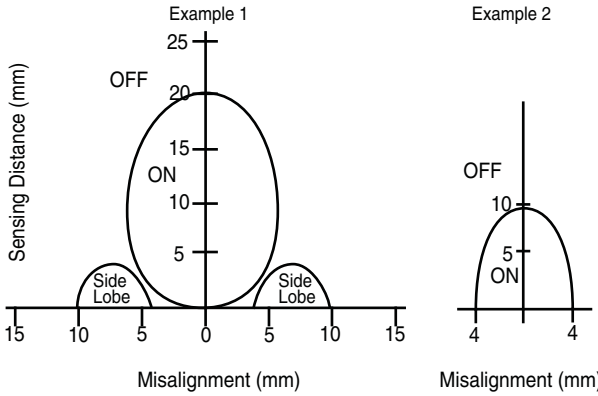


Figure 69: Non-Contact Operating Curve

Another important consideration for applying non-contact switches is the direction of approach of the actuator, as shown in Figure 70. The coding techniques determine which approaches are acceptable.

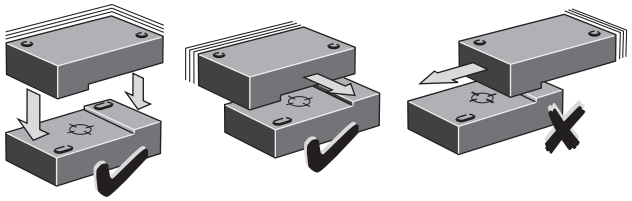


Figure 70: Approach of Actuator Affects Performance

Defeatability—Non-Contact Interlock Switches

It is important that the switch is only operated by its intended actuator. This means that ordinary proximity devices which sense ferrous metal are not appropriate. The switch should be operated by an "active" actuator.

When protection against defeatability by simple tools (a screwdriver, pliers, wire, coin, or a single magnet) is deemed necessary by the risk assessment, the noncoded actuation types must be installed so that they cannot be accessed while the guard is open. An example of this is shown in Figure 71. They should also be installed where they are not subjected to extraneous interference by magnetic/electric fields.

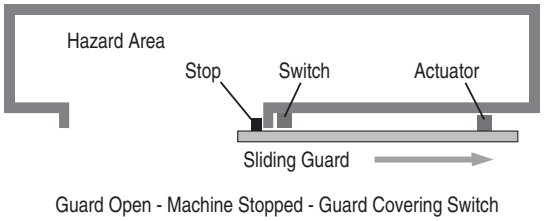


Figure 71: Sliding Guard Protects Access to Sensor

A high security against defeat can be achieved by using a coded actuator and sensor. For magnetically actuated and coded devices the actuator incorporates multiple magnets arranged to create multiple specific magnetic fields. The sensor has multiple reed switches specifically arranged to operate only with the specific magnetic fields of the actuator. Unique coding is generally not feasible using magnetic coding techniques. Unique coding, where an individual actuator is “tuned” to an individual sensor.

The reed switches used with magnetically coded switches are often small. To avoid the risk of welded contacts some switches use one normally open contact and one normally closed contact as outputs. This is based on the premise that you cannot weld an open contact. The logic device or control unit must be compatible with the N.C. + N.O. circuit arrangement and must also provide overcurrent protection. The Allen-Bradley Guardmaster Sipha interlocks use the coded magnetic technique.

RFID Non-Contact Interlock Switches

Non-contact interlock switches based on RFID (Radio Frequency Identification) technology can provide a very high level of security against defeat by “simple” tools. This technology can also be used to provide devices with unique coding for applications where security is paramount.

The use of RFID technique has many other important advantages. It is suitable for use with high integrity circuit architectures such as Category 4 or SIL 3.

It can be incorporated into devices with fully sealed IP69K enclosures manufactured from plastic or stainless steel.

When RFID technology is used for coding, and inductive technology for sensing, a large sensing range and tolerance to misalignment can be achieved, typically 15…25 mm. This means that these devices can provide very stable and reliable service combined with high levels of integrity and security over a wide range of industrial safety applications.

The Allen-Bradley Guardmaster SensaGuard interlocks use the RFID technique.

Hinge Switches

The device is mounted over the hinge-pin of a hinged guard as shown in Figure 72. The opening of the guard is transmitted via a positive mode operating mechanism to the control circuit contacts.

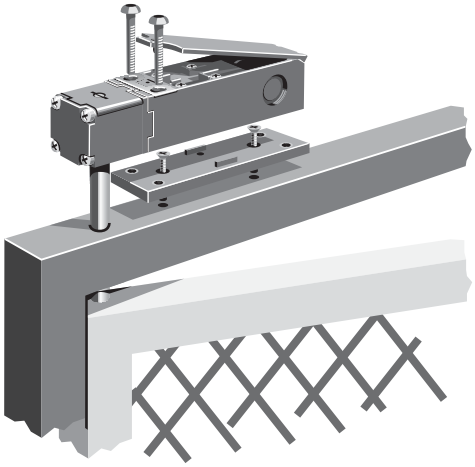


Figure 72: Hinge Switch Installation

When properly installed these types of switches are ideal for most hinged guard doors where there is access to the hinge center line. They can isolate the control circuit within 3° of guard movement and they are virtually impossible to defeat without dismantling the guard.

Care must be taken since an opening movement of only 3° can still result in a significant gap at the opening edge on very wide guard doors. It is also important to ensure that a heavy guard does not put excessive stress on the switch actuator shaft.

Position (Limit Switch) Interlocks

Cam operated actuation usually takes the form of a positive mode limit (or position) switch and a linear or rotary cam (as shown in Figure 73). It is generally used on sliding guards. When the guard is opened, the cam forces the plunger down to open the control circuit contacts. The simplicity of the system allows the switch to be both small and reliable.

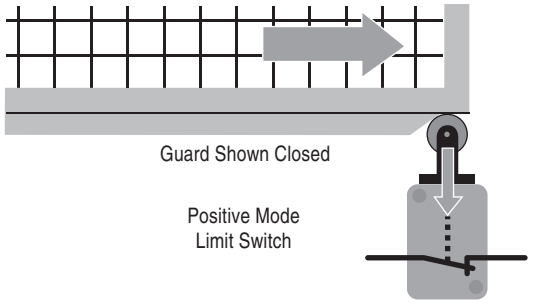


Figure 73: Positive Mode Limit Switch

Position (limit) interlocks must not be used on lift-off or hinged guards.

It is extremely important that the switch plunger can only extend when the guard is fully closed. This means that it may be necessary to install additional stops to limit the guard movement in both directions.

It is necessary to fabricate a suitably profiled cam that will operate within defined tolerances. The guard-mounted cam must never become separated from the switch as this will cause the switch contacts to close. Such a system can be prone to failures due to wear, especially when badly profiled cams or the presence of abrasive materials is a factor.

It is often advisable to use two switches as shown in Figure 74. One operates in positive mode (direct action to open contact), and one operates in negative mode (spring return).

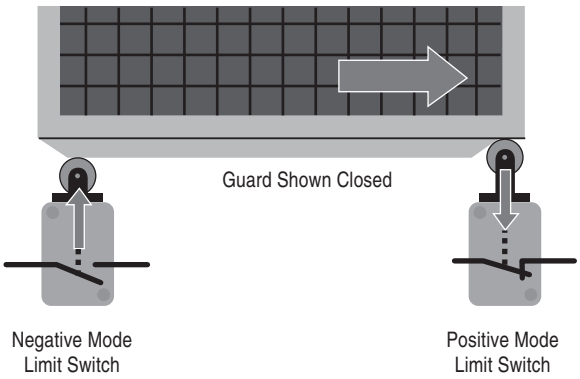


Figure 74: Diverse Redundant Position Switches

Trapped Key Interlocks

Trapped keys can perform control interlocking as well as power interlocking. With “control interlocking,” an interlock device initiates a stop command to an intermediate device, which turns off a subsequent device to disconnect the energy from the actuator. With “power interlocking,” the stop command directly interrupts the energy supply to the machine actuators.

The most practical method of power interlocking is a trapped key system (see Figure 75). The power isolation switch is operated by a key that is trapped in position while the switch is in the ON position. When the key is turned, the isolation switch contacts are locked open (isolating the power supply) and the key can be withdrawn.

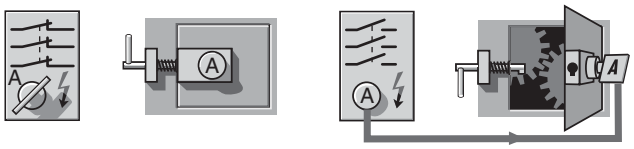


Figure 75: Power Interlocking with Trapped Key System

The guard door is locked closed and the only way to unlock it is by using the key from the isolator. When turned to release the guard locking unit, the key is trapped in position and cannot be removed until the guard is closed and locked again.

Therefore it is impossible to open the guard without first isolating the power source and it is also impossible to switch on the power without closing and locking the guard.

This type of system is extremely reliable and has the advantage of not requiring electrical wiring to the guard. The main disadvantage is that because it requires the transfer of the key every time, it is not suitable if guard access is required frequently.

Whenever whole body access is required, the use of a personnel key is recommended. As shown in Figure 76, the “B” key is the personnel key. The “B” key is taken by the operator into the hazard area. The trapped key range is available in double, triple, and quad key versions for multiple access points. The use of a personnel key ensures that the operator cannot be locked in the guarded area. The key can also be taken into the cell and inserted into another switch to enable functions like robot teach and machine jog modes.

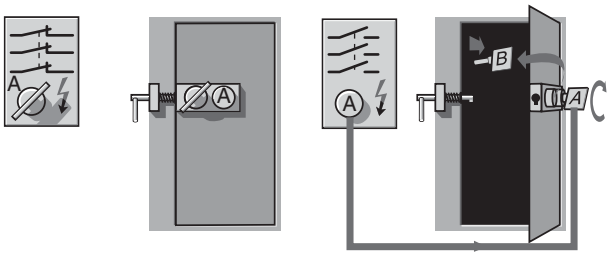


Figure 76: Full Body Access—Operator Takes "B" Key

In another example shown in Figure 77, rotate and remove Key “A” from the power isolator. Power is then OFF. To gain access through guard doors Key “A” is inserted and rotated in the Key Exchange Unit. Both “B” Keys are then released for guard locks. Key “A” is trapped preventing power from being switched on. Two “C” Keys are released from the guard door locks for use in the next sequence step or as personnel keys.

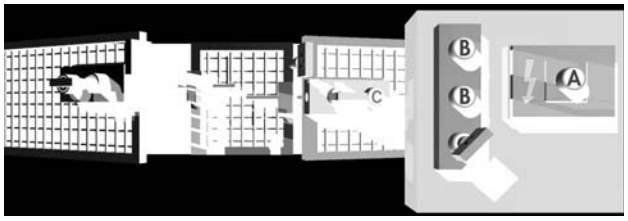


Figure 77: Multiple Doors Are Accessible

Figures 78 shows another example of trapped key interlock applications by using both single and double key locking units and keys with different codes together with a key exchange unit, complex systems can be formed. Besides ensuring that the power is isolated before access can be gained it is also possible to use the system to enforce a pre-defined sequence of operation.

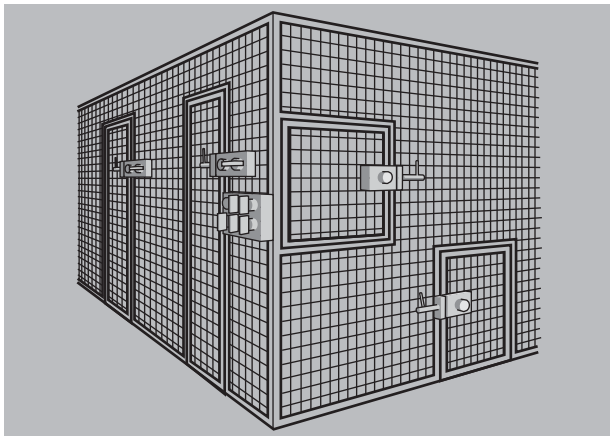


Figure 78: Defined Sequence of Events

Because the entire safety of this type of system depends on its mechanical operation it is critical that the principles and materials used are suitable for the expected demand made on them.

If an isolation switch is part of the system it should have positive mode operation and it should satisfy the requirements of the relevant parts of IEC 60947.

The integrity and security of the system revolves around the fact that under certain conditions the keys are trapped in place, therefore two basic features need to be ensured:

1. THE LOCK CAN ONLY BE OPERATED BY THE DEDICATED KEY.

This means that it should not be possible to “cheat” the lock by using screwdrivers, etc., or defeat the mechanism by mistreating it in any straightforward manner. Where there is more than one lock on the same site it also means that the specifying of key codes must in itself prevent any possibility of spurious operation.

2. IT IS NOT POSSIBLE TO OBTAIN THE KEY IN ANY WAY OTHER THAN THE INTENDED MANNER.

This means that, for example, once the key is trapped, any excessive force applied to it will result in a broken key as opposed to a broken lock.

Operator Interface Devices

Stop Function

In the U.S., Canada, Europe, and at the international level, harmonization of standards exist with regard to the descriptions of stop categories for machines or manufacturing systems.

NOTE: these categories are different to the categories from EN 954-1 (ISO 13849-1). See standards NFPA79 and IEC/EN60204-1 for further details. Stops fall into three categories:

- Category 0 is stopping by immediate removal of power to the machine actuators. This is considered an uncontrolled stop. With power removed, braking action requiring power will not be effective. This will allow motors to free spin and coast to a stop over an extended period of time. In other cases, material may be dropped by machine holding fixtures, which require power to hold the material. Mechanical stopping means, not requiring power, may also be a used with a category 0 stop. The category 0 stop takes priority over category 1 or category 2 stops.
- Category 1 is a controlled stop with power available to the machine actuators to achieve the stop. Power is then removed from the actuators when the stop is achieved. This category of stop allows powered braking to quickly stop hazardous motion, and then power can be removed from the actuators.
- Category 2 is a controlled stop with power left available to the machine actuators. A normal production stop is considered a category 2 stop.

These stop categories must be applied to each stop function, where the stop function is the action taken by the safety related parts of the control system in response to an input, category 0 or 1 should be used. Stop functions must override related start functions. The selection of the stop category for each stop function must be determined by a risk assessment.

Emergency Stop Function

The emergency stop function must operate as either a category 0 or category 1 stop, as determined by a risk assessment. It must be initiated by a single human action. When executed, it must override all other functions and machine operating modes. The objective is to remove power as quickly as possible without creating additional hazards.

Until recently, hardwired electro-mechanical components were required for e-stop circuits. Recent changes to standards such as IEC 60204-1 and NFPA 79 mean that safety PLCs and other forms of electronic logic meeting the requirements of standards like IEC61508, can be used in the e-stop circuit.

Emergency Stop Devices

Wherever there is a danger of an operator getting into trouble on a machine there must be a facility for fast access to an emergency stop device. The e-stop device must be continuously operable and readily available. Operator panels should contain at least one e-stop device. Additional e-stop devices may be used at other locations as needed. E-Stop devices come in various forms. Pushbutton switches and cable pull switches are examples of the more popular type devices. When the e-stop device is actuated, it must latch in and it must not be possible to generate the stop command without latching in. The resetting of the emergency stop device must not cause a hazardous situation. A separate and deliberate action must be used to re-start the machine.

For further information on e-stop devices, read ISO/EN13850, IEC 60947-5-5, NFPA79 and IEC60204-1, AS4024.1, Z432-94.

Emergency Stop Buttons

Emergency stop devices are considered complimentary safeguarding equipment. They are not considered primary safeguarding devices because they do not prevent access to a hazard nor do they detect access to a hazard.

The usual way of providing this is in the form of a red-colored mushroom-headed push button on a yellow background which the operator strikes in the event of an emergency (see Figure 79). They must be strategically placed in sufficient quantity around the machine to ensure that there is always one in reach at a hazard point.

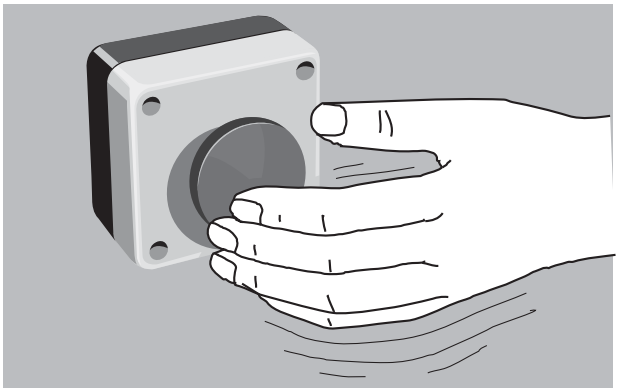


Figure 79: E-Stop Push Button—Red Colored Mushroom Head on a Yellow Background

E-Stop buttons must be readily accessible and must be available in all modes of machine operation. When a pushbutton is used as an e-stop device, it must be a mushroom (or palm operated) shaped, red colored, with a yellow background. When the button is pressed, the contacts must change state at the same time the button latches in the depressed position.

One of the latest technologies to be applied to e-stops is a self-monitoring technique. An additional contact is added to the back e-stop that monitors whether the back of the panel components are still present. This is known as a self-monitoring contact block. It consists of a spring actuated contact that closes when the contact block is snapped into place onto the panel. Figure 80 shows the self-monitoring contact connected in series with one of the direct opening safety contacts.

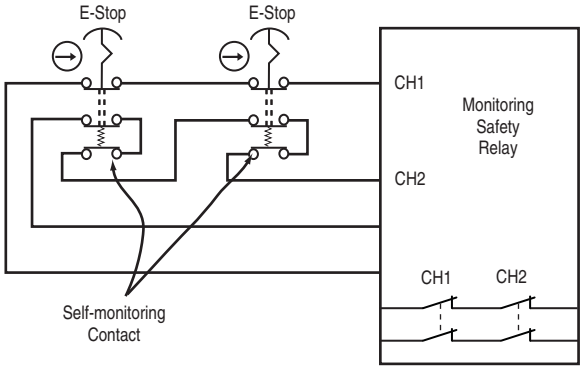


Figure 80: Self-Monitoring Contacts on E-Stop

Cable Pull Switches

For machinery such as conveyors, it is often more convenient and effective to use a cable pull device along the hazard area (as shown in Figure 81) as the emergency stop device. These devices use a steel wire rope connected to latching pull switches so that pulling on the rope in any direction at any point along its length will trip the switch and cut off the machine power.

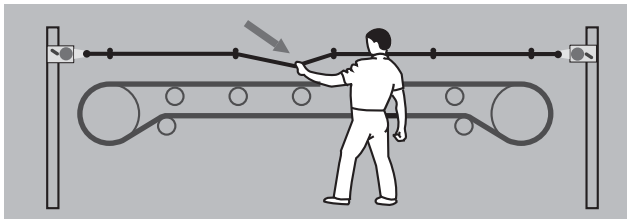


Figure 81: Cable Pull Switches

The cable pull switches must detect both a pull on the cable as well as when the cable goes slack. Slack detection ensures that the cable is not cut and is ready for use.

Cable distance affects performance of the switch. For short distances, the safety switch is mounted on one end and a tension spring mounted at the other. For longer distances, a safety switch must be mounted at both ends of the cable to ensure that a single action by the operator initiates a stop command.

The required cable pull force should not exceed 200 N (45 lb) or a distance of 400 mm (15.75 in.) at a position centered between two cable supports.

Two-Hand Controls

The use of two-hand controls (also referred to as bi-manual controls) is a common method of preventing access while a machine is in a dangerous condition. Two controls must be operated concurrently (within 0.5 s of each other) to start the machine. This ensures that both hands of the operator are occupied in a safe position (i.e., at the controls) and therefore cannot be in the hazard area. The controls must be operated continuously during the hazardous conditions. Machine operation must cease when either of the controls are released, if one control is released, the other control must also be released before the machine can be restarted.

A two-hand control system depends heavily on the integrity of its control and monitoring system to detect any faults, so it is important that this aspect is designed to the correct specification. Performance of the two-hand safety system is characterized into Types by ISO 13851 (EN 574) as shown and they are related to the Categories from ISO 13849-1. The types most commonly used for machinery safety are IIIB and IIIC. Table 4.1 shows the relationship of the types to the categories of safety performance.

	Types				
			III		
Requirements	I	II	A	B	C
Synchronous actuation			X	X	X
Use of Category 1 (from ISO 13849-1)	X		X		
Use of Category 3 (from ISO 13849-1)		X		X	
Use of Category 4 (from ISO 13849-1)					X

Table 3: Two-Hand Control Types and Categories

The physical design spacing should prevent improper operation (e.g., by hand and elbow). This can be accomplished by distance or shields as the examples shown in Figure 82.

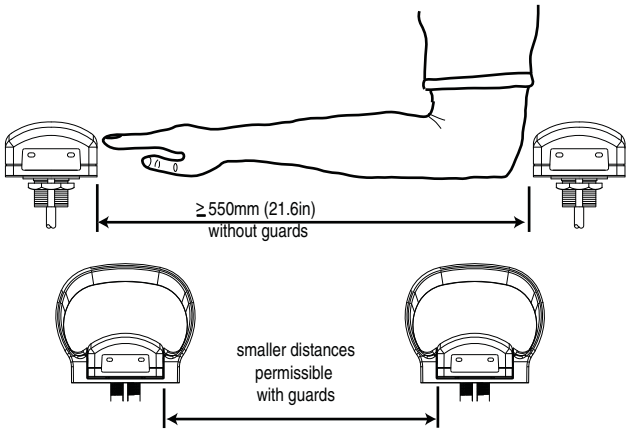


Figure 82: Separation of Two hand Controls

The machine should not go from one cycle to another without the releasing and pressing of both buttons. This prevents the possibility of both buttons being blocked, leaving the machine running continuously. Releasing of either button must cause the machine to stop.

The use of two-hand control should be considered with caution as it usually leaves some form of risk exposed. The two-hand control only protects the person using them. The protected operator must be able to observe all access to the hazard, as other personnel may not be protected.

ISO 13851 (EN574) provides additional guidance on two-hand control.

Enabling Devices

Enabling devices are controls that allow an operator to enter a hazard area with the hazard running only while the operator is holding the enabling device in the actuated position. Enabling devices use either two-position or three position types of switches. Two position types are off when the actuator is not operated, and are on when the actuator is operated. Three position switches are off when not actuated (position 1), on when held in the center position (position 2) and off when the actuator is operated past the mid position (position 3). In addition, when returning from position 3 to 1, the output circuit must not close when passing through position 2. This concept is shown in Figure 83.

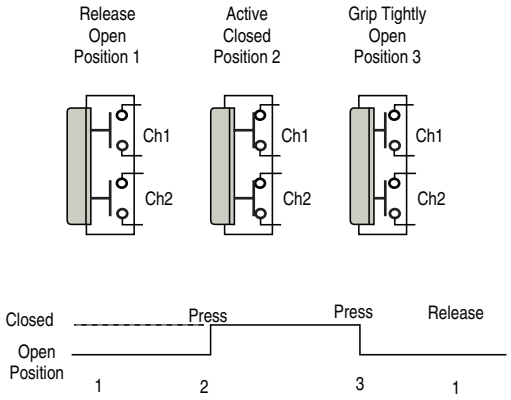


Figure 83: Three-Position Enabling Switch Operation

Enabling devices must be used in conjunction with other safety related function. A typical example is placing the motion is a controlled slow mode. Once in slow mode, an operator can enter the hazard area holding the enabling device.

When using an enabling device, a signal must indicate that the enabling device is active.

Logic Devices

Logic devices play the central role of the safety related part of the control system. Logic devices perform the checking and monitoring of the safety system and either allow the machine to start or execute commands to stop the machine.

A range of logic devices are available to create a safety architecture that meets the complexity and the functionality required for the machine. Small hardwired monitoring safety relays are most economical for smaller machines where a dedicated logic device is needed to complete the safety function. Modular and configurable monitoring safety relays are preferred where a large and diverse number of safeguarding devices and minimal zone control are required. The medium to large and more complex machine will find programmable systems with distributed I/O to be preferable.

Monitoring Safety Relays

Monitoring safety relay (MSR) modules play a key role in many safety systems. These modules are usually comprised of two or more positively guided relays with additional circuitry to ensure the performance of the safety function.

Positive guided relays are specialized “ice-cube” relays. Positively guided relays must meet the performance requirements of EN50025. Essentially, they are designed to prevent the normally closed and normally open contacts from being closed simultaneously. Newer designs replace the electromechanical outputs with safety rated solid state outputs.

Monitoring safety relays perform many checks on the safety system. Upon power-up, they perform self-checks on their internal components. When the input devices are activated, the MSR compares the results of redundant inputs. If acceptable, the MSR checks external actuators. If okay, the MSR awaits a reset signal to energize its outputs.

The selection of the appropriate safety relay is dependent on a number of factors: type of device it monitors, the type of reset, the number and type of outputs.

Inputs Types

Safeguarding devices have different types of methods of indicating something has happened:

- Contact Interlocks and E-stops:
  Mechanical contacts, single channel with one normally closed contact or dual channel, both normally closed. The MSR must be able to accept single or dual channel and provide cross fault detection for the dual channel arrangement.
- Non-Contacts Interlocks and E-stops
  Mechanical contacts, dual channel, one normally open and one normally closed contact. The MSR must be able to process diverse inputs.
- Output Solid State Switching Devices
  Light curtains, laser scanners, solid-state non-contacts have two sourcing outputs and perform their own cross fault detection. The MSR must be able to ignore the devices cross fault detection method.
- Mats:
  Mats create a short circuit between two channels. The MSR must be able to withstand the repeated short circuits.
- Edges:
  Some edges are designed like 4-wire mats. Some are two wire devices that create a change in resistance. The MSR must be able to detect a short circuit or the change resistance.
- Voltage
  Measures the Back EMF of a motor during rundown. The MSR must be able to tolerate high voltages as well as detect low voltages as the motor spins down.
- Stopped Motion
  The MSR must detect pulse streams from diverse, redundant sensors.
- Two-hand Control
  The MSR must detect normally open and normally closed diverse inputs as well as provide 0.5s timing and sequencing logic.

Input Impedance

The input impedance of the monitoring safety relays determines how many input devices can be connected to the relay and how far away the input devices can be mounted. For example, a safety relay may have a maximum allowable input impedance of 500 ohms (Ω). When the input impedance is greater than 500Ω, it will not switch on its outputs. Care must be taken by the user to ensure that the input impedance remains below the maximum specification. The length, size and type of wire used affects input impedance. Table 4 shows typical resistance of annealed copper wire at 25°C.

ISO Cross Section mm²	AWG Size	Ω per 1000 m	Ω per 1000 ft
0.5	20	33.30	10.15
0.75	18	20.95	6.385
1.5	16	13.18	4.016
2.5	14	8.28	2.525
4	12	5.21	1.588

Table 4: Wire Resistance Values

Number of Input Devices

The risk assessment process should be used to help determine how many inputs devices should be connected to a monitoring safety relay unit MSR and how often the input devices should be checked. To assure that E-Stops and gate interlocks are in an operational state, they should be checked for operation at regular intervals, as determined by the risk assessment. For example, a dual channel input MSR connected to an interlocked gate that must be opened every machine cycle (e.g., several times per day) may not have to be checked. This is because opening the guard causes the MSR to check itself, its inputs and its outputs (depending on configuration) for single faults. The more frequent the guard opening the greater the integrity of the checking process.

Another example might be E-Stops. Since E-Stops are typically used only for emergencies, they are likely to be rarely used. Therefore a program should be established to exercise the E Stops and confirm their effectiveness on a scheduled basis. Exercising the safety system in this way is called performing a Proof Test, and the time in between Proof Tests is called the Proof Test Interval. A third example might be access doors for machine adjustments, which like E-Stops might be rarely used Here again a program should be established to exercise the checking function on a scheduled basis.

The risk assessment will help determine whether the input devices need to be checked and how often they should be checked. The higher the level of risk, the greater integrity required of the checking process. And the less frequent the "automatic" checking, the more frequent should be the imposed "manual" check.

Input Crossfault Detection

In dual channel systems, channel-to-channel short circuit faults of the input devices, also known as cross faults, must be detected by the safety system. This is accomplished by the sensing device or the monitoring safety relay.

Microprocessor based monitoring safety relays, like light curtains, laser scanners and the advanced non-contact sensors detect these shorts in a variety of ways. One common way of detecting cross faults is by using diverse pulse testing shown in Figure 84. The output signals are pulsed very quickly. The channel 1 pulse is offset from the channel 2 pulse. If a short occurs, the pulses occur concurrently and are detected by the device.

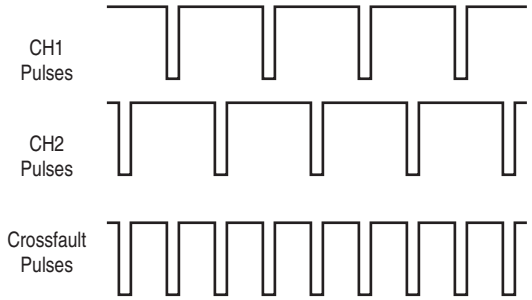


Figure 84: Pulse Testing to Detect Crossfaults

Electro-mechanical based monitoring safety relays employ a different diversity technique: one pull-up input and one pull-down input. This is shown in Figure 85. A short from Channel 1 to Channel 2 will make the overcurrent protection device active and the safety system will shut down.

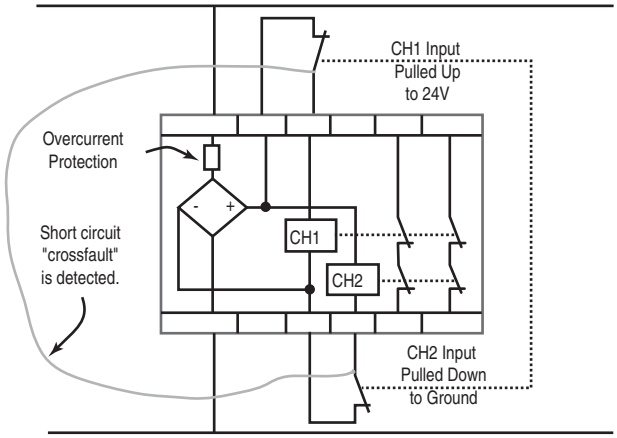


Figure 85: Diverse Inputs Detect Crossfaults

Outputs

MSRs come with various numbers of outputs. The types of outputs help determine which MSR must be used in specific applications.

Most MSRs have at least 2 immediately operating safety outputs. MSR safety outputs are characterized as normally-open. These are safety rated due to the redundancy and internal checking.

A second type of output is delayed outputs. Delayed outputs are typically used in Category 1 stops, where the machine requires time to execute the stopping function before allowing access to the hazard area. Figure 86 shows the symbols used for immediate and delayed contacts.

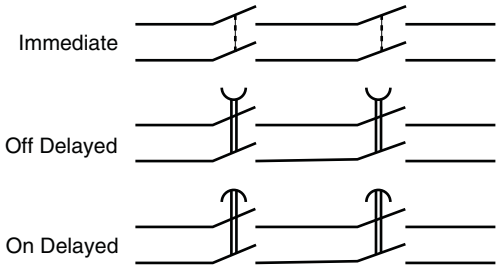


Figure 86: Symbols for Contact Types

MSRs also have auxiliary outputs. Generally these are considered normally closed. Figure 87 shows three arrangements of normally closed contacts. The circuit on the left only allows the normally closed contacts to be used as auxiliary circuits as a single fault in CH1 or CH2 will close the circuit. The middle arrangement can be auxiliary usage as shown or safety usage if connected in series. The circuit on the right shows the normally closed contacts in a redundant arrangement, so they can be used in safety related circuits.

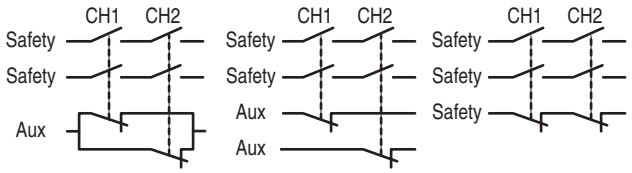


Figure 87: NC Contact Usage

Output Ratings

Output ratings describe the ability of the safeguarding device to switch loads. Typically, the ratings for industrial devices are described as resistive or electromagnetic. A resistive load may be a heater type element. Electromagnetic loads are typically relays, contactors, or solenoids; where there is a large inductive characteristic of the load. Annex A of standard IEC 60947-5-1, shown in Table 5 describes the ratings for loads.

Designation Letter: The designation is a letter followed by a number, for example A300.

The letter relates to the conventional enclosed thermal current and whether that current is direct or alternating. For example A represents 10 amps alternating current. The number stands for the rated insulation voltage. For example, 300 represents 300V.

Designation	Utilization	Enclosed Thermal Current	Rated Operational Current Ie at the Rated Operational Voltage Ue						VA	
			120V	240V	380V	480V	500V	600V	Make	Break
A150	AC-15	10	6	—	—	—	—	—	7200	720
A300	AC-15	10	6	3	—	—	—	—	7200	720
A600	AC-15	10	6	3	1.9	1.5	1.4	1.2	7200	720
B150	AC-15	5	3	—	—	—	—	—	3600	360
B300	AC-15	5	3	1.5	—	—	—	—	3600	360
B600	AC-15	5	3	1.5	0.95	0.92	0.75	0.6	3600	360
C150	AC-15	2.5	1.5	—	—	—	—	—	1800	180
C300	AC-15	2.5	1.5	0.75	—				1800	180
C600	AC-15	2.5	1.5	0.75	0.47	0.375	0.35	0.3	1800	180
D150	AC-14	1.0	0.6	—	—	—	—	—	432	72
D300	AC-14	1.0	0.6	0.3	—	—	—	—	432	72
E150	AC-14	0.5	0.3	—	—	—	—	—	216	36
Direct Current			125V	250V		400V	500V	600V		
N150	DC-13	10	2.2	—		—	—	—	275	275
N300	DC-13	10	2.2	1.1		—	—	—	275	275
N600	DC-13	10	2.2	1.1		0.63	0.55	0.4	275	275
P150	DC-13	5	1.1	—		—	—	—	138	138
P300	DC-13	5	1.1	0.55		—	—	—	138	138
P600	DC-13	5	1.1	0.55		0.31	0.27	0.2	138	138
Q150	DC-13	2.5	0.55	—		—	—	—	69	69
Q300	DC-13	2.5	0.55	0.27		—	—	—	69	69
Q600	DC-13	2.5	0.55	0.27		0.15	0.13	0.1	69	69
R150	DC-13	1.0	0.22	—		—	—	—	28	28
R300	DC-13	1.0	0.22	0.1		—	—	—	28	28

Table 5: Contact Ratings for Inductive Load Switching

Utilization: The Utilization describes the types of loads the device is designed to switch. The utilizations relevant to IEC 60947-5 are shown in Table 6.

Utilization	Description of Load
AC-12	Control of resistive loads and solid-state loads with isolation by opto-couplers
AC-13	Control of solid-state loads with transformer isolation
AC-14	Control of small electromagnetic loads (less than 72 VA)
AC-15	Electromagnetic loads greater than 72 VA
DC-12	Control of resistive loads and solid-state loads with isolation by opto-couplers
DC-13	Control of electromagnets
DC-14	Control of electromagnetic loads having economy resistors in circuit

Table 6: Utilization Categories

Thermal Current, Ith: The conventional enclosed thermal current is the value of current used for the temperature-rise tests of the equipment when mounted in a specified enclosure.

Rated Operational Voltage Ue and Current Ie; The rated operational current and voltage specify the making and breaking capacities of the switching elements under normal operating conditions. The Allen-Bradley Guardmaster products are specifically rated at 125V AC, 250V AC and 24V DC. Consult the factory for usage at voltages other than these specified ratings.

VA: The VA (Voltage x Amperage) ratings indicate the ratings of the switching elements when making the circuit as well as breaking the circuit.

Example 1: An A150, AC-15 rating indicates that the contacts can make a 7200V A circuit. At 120V AC, the contacts can make a 60 amp inrush circuit. Since the AC-15 is an electromagnetic load, the 60 amp is only for a short duration; the inrush current of the electromagnetic load. The breaking of the circuit is only 720V A because the steady state current of the electromagnetic load is 6 A, which is the rated operational current.

Example 2: An N150, DC-13 rating indicates that the contacts can make a 275V A circuit. At 125V AC, the contacts can make a 2.2 amp circuit. DC electromagnetic loads do not have an inrush current like AC electromagnetic loads. The breaking of the circuit is also 275V A because the steady state current of the electromagnetic load is 2.2, which is the rated operational current.

Machine Restart

If, for example, an interlocked guard is opened on an operating machine, the safety interlock switch will stop that machine. In most circumstances it is imperative that the machine does not restart immediately when the guard is closed. A common way of achieving this is to rely on a latching contactor start arrangement as shown in Figure 88. An interlocked guard door is used as an example here but the requirements apply to other protection devices and emergency stop systems.

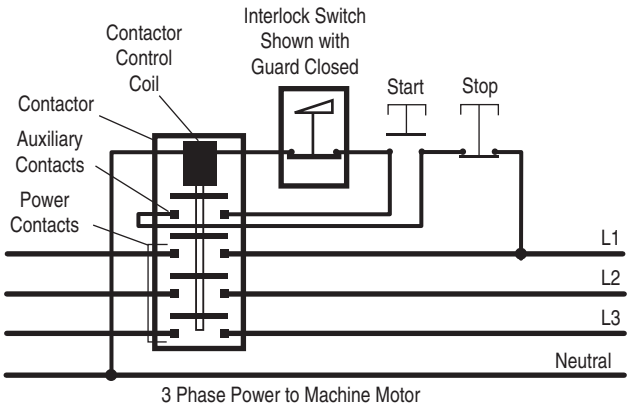


Figure 88: Simple Machine Start Stop Interlock Circuit

Pressing and releasing the start button momentarily energizes the contactor control coil which closes the power contacts. As long as power is flowing through the power contacts the control coil is kept energized (electrically latched) via the contactor's auxiliary contacts which are mechanically linked to the power contacts. Any interruption to the main power or control supply results in the de-energizing of the coil and opening of the main power and auxiliary contacts. The guard interlock is wired into the contactor control circuit. This means that restart can only be achieved by closing the guard and then switching “ON” at the normal start button which resets the contactor and starts the machine.

The requirement for normal interlocking situations is made clear in ISO 12100-1 Paragraph 3.22.4 (extract).

When the guard is closed, the hazardous machine functions covered by the guard can operate, but the closure of the guard does not by itself initiate their operation.

Many machines already have either single or double contactors which operate as described above (or have a system which achieves the same result). When fitting an interlock to existing machinery it is necessary to determine whether the power control arrangement meets this requirement and take additional measures if necessary.

Reset Functions

Allen-Bradley Guardmaster monitoring safety relays are designed with either monitored manual reset or automatic/manual reset.

Monitored Manual Reset

A monitored manual reset requires a change of state of the reset circuit after the gate is closed or the E-Stop is reset. Figure 89 shows a typical configuration of a reset switch connected in the output monitoring circuit of a safety relay with a monitored manual reset function. The mechanically linked normally closed auxiliary contacts of the power switching contactors are connected in series with a momentary push button. After the guard has been opened and closed again, the safety relay will not allow the machine to be restarted until there is a change of state at the reset button. This is in compliance with the intent of the requirements for additional manual reset as given in EN ISO 13849-1. i.e., the reset function ensures that both contactors are OFF and that both interlock circuits (and therefore the guards) are closed and also (because a change of state is required) that the reset actuator has not been bypassed or blocked in any way. If these checks are successful the machine can then be restarted from the normal controls. EN ISO 13849-1 cites the change of state from energized to de-energized but the same protective principle can also be achieved by the opposite effect.

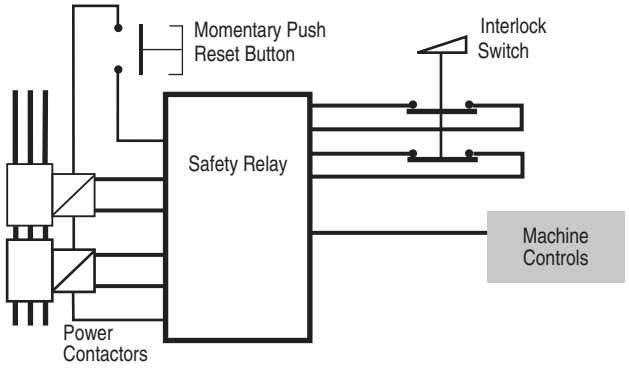


Figure 89: Monitored Manual Reset

The reset switch should be located in a place that provides a good view of the hazard so that the operator can check that the area is clear before operation.

Auto/Manual Reset

Some safety relays have automatic/manual reset. The manual reset mode is not monitored and reset occurs when the button is pressed. A short circuited or jammed in reset switch will not be detected. With this approach it may not be possible to achieve the requirements for additional manual reset as given in EN ISO 13849-1 unless additional means are used.

Alternatively the reset line can be jumpered allowing an automatic reset. The user must then provide another mechanism for preventing machine start-up when the gate closes.

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Alternatively the reset line can be jumpered allowing an automatic reset. The user must then provide another mechanism for preventing machine start-up when the gate closes.

An auto-reset device does not require a manual switching action but after de-actuation it will always conduct a system integrity check before resetting the system. An auto-reset system should not be confused with a device without reset facilities. In the latter the safety system will be enabled immediately after de-actuation but there will be no system integrity check.

Control Guards

A control guard stops a machine when the guard is opened and directly starts it again when the guard is closed. The use of control guards is only allowed under certain stringent conditions because any unexpected start-up or failure to stop would be extremely dangerous. The interlocking system must have the highest possible reliability (it is often advisable to use guard locking). The use of control guards can ONLY be considered on machinery where there is NO POSSIBILITY of an operator or part of his body staying in or reaching into the danger zone while the guard is closed. The control guard must be the only access to the hazard area.

Safety Programmable Logic Controls

The need for flexible and scaleable safety applications drove the development of safety PLCs/controllers. Programmable safety controllers provide users the same level of control flexibility in a safety application that they are accustomed to with standard programmable controllers. However there are extensive differences between standard and safety PLCs. Safety PLCs, shown in Figure 90 come in various platforms to accommodate the scalability, functional and integration requirements of the more complex safety systems.



Figure 90: Safety PLC Platforms

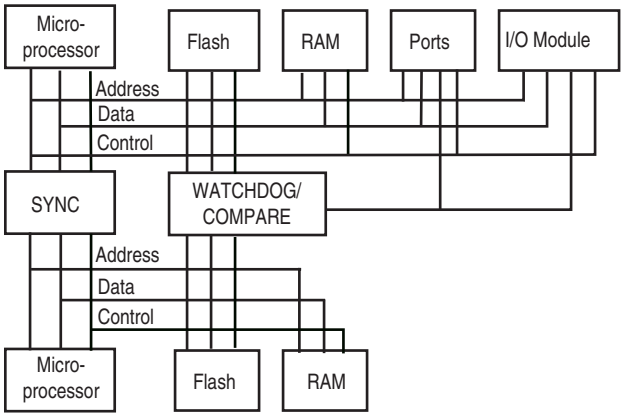


Figure 91: 1oo2D Architecture

Multiple microprocessors are used to process the I/O, memory, and safe communications. Watchdog circuits perform diagnostic analysis. This type of construction is known as 1oo2D, because either one of the two microprocessors can perform the safety function, and extensive diagnostics are performed to ensure that both microprocessors are operating in sync.

Also, each input circuit is internally tested many times each second to make sure that it is operating correctly. Figure 92 shows a block diagram of an input. You may only hit the E-Stop once a month; but when you do, the circuit has been continuously tested so that the E-Stop will be sensed correctly internal to the safety PLC.

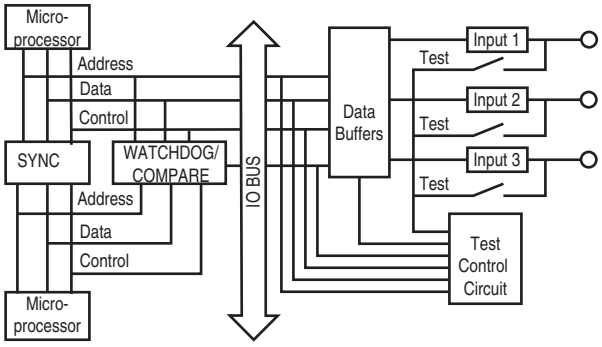


Figure 92: Block Diagram of a Safety Input Module

Safety PLC outputs are electromechanical or safety rated solid state. Figure 93 shows multiple switches in every output circuit of a safety PLC. Like the input circuits, the output circuits are tested multiple times every second to make sure that they can turn the output off. If one of the three fails, the output is turned off by the other two, and the fault is reported by the internal monitoring circuit.

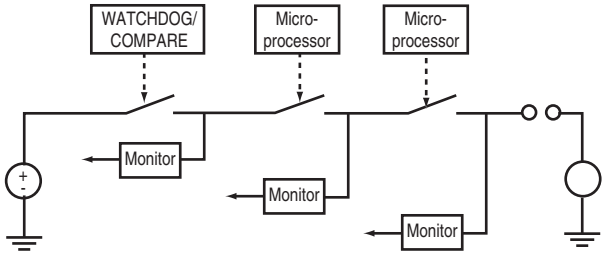


Figure 93: Safety Output Module Block Diagram

When using safety devices with mechanical contacts (E-stops, gate switches, etc), the user can apply pulse test signals to detect cross faults. To not use up expensive safety outputs, many safety PLCs provides specific pulsing outputs that can be connected to mechanical contact devices. A wiring example is shown in Figure 94. In this example, outputs O1, O2, O3, and O4 are all pulsing at different rates. The safety PLC expects to see these different pulse rates reflected in the inputs. If identical pulse rates are detected, a cross fault has occurred and appropriate action is taken in the safety PLC.

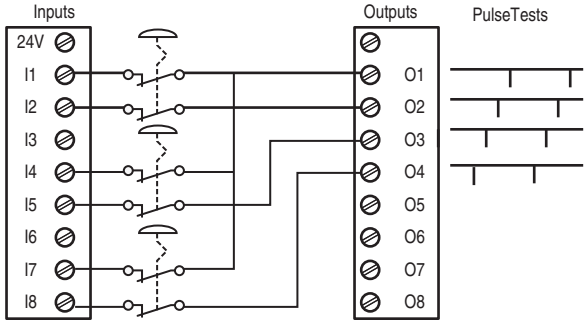


Figure 94: Pulse Testing of 2 N.C. Mechanical Inputs

Software

Safety PLCs program very much like standard PLCs do. All of the additional diagnostics and error checking mentioned earlier is done by the operating system, so the programmer is not even aware that it is happening. Most safety PLCs will have special instructions used to write the program for the safety system, and these instructions tend to mimic the function of their safety relay counterparts. For example, the Emergency Stop instruction in Figure 95 operates very much like an MSR127. Though the logic behind each of these instructions is complex, the safety programs look relatively simple because the programmer simply connects these blocks together. These instructions, along with other logical, math, data manipulation, etc. instructions are certified by a third party to ensure their operation is consistent with the applicable standards.

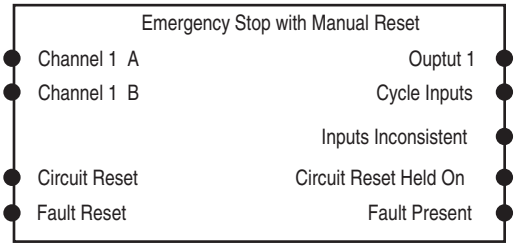


Figure 95: E-Stop Function Block

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Function blocks are the predominant methods for programming safety functions. In addition to Function Blocks and Ladder Logic, safety PLCs also provide certified safety application instructions. Certified safety instructions provide application specific behavior. This example shows an emergency stop instruction. To accomplish the same function in ladder logic would require approximately 16 rungs of ladder logic. Since the logic behavior is embedded in the E-Stop instruction, the embedded logic does not have to be tested.

Certified function blocks are available to interface with almost all safety devices. One exception to this list is the safety edge that uses resistive technology. Here is a list of certified application instructions available in the GuardPLC.

1. Diverse (1 N.O. + 1 N.C.) Input with Auto Reset
2. Diverse (1 N.O. + 1 N.C.) Input with Manual Reset
3. Emergency Stop with Auto Reset
4. Emergency Stop with Manual Reset
5. Redundant (2 N.C.) Input with Auto Reset
6. Redundant (2 N.C.) Input with Manual Reset
7. Redundant Output with Positive Feedback
8. Redundant Output with Negative Feedback
9. Enable Pendant with Auto Reset
10. Enable Pendant with Manual Reset
11. Two Hand Run Station with Active Pin
12. Two Hand Run Station without Active Pin
13. Light Curtain with Auto Reset
14. Light Curtain with Manual Reset
15. Five Position Mode Selector
16. Single Pulse Test Output
17. Redundant Pulse Test Output

Safety PLCs generate a “signature” that provides the ability to track whether changes were made. This signature is usually a combination of the program, input/output configuration, and a time stamp. When the program is finalized and validated, the user should record this signature as part of the validation results for future reference. If the program needs modification, revalidation is required and a new signature must be recorded. The program can also be locked with a password to prevent unauthorized changes.

Wiring is simplified with programmable logic systems as compared to monitoring safety relays. Unlike wiring to specific terminals on monitoring safety relays, input devices are connected to any input terminals and output devices are connected to any output terminals. The terminals are then assigned through software.

Integrated Safety Controllers

Safety control solutions now provide complete integration within a single control architecture where safety and standard control functions reside and work together. The ability to perform motion, drive, process, batch, high speed sequential, and SIL 3 safety in one controller provides significant benefits. The integration of safety and standard control provides the opportunity to utilize common tools and technologies which reduce costs associated with design, installation, commissioning and maintenance. The ability to utilize common control hardware, distributed safety I/O or devices on safety networks and common HMI devices reduce purchase and maintenance costs, and also reduce development time. All of these features improve productivity, the speed associated with troubleshooting and the lowering of training costs due to commonality.

Figure 96 shows an example of the integration of control and safety. The standard non-safety related control functions reside in the Main Task. The safety related functions reside in the Safety Task.

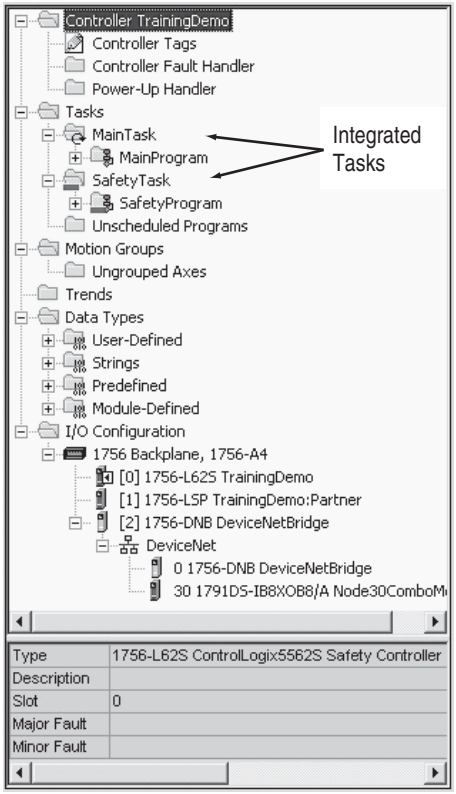


Figure 96: Integrated Safety and Nonsafety Tasks

All standard and safety related functions are isolated from each other. Figure 97 shows a block diagram of allowed interaction between the standard and safety portions of the application. For example, safety tags can be directly read by the standard logic. Safety tags can be exchanged between GuardLogix controllers over EtherNet, ControlNet or DeviceNet. Safety tag data can be directly read by external devices, Human Machine Interfaces (HMI), personal computers (PC) or other controllers.

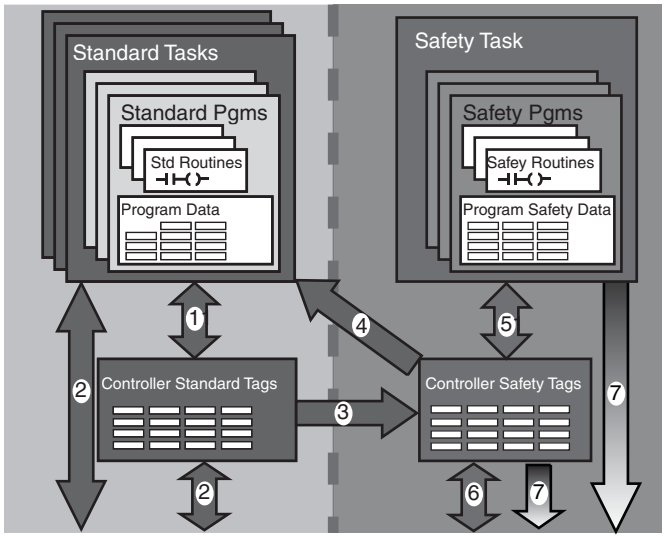


Figure 97: Standard and Safety Task Interaction

1. Standard tags and logic behave the same as ControlLogix.
2. Standard tag data, program or controller scoped and external devices, HMI, PC's, other controllers, etc.
3. As an integrated controller, GuardLogix provides the ability to move (map) standard tag data into safety tags for use within the safety task. This is to provide users the ability read status information from the standard side of GuardLogix. This data must not be used to directly control a safety output.
4. Safety tags can be directly read by standard logic.
5. Safety tags can be read or written by safety logic.
6. Safety tags can be exchanged between GuardLogix controllers over EtherNet.
7. Safety tag data, program or controller scoped can be read by external devices, HMIs, PCs, other controllers, etc. Note, once this data is read, it is considered standard data, not safety data.

Safety Networks

Plant floor communication networks have traditionally provided manufacturers the capability to improve flexibility, increase diagnostics, increase distance, reduce installation and wiring cost, ease maintainability and generally improve the productivity of their manufacturing operations. These same motivations are also driving the implementation of industrial safety networks. These safety networks allow manufacturers to distribute safety I/O and safety devices around their machinery using a single network cable, reducing installation costs while improving diagnostics and enabling safety systems of increased complexity. They also enable safe communications between safety PLCs/controllers, allowing users to distribute their safety control among several intelligent systems.

Safety networks do not prevent communication errors from occurring. Safety networks are more capable of detecting transmission errors and then allow safety devices to take the appropriate actions. Communication errors that are detected include: message insertion, message loss, message corruption, message delay, message repeat, and incorrect message sequence.

For most applications, when an error is detected the device will go to a known de-energized state, typically called a "safety state." The safety input or output device is responsible for detecting these communication errors and then going to the safe state if appropriate.

Early safety networks were tied to a particular media type or media access scheme, so manufacturers were required to use specific cables, network interface cards, routers, bridges, etc. that also became part of the safety function. These networks were limited in that they only supported communication between safety devices. This meant that manufacturers were required to use two or more networks for their machine control strategy (one network for standard control and another for safety related control) increasing installation, training and spare parts costs.

Modern safety networks allow a single network cable to communicate with safety and standard control devices. CIP (Common Industrial Protocol) Safety is an open standard protocol published by ODVA (Open DeviceNet Vendors Association) that allows for safety communications between safety devices on DeviceNet, ControlNet and EtherNet/IP networks. Because CIP Safety is an extension to the standard CIP protocol, safety devices and standard devices can all reside on the same network. Users can also bridge between networks containing safety devices, allowing them to subdivide safety devices to fine-tune safety response times, or to simply make distribution of safety devices easier. Because the safety protocol is solely the responsibility of the end devices (safety PLC/controller, safety I/O module, safety component), standard cables, network interface cards, bridges, and routers are used, eliminating any special networking hardware and removing these devices from the safety function.

Figure 98 shows a simplified example of a distributed I/O system. The operator opens the gate. The interlock switch, connected to the local Safety I/O block, sends its safety data over the DeviceNet network to the Safety PLC. The Safety PLC sends a signal back to the Safety I/O block to shut down the equipment inside of the gate and sends a standard output to a stack light to annunciate the gate is open. The HMI and the standard PLC monitors the safety data for display and additional control measures, like performing a cycle stop of adjacent equipment.

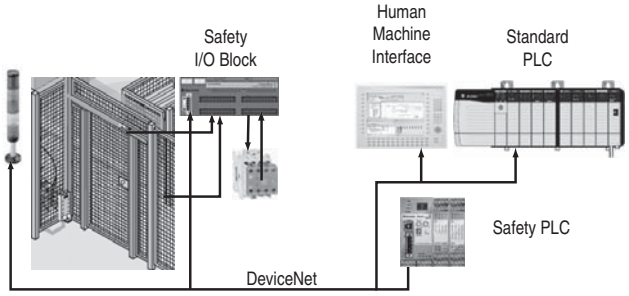


Figure 98: Example of a Simple Distributed Safety Network

For larger manufacturing systems, where safety information and control must be shared, Ethernet/IP can also be used. Figure 99 shows an example of communications between two safety controllers while DeviceNet is used for local distribution of I/O within a smaller subsystem.

Output Devices

Safety Control Relays and Safety Contactors

Control Relays and Contactors are used to remove power from the actuator. Special features are added to control relays and contactors to provide the safety rating.

Mechanically linked normally closed contacts are used to feed back the status of the control relays and contactors to the logic device. The use of mechanically linked contacts helps ensure the safety function. To meet the requirements of mechanically linked contacts, the normally closed and the normally open contacts cannot be in the closed state at the same time. IEC 60947-5-1 defines the requirements for mechanically linked contacts. If the normally open contacts were to weld, the normally closed contacts remain open by at least 0.5 mm. Conversely, if the normally closed contacts were to weld, then the normally open contacts remain open. If the product meets this requirement, the symbol shown in Figure 100 is applied to the product.

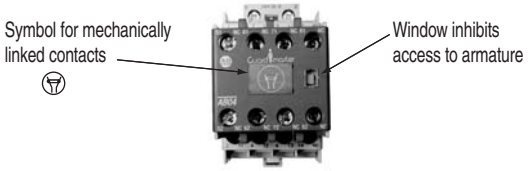


Figure 100: Mechanically Linked Contact Symbol

Safety systems must only be started at specific locations. Standard rated control relays and contactors allow the armature to be depressed to close the normally open contacts. On safety rated devices, the armature is protected from manual override to mitigate unexpected startup.

On safety control relays, the normally closed contact is driven by the main spanner. Safety contactors use an adder deck to locate the mechanically linked contacts. If the contact block were to fall off the base, the mechanically linked contacts remain closed. The mechanically linked contacts are permanently affixed to the safety control relay or safety contactor.

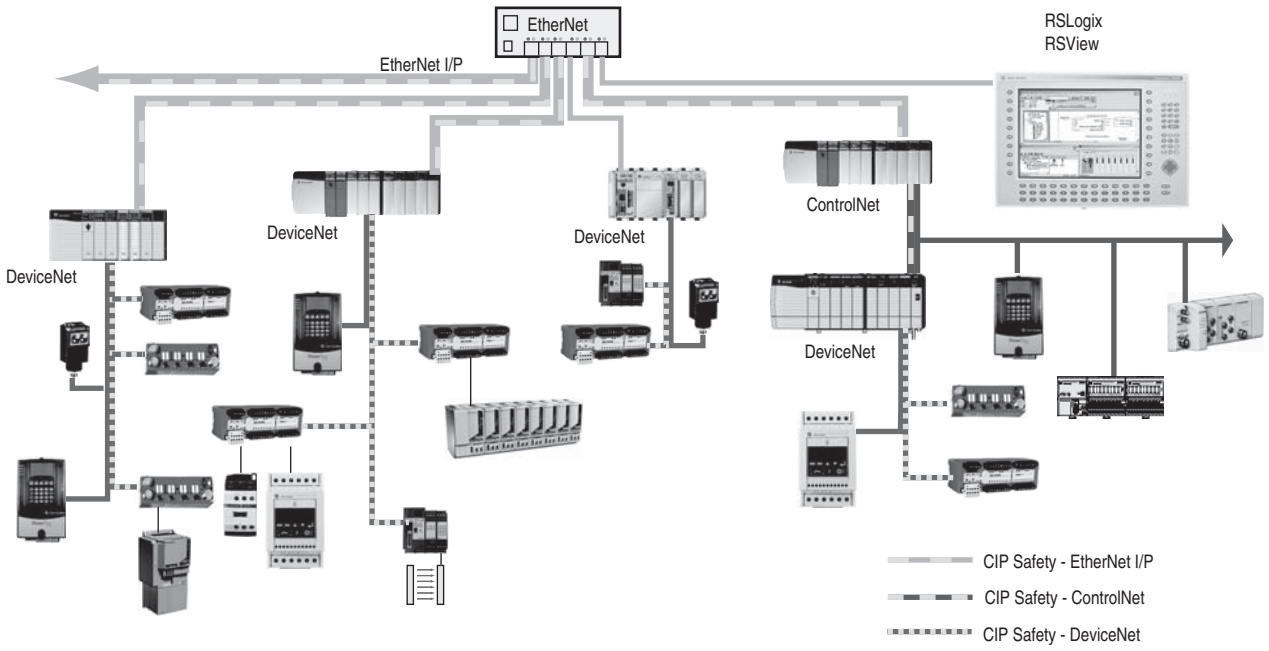


Figure 99: Example of a Complex Distributed Safety Network

On the larger contactors, an adder deck is insufficient to accurately reflect the status of the wider spanner. Mirrored contacts, shown in Figure 101 are located on either side of the contactor are used.

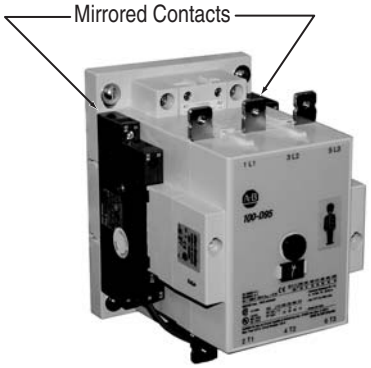


Figure 101: Mirrored Normally Closed Contacts

Dropout time of control relays or contactors play a role in the safety distance calculation. Often, a surge suppressor is placed across the coil to improve the life of the contacts driving the coil. For AC powered coils, the drop out time is not affected. For DC powered coils, the drop out time is increased. The increase is dependent on the type of suppression selected.

Control relays and contactors are designed to switch large loads, anywhere from 0.5 A to over 100 A. The safety system operates on low currents. The feedback signal generated by the safety system logic device can be on the order of a few milliamps to tens of milliamps, usually at 24V DC. The safety control relays and safety contactors use gold plated bifurcated contacts to reliably switch this small current.

Overload Protection

Overload protection for motors is required by electrical standards. Diagnostics provided by the overload protection device enhances not only equipment safety but operator safety as well. Technologies available today can detect fault conditions like an overload, phase loss, ground fault, stall, jam, under-load, current imbalance and over-temperature. Detecting and communicating abnormal conditions prior to tripping help to improve production up time and help prevent operators and maintenance people from unforeseen hazardous conditions

Figure 102 shows examples of overload protection devices. When dual contactors are used to ensure the switching off of a motor in Category 3, 4 or Control reliable solution, only one overload protection device is needed for each motor.



Figure 102: Contactor Overload Protection

Drives and Servos

Safety rated drives and servos can be used to prevent rotational energy from being delivered to achieve a safety stop as well as an emergency stop.

AC drives achieve the safety rating with redundant channels to remove power to the gate control circuitry. One channel is the Enable signal, a hardware signal that removes the input signal to the gate control circuitry. The second channel is positive guided relay that remove the power supply from the Gate control circuitry. The positive guided relay also provides a status signal back to the logic system. A block diagram of the implementation of safe off feature in the PowerFlex drive is shown in Figure 103.

This redundant approach allows the safety rated drive to be applied in emergency stop circuits without the need for a contactor.

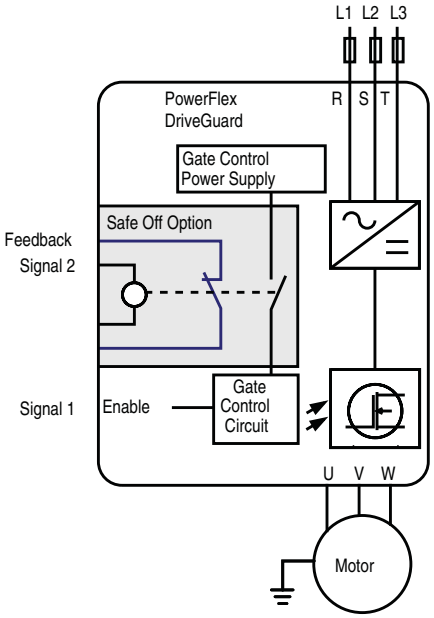


Figure 103: Drive Safety Signals

The Servo achieves a result in a manner similar to the AC drives. Figure 104 shows that redundant safety signals are used to achieve the safety function. One signal interrupts the drive to the Gate Control Circuitry. A second signal interrupts power to the power supply of the Gate control circuitry. Two positive guided relays are used to remove the signals and provide feedback to the safety logic device as well.

Connection Systems

Connection systems add value by reducing the installation and maintenance costs of safety systems. Designs must take into account consideration of single channel, dual channel, dual channel with indication and multiple types of devices.

When a series connection of dual channel interlocks is needed, a distribution block can simplify installation. Figure 105 shows a simple example of a series of interlocks connected to one port. With an IP67 rating, these types of boxes can be mounted on the machine at remote locations.

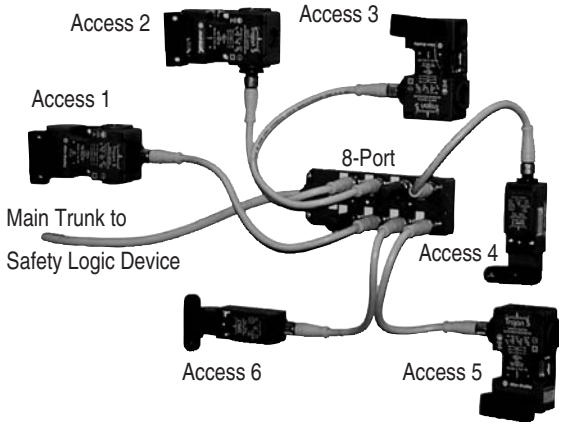


Figure 105: Safety Distribution Block

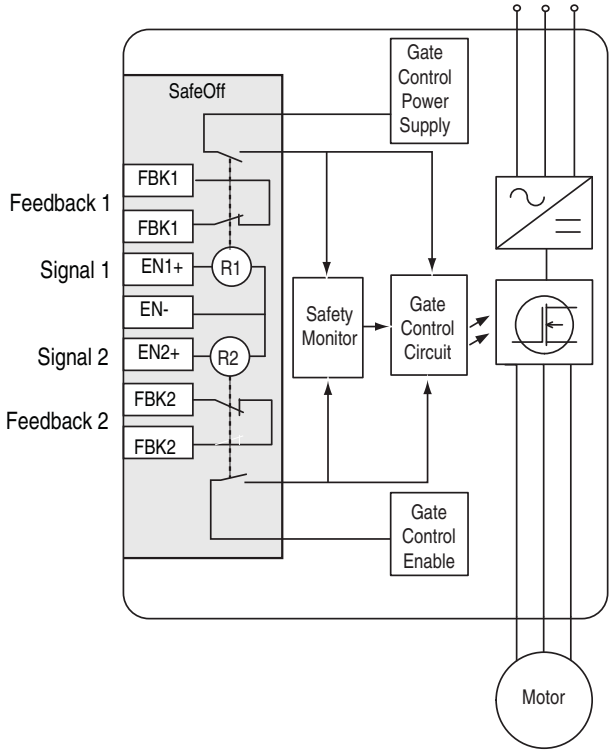


Figure 104: Kinetix Drive Safety Signals

When a diverse set of devices is required, an ArmorBlock Guard I/O box can be used. Figure 106 shows an eight port and four port block with an IP67 rating, which can be mounted directly on the machine without an enclosure. The inputs can be configured by software to accommodate various types of devices.

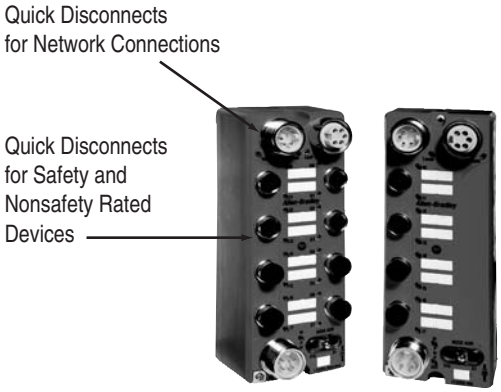


Figure 106: ArmorBlock Guard I/O

Safety Distance Calculation

Hazards must come to a safe state prior to an operator reaching the hazard. For the safety distance calculation, there are two groups of standards that have proliferated. In this chapter, these standards are grouped as follows:

ISO EN: (ISO 13855 and EN 999)

US CAN (ANSI B11.19, ANSI RIA R15.06 and CAN/CSA Z434-03)

Formula

The minimum safety distance is dependent on the time required to process the Stop command and how far the operator can penetrate the detection zone before detection. The formula used throughout the world has the same form and requirements. The differences are the symbols used to represent the variables and the units of measure.

The formulas are:

ISO EN:S =K x T+ C

US CAN: Ds =K x(Ts + Tc + Tr + Tbm) + Dpf

Where:

Ds and S are the minimum safe distance from the danger zone to the closest detection point.

Directions of Approach

When considering the safety distance calculation where a light curtains or area scanner is used, the approach to the detection device must be taken into consideration. Three types of approaches are considered:

Normal: an approach perpendicular to the detection plane

Horizontal: an approach parallel to the detection plan

Angled: an angled approach to the detection zone.

Speed Constant

K is a speed constant. The value of the speed constant is dependent on movements of the operator (i.e. hand speeds, walking speeds, and stride lengths). This parameter is based on research data showing that it is reasonable to assume a 1600 mm/sec (63 in./s) hand speed of an operator while the body is stationary. The circumstances of the actual application must be taken into account. As a general guideline, the approach speed will vary from 1600 mm/s (63 in./s) to 2500 mm/sec (100 in./s). The appropriate speed constant must be determined by the risk assessment.

Stopping Time

T is the overall stopping time of the system. The total time, in seconds, starts from the initiation of the stop signal to the cessation of the hazard. This time can be broken down to its incremental parts (Ts, Tc, Tr and Tbm) for easier analysis. Ts is the worst stopping time of the machine/equipment. Tc is the worst stopping time of the control system. Tr is the response time of the safeguarding device, including its interface. Tbm is additional stopping time allowed by the brake monitor before it detects stop-time deterioration beyond the end users' predetermined limits. Tbm is used with part revolution mechanical presses. Ts + Tc + Tr are usually measured by a stop-time measuring device if the values are unknown.

Depth Penetration Factor

The Depth Penetration Factors is represented by the symbols C and Dpf. It is the maximum travel towards the hazard before detection by the safeguarding device. Depth penetration factors will change depending on the type of device and application. Appropriate standard must be checked to determine the best depth penetration factor. For a normal approach to a light curtain or area scanner, whose object sensitivity is less than 64 mm (2.5 in.), the ANSI and Canadian standards use:

Dpf = 3.4 x (Object Sensitivity – 6.875 mm), but not less than zero.

For a normal approach to a light curtain or area scanner, whose object sensitivity is less than 40 mm (1.57 in.), the ISO and EN standards use:

C = 8 x (Object Sensitivity – 14 mm), but not less than 0

Figure 107 shows a comparison of these two factors. These two formulas have a cross over point at 19.3 mm. For object sensitivity less than 19 mm, the US CAN approach is more restrictive, as the light curtain or area scanner must be set back further from the hazard. For object sensitivities greater than 19.3 mm, the ISO EN standard is more restrictive. Machine builders, who want to build one machine for use throughout the world, must take the worst case conditions from both equations.

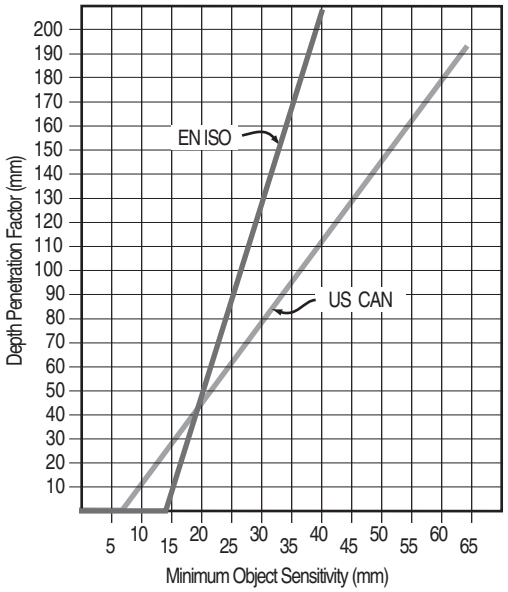


Figure 107: Depth Penetration vs. Object Sensitivity

Reach Through Applications

When larger object sensitivities are used, the US CAN and ISO EN standards differ slightly on the depth penetration factor and the object sensitivity. Figure 108 summarizes the differences. The ISO EN value is 850mm where the US CAN value is 900 mm. The standards also differ in the object sensitivity. Where the ISO EN standard allows for 40 to 70 mm, the US CAN standard allows up to 600 mm.

Safety Distance Calculation

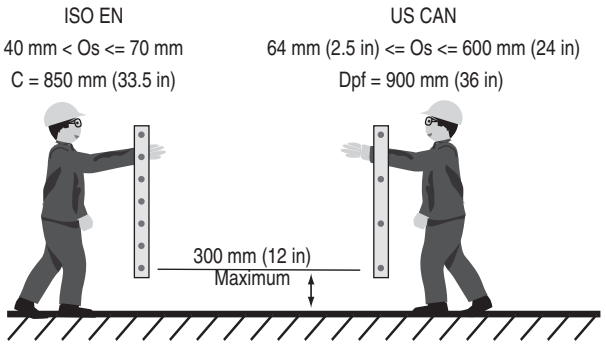


Figure 108: Depth Penetration Factors for Reach-Through Applications

Reach-Over Applications

Both standards agree that the minimum height of the lowest beam should be 300 mm, but differ with respect to the minimum height of the highest beam. The ISO EN states 900 mm, whereas the US CAN states 1200 mm. Figure 109 summarizes the differences.

The value for the highest beam seems to be moot. When considering this to be a reach-through application, the height of the highest beam will have to be much higher to accommodate an operator in a standing position. If the operator can reach over the detection plane, then the reach over criteria applies.

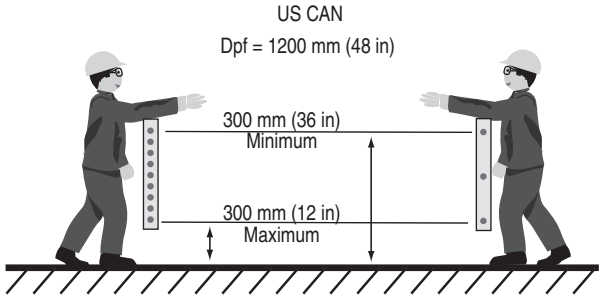


Figure 109: Depth Penetration Factors for Reach-Over Applications

Single or Multiple Beams

Single or multiple separate beams are further defined by the ISO EN standards. Table 5.1 shows the “practical” heights of multiple beams above the floor. The depth penetration is 850 mm for most cases and 1200 mm for the single beam usage. In comparison, the US CAN approach takes this into account by the Reach-Through requirements. Getting over, under or around the single and multiple beams must always be taken into consideration.

No. of Beams	Height Above the Floor [mm (in.)]	C [mm (in.)]
1	750 (29.5)	1200 (47.2)
2	400 (15.7), 900 (35.4)	850 (33.4)
3	300 (11.8), 700 (27.5), 1100 (43.3)	850 (33.4)
4	300 (11.8), 600 (23.6), 900 (35.4), 1200 (47.2)	850 (33.4)

Table 7: Single and Multiple Beam Heights and Depth Penetration Factor

Distance Calculations

For the normal approach to light curtains, the safety distance calculation for the ISO EN and U.S. CAN are close, but differences do exist. For the normal approach to vertical light curtains where the object sensitivity is a maximum of 40 m, the ISO EN approach requires two steps. First, calculate S using 2000 for the speed constant.

S = 2000 x T + 8 x (d -1 4)

The minimum distance that S can be is 100 mm.

A second step can be used when the distance is greater than 500 mm. Then the value of K can be reduced to 1600. When using K=1600, the minimum value of S is 500 mm.

The U.S. CAN approach uses a one step approach:

Ds = 1600 x T * Dpf

This leads to differences greater than 5% between the standards, when the response time is less than 560 ms. Figure 110 shows the minimum safety distance as a function of the total stopping time for 14 and 30 mm object sensitivity. A combination of both approaches needs to be examined to achieve the worst case scenario for globally designed machines.

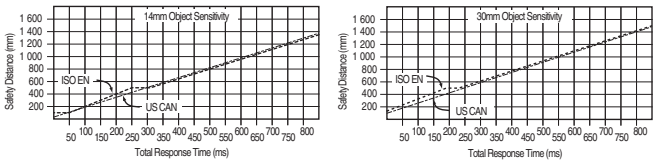


Figure 110: Safety Distance Comparisons

Angled Approaches

Most applications of light curtains and scanners are mounted in vertical (normal approach) or horizontal (parallel approach). These mountings are not considered angled if they are within ±5° of the intended design. When the angle exceeds ±5°, the potential risks (e.g. shortest distance) of foreseeable approaches must be taken into consideration. In general, angles greater than 30° from the reference plane (e.g. floor) should be consider normal and those less than 30 considered parallel. This is depicted in Figure 111.

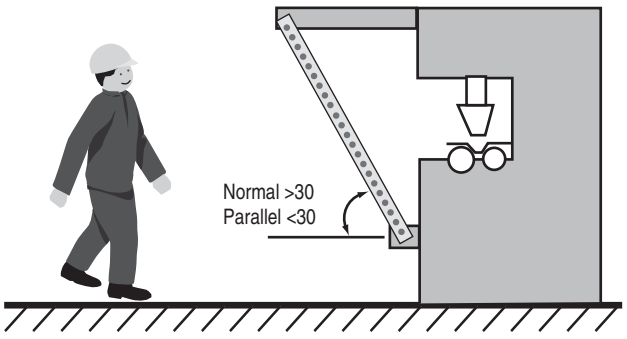


Figure 111: Angle Approach to the Detection Field

Safety Mats

With safety mats, the safety distance must take into account the operators pace and stride. Assuming the operator is walking and the safety mats are mounted on the floor. The operator's first step onto the mat is a depth penetration factor of 1200 mm or 48 in. An example arrangement is shown in Figure 112.

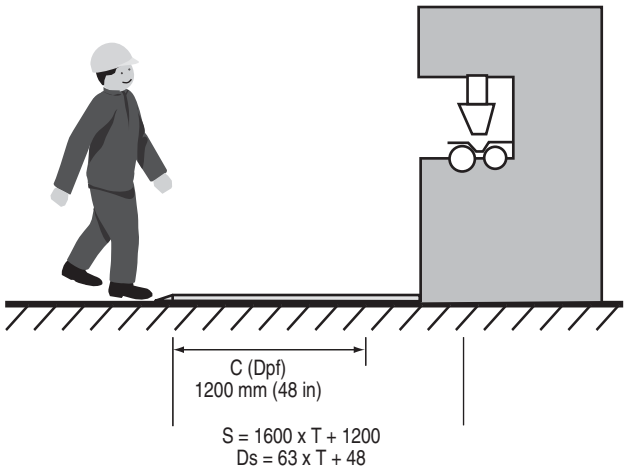


Figure 112: Safety Mat Mounted on Floor

If the operator must step up onto a platform, then the depth penetration factor can be reduced by a factor of 40% of the height of the step (see Figure 113).

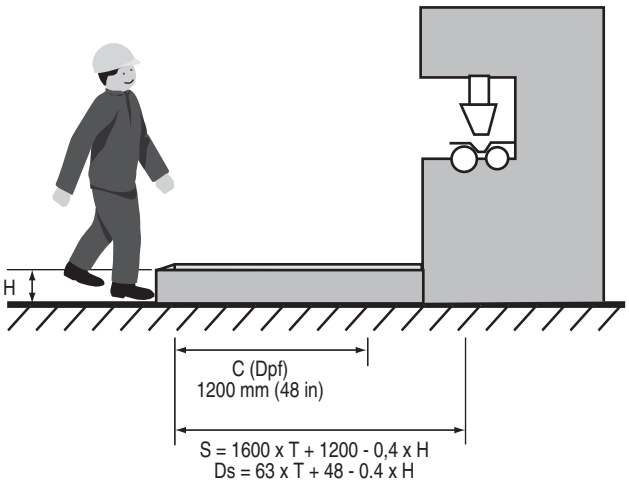


Figure 113: Step Up to Safety Mat Mounted on a Platform

Examples

Example: An operator uses a normal approach to a 14 mm light curtain, which is connected to a monitoring safety relay which is connected to a DC powered contactor with a diode suppressor. The safety system response time, Tr, is 20 + 15 + 95 = 130 ms. The machine stopping time, Ts+Tc, is 170 ms. A brake monitor is not used. The Dpf value is 1 inch, and the C value is zero. The calculation would be as follows:

Dpf = 3.4 (14 - 6.875) = 24.2 mm (1 in) C = 8 (14-14) = 0
Ds = K x (Ts + Tc + Tr + Tbm) + Dpf S = K x T + C
Ds = 63 x (0.17 + 0.13 + 0) + 1 S = 1600 x (0,3) + 0
Ds = 63 x (0.3) + 1 S = 480 mm (18.9 in)
Ds = 18.9 + 1
Ds = 19.9 in (505 mm)

Therefore, the minimum safe distance the safety light curtain must be mounted from the hazard is 508 mm (20 in.) for a machine to be used anywhere in the world.

Prevention of Unexpected Power Up

Prevention of unexpected power up is covered by many standards. Examples include ISO 14118, EN 1037, ISO 12100, OSHA 1910.147, ANSI Z244-1, CSA Z460-05, and AS 4024.1603. These standards have a common theme: the primary method of preventing unexpected power up is to remove the energy from the system and to lock the system in the off state. The purpose is to safely allow people to enter a machine's danger zones.

Lockout/Tagout

New machines must be built with lockable energy isolating devices. The devices apply to all types of energy, including electrical, hydraulic, pneumatic, gravity, and lasers. Lockout refers to applying a lock to an energy isolating device. The lock must only be removed by its owner or by a supervisor under controlled conditions. When multiple individuals must work on the machine, each individual must apply their locks to the energy isolating devices. Each lock must be identifiable to its owner.

In the U.S., tagout is an alternative to lockout for older machines where a lockable device has never been installed. In this case, the machine is turned off and a tag is applied to warn all personnel to not start the machine while the tag holder is working on the machine. Beginning in 1990, machines that are modified must be upgraded to include a lockable energy isolating device.

An energy isolating device is a mechanical device that physically prevents the transmission or release of energy. These devices can take the form of a circuit breaker, a disconnect switch, a manually operated switch, a plug/socket combination or a manually operated valve. Electrical isolating devices must switch all ungrounded supply conductors and no pole can operate independently.

The purpose of lockout and tagout is to prevent the unexpected startup of the machine. Unexpected startup may be the result of various causes: a failure of the control system; an inappropriate action on a start control, sensor, contactor, or valve; a restoration of power after an interruption; or some other internal or external influences. After completion of the lockout or tagout process, the dissipation of the energy must be verified.

Safety Isolation Systems

Safety isolation systems execute an orderly shutdown of a machine and also provide an easy method of locking off the power to a machine. This approach works well for larger machines and manufacturing systems, especially when multiple energy sources are located on a mezzanine level or at distant locations.

Figure 114 shows an overview of the system layout. Lockable stations are remotely located at convenient access points throughout the machine. When necessary, an operator uses the remote station to turn off the machine and lock the machine in the off state. The control box disconnects electrical and pneumatic power and provides a signal back to the operator that the energy has been disconnected.

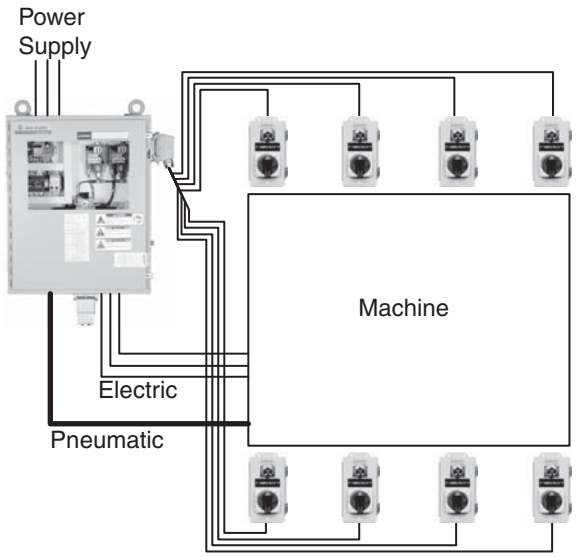


Figure 114: Layout of Safety Isolation System

Figure 115 shows that the safety isolation system not only removes power from the machine but also grounds the load side. The operator gets a monitored, visible signal at the remote station that the machine is in a safe state, and the energy is dissipated.

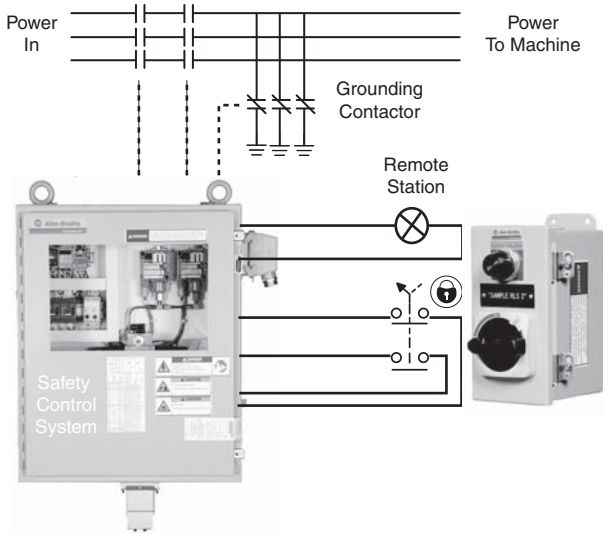


Figure 115: Machine side is grounded with signal to operator.

Load Disconnects

For local isolation of electrical devices, switches can be placed just prior to the device that needs to be isolated and locked out. The Bulletin 194E Load Switches are an example of a product that are capable of both isolation and lockout. Figure 116 shows an example of the Bulletin 194E.



Figure 116: Load switch with isolation and locking capability

Trapped Key Systems

Trapped key systems are another method for implementing a lockout system. Many trapped key systems start with an energy isolating device. When the switch is turned off by the “primary” key, the electrical energy to the machine is removed from all the ungrounded supply conductors simultaneously. The primary key can then be removed and taken to a location where machine access is needed. Figure 117 shows an example of the most basic system, an isolating switch and a gate access lock. Various components can be added to accommodate more complex lockout arrangements.

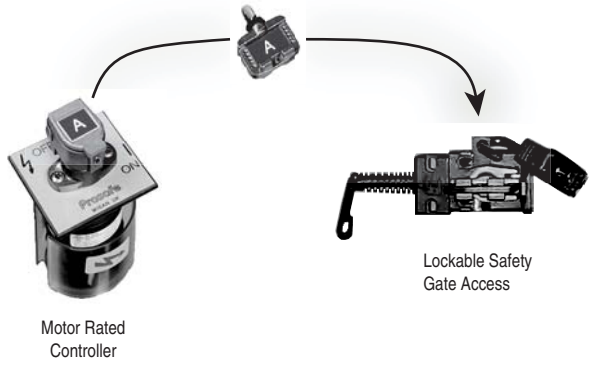


Figure 117: Trapped key isolation and lockable devices

Alternative Measures to Lockout

Lockout and tagout must be used during servicing or maintenance of the machines. Machine interventions during normal production operations are covered by safeguarding. The difference between servicing/maintenance and normal production operations is not always clear.

Some minor adjustments and servicing tasks, which take place during normal production operations, do not necessarily require the machine to be locked out. Examples include loading and unloading materials, minor tool changes and adjustments, servicing lubrication levels, and removing waste material. These tasks must be routine, repetitive, and integral to the use of the equipment for production, and the work is performed using alternative measures, like safeguarding, which provide effective protection. Safeguarding includes devices like interlocked guards, light curtains, and safety mats. Used with appropriate safety rated logic and output devices, operators can safety access the machine danger zones during normal production tasks and minor servicing.

Introduction to Safety-Related Control Systems

What is a safety-related control system (SRCS)? It is that part of the control system of a machine that prevents a hazardous condition from occurring. It can be a separate dedicated system or it may be integrated with the normal machine control system.

Its complexity will vary from a simple system, such as a guard door interlock switch and emergency stop switch connected in series to the control coil of power contactor, to a compound system comprising both simple and complex devices communicating through software and hardware.

Safety-related control systems are designed to perform safety functions. The SRCS must continue to operate correctly under all foreseeable conditions. So what is a safety function; how do we design a system to achieve this; and when we have done that, how do we show it?

Safety Function

A safety function is implemented by the safety-related parts of the machine control system to achieve or maintain the equipment under control in a safe state with respect to a specific hazard. A failure of the safety function can result in an immediate increase of the risks of using the equipment; that is, a hazardous condition.

A machine must have at least one “hazard,” otherwise, it is not a machine. A “hazardous condition” is when a person is exposed to a hazard. A hazardous condition does not imply that the person is harmed. The exposed person may be able to acknowledge the hazard and avoid injury. The exposed person may not be able to recognize the hazard, or the hazard may be initiated by unexpected startup. The main task of the safety system designer is to prevent hazardous conditions and to prevent unexpected startup.

The safety function can often be described with multi-part requirements. For example, the safety function initiated by an interlocking guard has three parts:

1. The hazard protected by the guard cannot operate until the guard is closed;
2. Opening the guard will cause the hazard to stop if operational at the time of the opening; and
3. The closure of the guard does not restart the hazard protected by the guard.

When stating the safety function for a specific application, the word “hazard” must be changed to the specific hazard. The hazard must not be confused with the results of the hazard. Crushing, cutting, and burning are results of a hazard. An example of a hazard is a motor, ram, knife, torch, pump, laser, robot, end-effector, solenoid, valve, other type of actuator, or a mechanical hazard involving gravity.

In discussing safety systems, the phrase “at or before a demand is placed on the safety function” is used. What is a demand on the safety function? Examples of demands placed on the safety function are the opening of an interlocked guard, the breaking of a light curtain, the stepping onto a safety mat, or the pressing of an e-stop. An operator is demanding that the hazard either stop or remain de-energized if it is already stopped.

The safety-related parts of the machine control system execute the safety function. The safety function is not executed by a single device, for example, just by the guard. The interlock on the guard sends a command to a logic device, which in turn, disables an actuator. The safety function starts with the command and ends with the implementation.

The safety system must be designed with a level of integrity that is commensurate with the risks of the machine. Higher risks require higher integrity levels to ensure the performance of the safety function. Machine safety systems can be classified into levels of performance of their ability to ensure the performance of their safety function or, in other words, their functional safety integrity level.

Introduction to Functional Safety of Control Systems

IMPORTANT The standards and requirements considered in this section are relatively new. Work is still being conducted by the drafting groups on some aspects especially with regard to clarification and combining some of these standards. Therefore it is possible that there will be some changes to some of the detail given in these pages. For the latest information please refer to the Rockwell Automation safety systems and components website at http://www.ab.com/safety and the Rockwell Automation Safety Solutions website at http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx.

What is Functional Safety?

Functional safety is the part of the overall safety that depends on the correct functioning of the process or equipment in response to its inputs. IEC TR 61508-0 provides the following example to help clarify the meaning of functional safety. “For example, an over-temperature protection device, using a thermal sensor in the windings of an electric motor to de-energize the motor before they can overheat, is an instance of functional safety. But providing specialized insulation to withstand high temperatures is not an instance of functional safety (although it is still an instance of safety and could protect against exactly the same hazard).” As another example, compare hard guarding to an interlocked guard. The hard guarding is not considered “functional safety” although it may protect against access to the same hazard as an interlocked door. The interlocked door is an instance of functional safety. When the guard is opened, the interlock serves as an “input” to a system that achieves a safe state. Similarly, personal protective equipment (PPE) is used as a protective measure to help increase safety of personnel. PPE is not considered functional safety.

Functional safety was a term introduced in IEC 61508:1998. Since then, the term has sometimes been associated with only programmable safety systems. This is a misconception. Functional safety covers a broad range of devices that are used to create safety systems. Devices like interlocks, light curtains, safety relays, safety PLCs, safety contactors, and safety drives are interconnected to form a safety system, which performs a specific safety-related function. This is functional safety. Therefore the functional safety of an electrical control system is highly relevant to the control of hazards arising from moving parts of machinery.

Two types of requirements are necessary to achieve functional safety:

- The safety function
- The safety integrity

Risk assessment plays a key role in developing the functional safety requirements. Task and hazard analysis leads to the function requirements for safety (i.e. the safety function). The risk quantification yields the safety integrity requirements (i.e. the safety integrity or performance level).

Four of the most significant control system functional safety standards for machinery are:

1. IEC/EN 61508 “Functional safety of electrical, electronic and programmable electronic control systems”

   This standard contains the requirements and provisions that are applicable to the design of complex electronic and programmable systems and subsystems. The standard is generic so it can be applicable to all industrial sectors.
2. IEC/EN 62061 “Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems”

   This standard is the machinery specific implementation of IEC/EN 61508. It provides requirements that are applicable to the system level design of all types of machinery safety-related electrical control systems and also for the design of non-complex subsystems or devices. It requires that complex or programmable subsystems should satisfy IEC/EN 61508.
3. EN ISO 13849-1 “Safety of machinery — Safety-related parts of control systems”

   This standard is intended to provide a direct transition path from the categories of the previous EN 954-1.
4. IEC 61511 “Functional safety — Safety instrumented systems for the process industry sector”

   This standard is the process sector specific implementation of IEC/EN 61508.

The functional safety standards represent a significant step beyond the familiar existing requirements such as Control Reliable and the Categories system of the previous ISO 13849-1:1999 (EN 954-1:1996).

Note: Recent to the time of publication of this text, CEN (European Committee for Standardization) announced that the final date for presumption of conformity of EN 954-1 will be extended to the end of 2011 to facilitate transition to the later standards. This replaces the original date of December 29, 2009.

For the latest information on the use and status of EN 954-1 visit: http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx. In the meantime, it is advised that the extension of the transition period is used to move over to the use of the later standards (EN ISO 13849-1 or IEC/EN 62061) in a timely manner.

Categories will not disappear completely; they are also used in current EN ISO 13849-1 which uses the functional safety concept and has introduced new terminology and requirements. It has significant additions and differences to the old EN 954-1 (ISO 13849-1:1999). In this section we will refer to the current version as EN ISO 13849-1. (EN ISO 13849-1:2008 has the same text as ISO 13849-1:2006).

IEC/EN 62061 and EN ISO 13849-1:2008

IEC/EN 62061 and EN ISO 13849-1 both cover safety-related electrical control systems. It is intended that they will eventually be combined into one standard with common terminology. Both standards produce the same results but use different methods. They are intended to provide users with an option to choose the one most suitable for their situation. A user can choose to use either standard and they are both harmonized under the European Machinery Directive.

The outputs of both standards are comparable levels of safety performance or integrity. The methodologies of each standard have differences that are appropriate for their intended users.

The methodology in IEC/EN 62061 is intended to allow for complex safety functionality which may be implemented by previously unconventional system architectures. The methodology of EN ISO 13849-1 is intended to provide a more direct and less complicated route for more conventional safety functionality implemented by conventional system architectures.

An important distinction between these two standards is the applicability to various technologies. IEC/EN 62061 is limited to electrical systems. EN ISO 13849-1 can be applied to pneumatic, hydraulic, mechanical as well as electrical systems.

Figure 118 provides a simplified flow chart to help the safety system designer determine which of these two standards to use.

Joint Technical Report on IEC/EN 62061 and EN ISO 13849-1

A joint report has been prepared within IEC and ISO to help users of both standards.

It explains the relationship between the two standards and explains how the equivalence can be drawn between PL (Performance level) of EN ISO 13849-1 and SIL (Safety Integrity Level) of IEC.EN 62061 both at system and subsystem level.

In order to show that both standards give equivalent results the report shows an example safety system calculated according to the methodologies of both standards.

The report also clarifies a number of issues that have been subject to different interpretations. Perhaps one of the most significant issues is the aspect of fault exclusion.

In general, where PLe is required for a safety function to be implemented by a safety-related control system it is not normal to rely upon fault exclusions alone to achieve this level of performance. This is dependent upon the technology used and the intended operating environment. Therefore it is essential that the designer takes additional care on the use of fault exclusions as the PL requirement increases.

In general the use of fault exclusions is not applicable to the mechanical aspects of electromechanical position switches and manually operated switches (e.g. an emergency stop device) in order to achieve PLe in the design of a safety-related control system. Those fault exclusions that can be applied to specific mechanical fault conditions (e.g. wear/corrosion, fracture) are described in Table A.4 of ISO 13849-2.

For example, a door interlocking system that has to achieve PLe will need to incorporate a minimum fault tolerance of 1 (e.g. two conventional mechanical position switches) in order to achieve this level of performance since it is not normally justifiable to exclude faults, such as, broken switch actuators. However, it may be acceptable to exclude faults, such as short circuit of wiring within a control panel designed in accordance with relevant standards.

SIL and IEC/EN 62061

IEC/EN 62061 describes both the amount of risk to be reduced and the ability of a control system to reduce that risk in terms of SIL (Safety Integrity Level). There are three SILs used in the machinery sector, SIL 1 is the lowest and SIL 3 is the highest.

Because the term SIL is applied in the same manner in other industrial sectors such as petro-chemicals, power generation and railways, IEC/EN 62061 is very useful when machinery is used within those sectors.

Risks of greater magnitude can occur in other sectors such as the process industry and for that reason IEC 61508 and the process sector specific standard IEC 61511 include SIL 4.

A SIL applies to a safety function. The subsystems that make up the system that implements the safety function must have an appropriate SIL capability. This is sometimes referred to as the SIL Claim Limit (SIL CL).

A full and detailed study of IEC/EN 62061 is required before it can be correctly applied. Some of the most commonly applicable requirements of the standard are summarized later in this text.

System Level Design
Conduct a task analysis and risk assessment to identify any hazards.
Decide which hazards will be addressed by a safety related control system.

Decide on which of the two alternative standards to use.

Are there complex safety functions or will the system require complex programmable electronics to a high level of intergrity?

If the answer to either question is yes, use

IEC62061:2005

Can the system be designed simply using the designated architectures of Categoies B, 1, 2, 3 or 4, or will the system include technologies other than electrical?
If the answer to either question is yes, use

EN/ISO13849-1:2006

Determine the functionality required for the safety function, for example:

Position Sensing → Logic Solving → Output Actuation

Note: This should take account of all tasks required at the machine and it is very important to also give full consideration to production and maintenance requirements when deciding on the safety function concept.

Use the risk assessment process to determine the required safety integrity level, SIL, for each safety function, for example SIL2

Use the risk assessment process to determine the required performance level, PL_r, for each safety function, for example, PL_d

Using the requirements for system design determine what subsystem components are required to implement the Function Blocks. Each subsystem must be suitable for the required SIL. For each subsystem, choose a combination of Safe Failure Fraction (SFF), fault tolerance, PFHd to achieve the required SIL Claim Limit.

For example for SIL2, the following is possible:

Sensing subsystem → Logic subsystem → Output subsytem

where each subsystem has
Fault Tolerance: 1, SFF: 80%, PFH_D: 1×10^{-7}

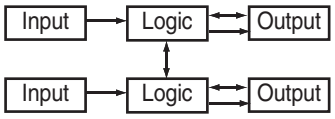
The combined PFH_D of all three subsystems is 3×10^{-7} and therefore meets the target PFH_D of 1×10^{-6} for the safety function.

The following information is required for each subsystem: PFH_D, fault tolerance, SFF.

The following is required for each system: measures against systematic failure.

Using the risk assessment charts or tables, determine which combination of architecture, diagnostic coverage and mean time to failure will achieved the required performance level.

For example, for PLd the following is possible



Designated architecture: Category 3
Diagnostic Coverage: Medium (95%)
$MTTF_d$ for each channel: 15yrs

The following information is required for each component:
$MTTF_d$

The following information is required for each system: designated architecture, diagnostic coverage, and measures against common cause and systematic failures.

Figure 118: System Design Flow Diagram

PL and EN ISO 13849-1

EN ISO 13849-1 does not use the term SIL; instead it uses the term PL (Performance Level). In many respects PL can be related to SIL. There are five performance levels, PLa is the lowest and PLe is the highest.

Comparison of PL and SIL

Table 8 shows the relationship (in terms of probability of dangerous failure between PL and SIL when applied to typical circuit structures.

PL (Performance Level)	PFH_D (Probability of Dangerous Failure per Hour)	SIL
a	$\geq 10^{-5}$ to $<10^{-4}$	None
b	$\geq 3 \times 10^{-6}$ to $<10^{-5}$	1
c	$\geq 10^{-6}$ to $<3 \times 10^{-6}$	1
d	$\geq 10^{-7}$ to $<10^{-6}$	2
e	$\geq 10^{-8}$ to $<10^{-7}$	3

Table 8: Approximate correspondence between PL and SIL

IMPORTANT Table 8 is for general guidance and must NOT be used for conversion purposes. The full requirements of the standards must be taken into account.

System Design According to EN ISO 13849 and SISTEMA

A full and detailed study of EN ISO 13849-1 is required before it can be correctly applied. The following is a brief overview:

This standard provides requirements for the design and integration of safety-related parts of control systems, including some software aspects. The standard applies to a safety-related system but can also be applied to the component parts of the system.

SISTEMA Software PL Calculation Tool

SISTEMA is a software tool for the implementation of EN ISO 13849-1. Its use will greatly simplify the implementation of the standard.

SISTEMA stands for "Safety Integrity Software Tool for the Evaluation of Machine Applications" It was developed by the BGIA in Germany and is free for use. It requires the input of various types of functional safety data as described later in this section.

The Data can be input manually or automatically by using a Manufacturer's SISTEMA Data Library.

The Rockwell Automation SISTEMA Data Library is available for download, together with a link to the SISTEMA download site, at: http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx.

Overview of EN ISO 13849-1

This standard has wide applicability, as it applies to all technologies, including electrical, hydraulic, pneumatic and mechanical. Although ISO 13849-1 is applicable to complex systems, it also refers the reader to IEC 62061 and IEC 61508 for complex software embedded systems.

Let's have look at what are the basic differences between the old EN 954-1 and the new EN ISO 13849-1. The outputs of the old standard were Categories [B, 1, 2, 3 or 4]. The outputs of the new standard are Performance Levels [PL a, b, c, d or e]. The Category concept is retained but there are additional requirements to be satisfied before a PL can be claimed for a system.

The requirements can be listed in basic form as follows:

- The architecture of the system. Essentially this captures what we have become used to as the Categories
- Reliability data is required for the constituent parts of the system
- The Diagnostic Coverage [DC] of the system is required. This effectively represents the amount of fault monitoring in the system
- Protection against common cause failure
- Protection against systematic faults
- Where relevant, specific requirements for software

Later we will take a closer look at these factors but before we do it will be useful to consider the basic intent and principle of the whole standard. It is clear at this stage that there are new things to learn but the detail will make more sense once we have understood what it is trying to achieve and why.

First of all why do we need the new standard? It is obvious that the technology used in machine safety systems has progressed and changed considerably over the last ten years. Until relatively recently safety systems have depended on "simple" equipment with very foreseeable and predictable failure modes. More recently we have seen an increasing use of more complex electronic and programmable devices in safety systems. This has given us advantages in terms of cost, flexibility and compatibility but it has also meant that the pre-existing standards are no longer adequate. In order to know whether a safety system is good enough we need to know more about it. This is why the new standard asks for more information. As safety systems start to use a more "black box" approach we start to rely more heavily on their conformity to standards. Therefore those standards need to be capable of properly interrogating the technology. In order to fulfill this they must speak to the basic factors of reliability, fault detection, architectural and systematic integrity. This is the intent of EN ISO 13849-1.

In order to plot a logical course through the standard, two fundamentally different user types must be considered: the designer of safety-related subsystems and the designers of safety-related systems. In general the subsystem designer [typically a safety component manufacturer] will be subjected to a higher level of complexity. They will need to provide the required data in order that the system designer can ensure that the subsystem is of adequate integrity for the system. This will usually require some testing, analysis and calculation. The results will be expressed in the form of the data required by the standard.

The system designer [typically a machine designer or integrator] will use the subsystem data to perform some relatively straightforward calculations to determine the overall Performance Level [PL] of the system.

PLr is used to denote what performance level is required by the safety function. In order to determine the PLr the standard provides a risk graph into which the application factors of severity of injury, frequency of exposure and possibility of avoidance are input.

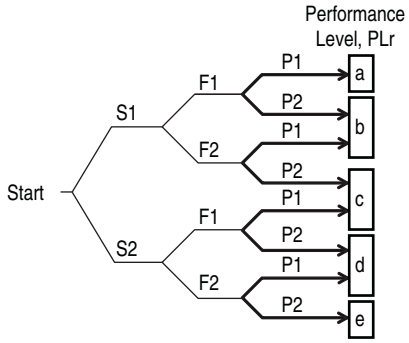


Figure 119: Risk Graph from Annex A of EN ISO 13849-1

The output is the PLr. Users of the old EN 954-1 will be familiar with this approach but take note that the S1 line now subdivides whereas the old risk graph did not. Note that this means a possible reconsideration of the integrity of safety measures required at lower risk levels.

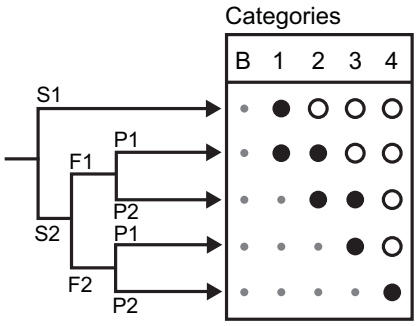


Figure 120: Risk Graph from Annex B of EN 945-1

There is one very important part yet to be covered however. We now know from the standard how good the system needs to be and also how to determine how good it is but we don't know what it needs to do. We need to decide what the safety function is. Clearly the safety function must be appropriate to the task so how do we ensure this? How does the standard help us?

It is important to realize that the functionality required can only be determined by considering the characteristics prevailing at the actual application. This can be regarded as the safety concept design stage. It cannot be completely covered by the standard because the standard does not know about all the characteristics of a specific application. This also often applies to the machine builder who produces the machine but does not necessarily know the exact conditions under which it will be used.

The standard does provide some help by listing out many of the commonly used safety functions (e.g. safety-related stop function initiated by safeguard, muting function, start/restart function) and giving some normally associated requirements. Other standards such as EN ISO 12100: Basic design principles and EN ISO 14121: Risk assessment, are highly recommended for use at this stage. Also there is a large range of machine specific standards that will provide solutions for specific machines. Within the European EN standards they are termed C type standards, some of them have exact equivalents in ISO standards.

So we can now see that the safety concept design stage is dependant on the type of machine and also on the characteristics of the application and environment in which it is used. The machine builder must anticipate these factors in order to be able to design the safety concept. The intended [i.e. anticipated] conditions of use should be given in the user manual. The user of the machine needs to check that they match the actual usage conditions.

So now we have a description of the safety functionality. From annex A of the standard we also have the required performance level [PLr] for the safety-related parts of the control system [SRP/CS] that will be used to implement this functionality. We now need to design the system and make sure that it complies with the PLr.

One of the significant factors in the decision on which standard to use [EN ISO 13849-1 or EN/IEC 62061] is the complexity of the safety function. In most cases, for machinery, the safety function will be relatively simple and EN ISO 13849-1 will be the most suitable route. Reliability data, diagnostic coverage [DC], the system architecture [Category], common cause failure and, where relevant, requirements for software are used to assess the PL.

This is a simplified description meant only to give an overview. It is important to understand that all the provisions given in the body of the standard must be applied. However, help is at hand. The SISTEMA software tool is available to help with the documentation and calculation aspects. It also produces a technical file.

At time of going to print of this publication SISTEMA is available in German and English. Other languages will be released in the near future. BGIA, the developer of SISTEMA, is a well-respected research and testing institution based in Germany. It is particularly involved in solving scientific and technical problems relating to safety in the context of statutory accident insurance and prevention in Germany. It works in cooperation with occupational health and safety agencies from over 20 countries. Experts from the BGIA, along with their BG colleagues had significant participation in the drafting of both EN ISO 13849-1 and IEC/EN 62061.

The “library” of Rockwell Automation safety component data for SISTEMA is available at:
http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx.

Whichever way the calculation of the PL is done it is important to start of from the right foundation. We need to view our system in the same way as the standard so let's start with that.

System Structure

Any system can be split into basic system components or “subsystems.” Each subsystem has its own discrete function. Most systems can be split into three basic functions; input, logic solving and actuation [some simple systems may not have logic solving]. The component groups that implement these functions are the subsystems.

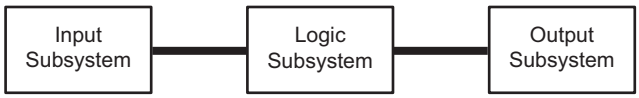


Figure 121

A simple single channel electrical system example is given in Figure 122. It comprises only input and output subsystems.

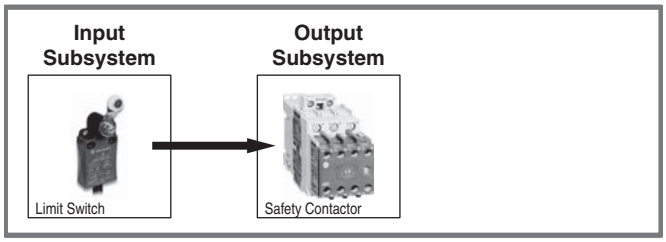


Figure 122: Interlock Switch and Contactor

In Figure 123 the system is a little more complex because some logic is also required. The safety controller itself will be fault tolerant (e.g. dual channel) internally but the overall system is still limited to single channel status because of the single limit switch and single contactor.

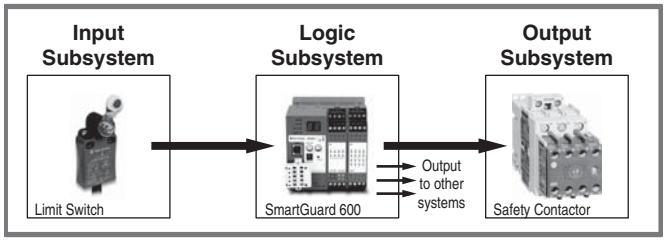


Figure 123: Interlock Switch, Safety Controller and Safety Contactor

If we take the basic architecture of Figure 123, there are also some other things to consider. First how many “channels” does the system have? A single channel system will fail if one of its subsystems fails. A two channel [also called redundant] system would need to have two failures, one in each channel before the system fails. Because it has two channels it can tolerate a single fault and still keep working. Figure 124 shows a two channel system.

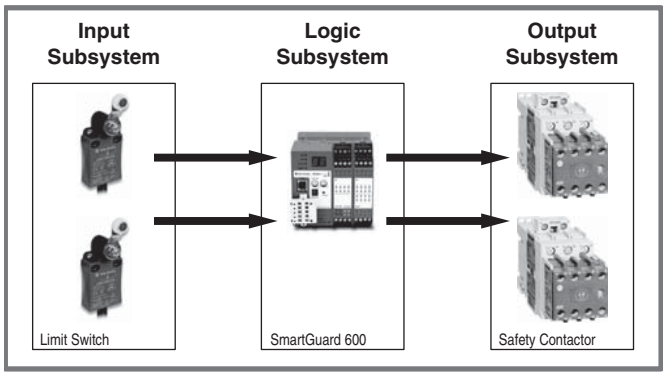


Figure 124: Dual Channel with Interlock Switch, Safety Controller and Safety Contactors

Clearly the system shown in Figure 124 is less likely to fail than the one shown in Figure 123 but we can make it even more reliable [in terms of its safety function] if we include diagnostic measures for fault detection. Of course, having detected the fault we also need to react to it and put the system into a safe state. Figure 125 shows the inclusion of diagnostic measures achieved through monitoring techniques.

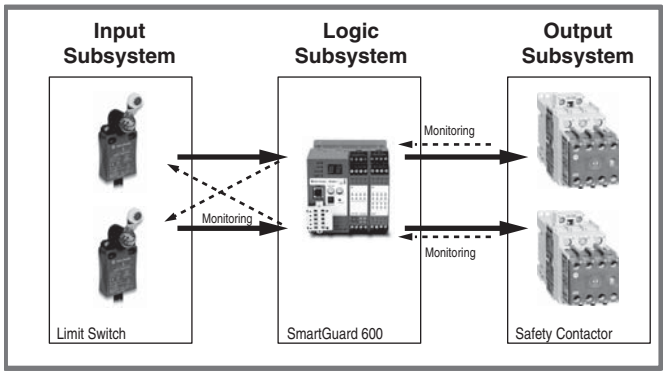


Figure 125: Dual Channel System with Interlock Switch, Safety Controller and Safety Contactors—Diagnostics Shown by Dashed Arrows

It is usually [but not always] the case that the system comprises two channels in all its subsystems as shown in Figure 125. Therefore we can see that, in this case each subsystem has two "sub channels." The standard describes these as “blocks.” A two channel subsystem will have two blocks and a single channel subsystem will have one block. It is possible that some systems will comprise a combination of dual channel and single channel blocks.

If we want to investigate the system in more depth we need to look at the components parts of the blocks. The SISTEMA tool uses the term “elements” for these component parts. Figure 126 shows our system using the SISTEMA terminology.

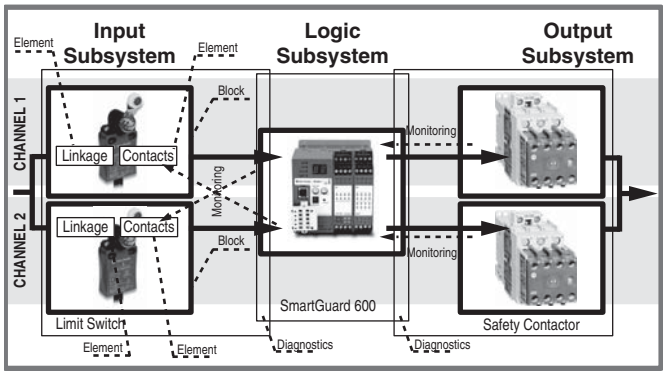


Figure 126: Dual Channel System Shown Subdivided into Subsystems, Blocks and Elements

The limit switches subsystem is shown subdivided down to its element level. The output contactor subsystem is subdivided down to its block level and the logic subsystem is not subdivided at all. The monitoring function for both the limit switches and the contactors is performed at the logic controller. Therefore the boxes representing the limit switch and contactor subsystems have a small overlap with the logic subsystem box.

This principle of system subdivision can be recognized in the methodology given in EN ISO 13849-1 and in the basic system structure principle for the SISTEMA tool. However, it is important to note that there are some subtle differences. The standard is not restrictive in its methodology but for the simplified method for estimating the PL the usual first step is to break the system structure into channels and the blocks within each channel. With SISTEMA the system is first divided into subsystems. The standard does not explicitly describe a subsystem concept but its use as given in SISTEMA provides a more understandable and intuitive approach. Of course there is no effect on the final calculation. SISTEMA and the standard both use the same principles and formulae. It is interesting to note that the subsystem approach is also used in EN/IEC 62061.

The system we have been using as an example is just one of the five basic types of system architectures that the standard designates. Anyone familiar with the Categories system will recognize our example as representative of either Category 3 or 4.

The standard uses the original EN 954-1 Categories as its five basic types of designated system architectures. It calls them Designated Architecture Categories. The requirements for the Categories are almost [but not quite] identical to those given in EN 954-1. The Designated Architecture Categories are represented by the following figures. It is important to note that they can be applied either to a complete system or a subsystem. The diagrams should not be taken purely as a physical structure. They are intended more as a graphical representation of conceptual requirements.

A more detailed look at the practical implementation of categories is dealt with in a later chapter.

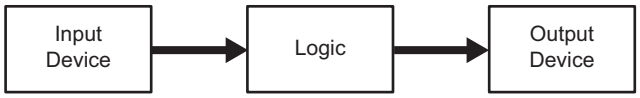


Figure 127: Designated Architecture Category B

Designated Architecture Category B must use basic safety principles [see annex of EN ISO 13849-2]. The system or subsystem can fail in the event of a single fault. See EN ISO 13849-1 for full requirements.

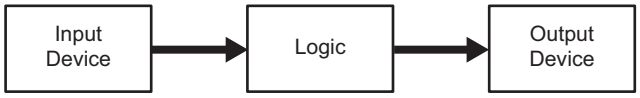


Figure 128: Designated Architecture Category 1

Designated Architecture Category 1 has the same structure as Category B and can still fail in the event of a single fault. But because it must also use well tried safety principles [see annex of EN ISO 13849-2] this is less likely than for Category B. See EN ISO 13849-1 for full requirements.

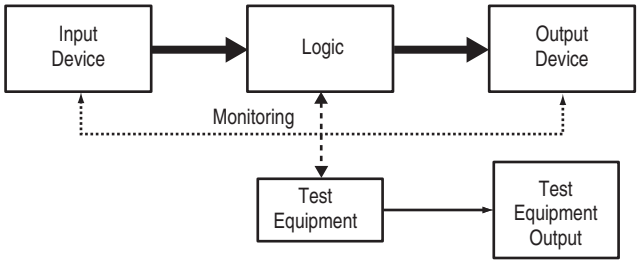


Figure 129: Designated Architecture Category 2

Designated Architecture Category 2 must use basic safety principles [see annex of EN ISO 13849-2]. There must also be diagnostic monitoring via a functional test of the system or subsystem. The test must occur at start up and then periodically with a frequency that equates to at least one hundred tests to every demand on the safety function. Note that this test rate is an additional requirement to that given in the old EN 954-1. The system or subsystem can still fail if a single fault occurs between the functional tests but this is usually less likely than for Category 1. See EN ISO 13849-1 for full requirements.

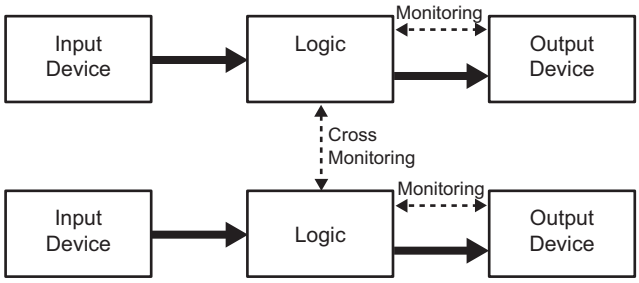


Figure 130: Designated Architecture Category 3

Designated Architecture Category 3 must use basic safety principles [see annex of EN ISO 13849-2]. There is also a requirement that the system/subsystem must not fail in the event of a single fault. This means that the system needs to have single fault tolerance with regard to its safety function. The most common way of achieving this requirement is to employ a dual channel architecture as shown in Figure 130. In addition a single fault shall be detected, wherever practicable. This requirement is the same as the original requirement for Category 3 from EN 954-1. In that context the meaning of the phrase “wherever practicable” proved somewhat problematic. It meant that Category 3 could cover everything from a system with redundancy but no fault detection [often descriptively and appropriately termed “stupid redundancy”] to a redundant system where all single faults are detected. This issue is addressed in EN ISO 13849-1 by the requirement to estimate the quality of the Diagnostic Coverage [DC]. By reference to Annex K or Table 9. We can see that the greater the reliability [MTTFd] of the system, the less the DC we need. However, DC needs to be at least 60% for Category 3 Architecture.

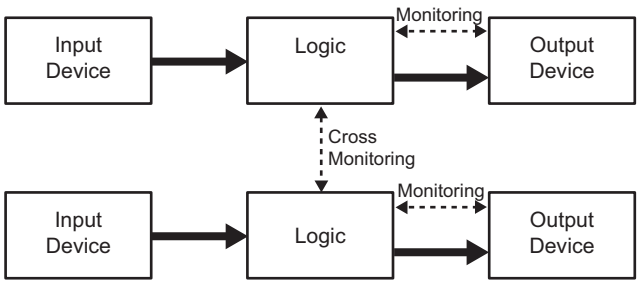


Figure 131: Designated Architecture Category 4

Designated Architecture Category 4 must use basic safety principles [see annex of EN ISO 13849-2]. It has a similar requirements diagram to Category 3 but it demands greater monitoring i.e. higher Diagnostic Coverage. This is shown by the heavier dotted lines representing the monitoring functions. In essence the difference between Categories 3 and 4 is that for Category 3 most faults must be detected but for Category 4 all faults must be detected. The DC needs to be at least 99%. Even an accumulation of faults must not cause a dangerous failure.

Reliability Data

EN ISO 13849-1 uses quantitative reliability data as part of the calculation of the PL achieved by the safety-related parts of a control system. This is a significant departure from EN 954-1. The first question this raises is "where do we get this data from?" It is possible to use data from recognized reliability handbooks but the standard makes it clear that the preferred source is the manufacturer. To this end, Rockwell Automation is making the relevant information available in the form of a data library for SISTEMA. In due course it will also publish the data in other forms. Before we go any further we should consider what types of data are required and also gain an understanding of how it is produced.

The ultimate type of data required as part of the PL determination in the standard [and SISTEMA] is the PFH [the probability of dangerous failure per hour]. This is the same data as represented by the PFHd abbreviation used in IEC/EN 62061.

PL	Average Probability of Dangerous Failure per Hour (1/h)	SIL
a	$\geq 10^{-5}$ to $<10^{-4}$	No correspondence
b	$\geq 3 \times 10^{-6}$ to $<10^{-5}$	1
c	$\geq 10^{-6}$ to $<3 \times 10^{-6}$	1
d	$\geq 10^{-7}$ to $<10^{-6}$	2
e	$\geq 10^{-8}$ to $<10^{-7}$	3

Table 9

Table 9 shows the relationship between PFH and PL and SIL. For some subsystems the PFH may be available from the manufacturer. This makes life easier for the calculation. The manufacturer will usually have to perform some relatively complex calculation and/or testing on their subsystem in order to provide it. In the event that it is not available, EN ISO13849-1 gives us an alternative simplified approach based on the average MTTFd [mean time to a dangerous failure] of a single channel. The PL [and therefore the PFH] of a system or subsystem can then be calculated using the methodology and formulae in the standard. It can be done even more conveniently using SISTEMA.

NOTE: It is important to understand that, for a dual channel system (with or without diagnostics), it is not correct to use $1/PFH_D$ to determine the MTTFd that is required by EN ISO 13849-1. The standard calls for the MTTFd of a single channel. This is a very different value to the MTTFd of the combination of both channels of a two channel subsystem. If the PFH_D of a two channel subsystem is known, it can simply be entered directly in to SISTEMA.

MTTFd of a Single Channel

This represents the average mean time before the occurrence of a failure that could lead to the failure of the safety function. It is expressed in years. It is an average value of the MTTFd's of the "blocks" of a single channel and can be applied to either a system or a subsystem. The standard gives the following formula which is used to calculate the average of all the MTTFd's of each element used in a single channel or subsystem.

At this stage the value of SISTEMA becomes apparent. Users are spared time consuming consultation of tables and calculation of formulae since these tasks are performed by the software. The final results can be printed out in the form of a multiple page report.

$$\frac{1}{MTTF_d} = \sum_{i=1}^{\tilde{N}} \frac{1}{MTTF_{di}} = \sum_{j=1}^{\tilde{N}} \frac{nj}{MTTF_{dj}}$$

Formula D1 from EN ISO 13849-1

In most dual channel systems both channel are identical therefore the result of the formula represents either channel.

If the system/subsystem channels are different the standard provides a formula to cater for this.

$$MTTF_d = \frac{2}{3}\left[MTTF_{dC1} + MTTF_{dC2} - \frac{1}{\frac{1}{MTTF_{dC1}} + \frac{1}{MTTF_{dC2}}}\right]$$

Formula 1 from EN ISO 13849-1

This, in effect, averages the two averages. In the cause of simplification it is also allowable to just use the worst case channel value.

The standard groups the MTTFd into three ranges as follows:

Denotation of MTTFd of each channel	Range of MTTFd of each channel
Low	3 years <= $MTTF_d$ < 10 years
Medium	10 years <= $MTTF_d$ < 30 years
High	30 years <= $MTTF_d$ < 100 years

Table 10: Levels of $MTTF_d$

Note that EN ISO 13849-1 limits the usable $MTTF_d$ of a single channel of a subsystem to a maximum of 100 years even though the actual values derived may be much higher.

As we will see later, the achieved range of MTTFd average is then combined with the designated architecture Category and the diagnostic coverage [DC] to provide a preliminary PL rating. The term preliminary is used here because other requirements including systematic integrity and measures against common cause failure still have to be met where relevant.

Methods of Data Determination

We now need to delve one stage deeper into how a manufacturer determines the data either in the form of PFH_D or $MTTF_d$. An understanding of this is essential when dealing with manufacturers data.

Data can be grouped into two basic types: 1) mechanistic (electro-mechanical, mechanical, pneumatic and hydraulic) and 2) electronic (solid state).

There is a fundamental difference between the common failure mechanisms of these three technology types. In basic form it can be summarized as follows:

Mechanistic Technology: Failure is proportional to both the inherent reliability and the usage rate. The greater the usage rate, the more likely that one of the component parts may be degraded and fail. Note that this is not the only failure cause, but unless we limit the operation time/cycles it will be the predominant one. It is self evident that a contactor that has switching cycle of once per ten seconds will operate reliably for a far shorter time than an identical contactor that operates one per day. Physical technology devices generally comprise components that are individually designed for their specific use. The components are shaped, molded, cast, machined etc. They are combined with linkages, springs, magnets, electrical windings etc to form a mechanism. Because the component parts do not, in general, have any history of use in other applications, we cannot find any pre-existing reliability data for them. The estimation of the PFH_D or $MTTF_d$ for the mechanism is normally based on testing. Both EN/IEC 62061 and EN ISO 13849-1 advocate a test process known as B10d Testing.

In the B10d test a number of device samples [usually at least ten] are tested under suitably representative conditions. The mean number of operating cycles achieved before 10% of the samples fail to the dangerous condition is known as the B10d value.

In practice it is often the case that all of the samples will fail to a safe state but in that case the standard states that the B10d[dangerous] value can be taken as twice the B10[safe] value.

Electronic Technology: There are no physical wear related moving parts. Given an operating environment commensurate with the specified electrical and temperature [etc] characteristics, the predominant failure of an electronic circuit is proportional to the inherent reliability of its constituent components [or lack off it]. There are many reasons for individual component failure; imperfection introduced during manufacture, excessive power surges, mechanical connection problems etc. In general, faults in electronic components are difficult to predict by analysis and they appear to be random in nature. Therefore testing of an electronic device in test laboratory conditions will not necessarily reveal typical long term failure patterns.

In order to determine the reliability of electronic devices it is usual to use analysis and calculation. We can find good data for the individual components in reliability data handbooks. We can use analysis to determine which component failure modes are dangerous. It is acceptable and usual to average out the component failure modes as 50% safe and 50% dangerous. This normally results in relatively conservative data.

IEC 61508 provides formulae that can be used to calculate the overall probability of dangerous failure [PFH or PFD] of the device i.e. the subsystem. The formulae are quite complex and take into account [where applicable] component reliability, potential for common cause failure [beta factor], diagnostic coverage [DC], functional test interval and proof test interval. The good news is that this complex calculation will normally be done by the device manufacturer. Both EN/IEC 62061 and EN ISO 13849-1 accept a subsystem calculated in this way to IEC 61508. The resulting PFH_D can be used directly into either Annex K of EN ISO 13849-1 or the SISTEMA calculation tool.

Software: Failures of software are inherently systematic in nature. Any failures are caused by the way it is conceived, written or compiled. Therefore all failures are caused by the system under which it is produced, not by its use. Therefore in order to control the failures we must control that system. Both IEC 61508 and EN ISO 13849-1 provide requirements and methodologies for this. We do not need to go into detail here other than to say they use the classic V model.

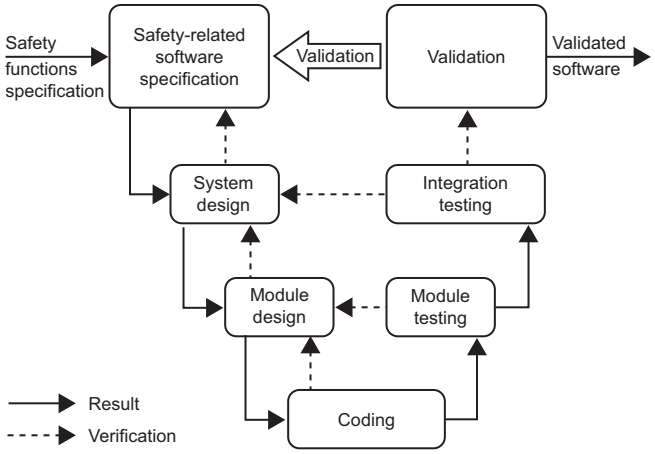


Figure 132: V Model for Software Development

Embedded software is an issue for the designer of the device. The usual approach is to develop embedded software in accordance with the formal methods explained in IEC 61508 part 3. When it comes to application code, the software that a user interfaces with, most programmable safety devices are provided with "certified" function blocks or routines. This simplifies the validation task for application code but it must be remembered that the completed application program still needs to be validated. The way the blocks are linked and parameterized must be proved correct and valid for the intended task. EN ISO 13849-1 and IEC/EN 62061 Both provide guidelines for this process.

Diagnostic Coverage

We have already touched on this subject when we considered the Designated Architecture Categories 2, 3 and 4. Those Categories require some form of diagnostic testing to check whether the safety function is still working. The term "diagnostic coverage" [usually abbreviated to DC] is used to characterise the effectiveness of this testing. It is important to realize that DC is not based just on the number of components that can fail dangerously. It takes account of the total dangerous failure rate. The symbol λ (lambda) is used for "failure rate." DC expresses the relationship of the rates of occurrence of the two following types of dangerous failure:

- Dangerous detected failure [λdd] i.e. Those failures would cause, or could lead to, a loss of the safety function, but which are detected. After detection, a fault reaction function causes the device or system to go to a safe state.
- Dangerous failure [λd] i.e. All those failures that could potentially cause, or lead to, a loss of the safety function. This includes both the failures that are detected and those that are not. Of course the failures that are that are truly dangerous are the dangerous undetected ones [termed λdu].

DC is expressed by the formula;

DC = λdd/λd expressed as a percentage.

This meaning of the term DC is common to EN ISO 13849-1 and EN/IEC 62061. However the way that it is derived differs. The latter standard proposes the use of calculation based on failure mode analysis but EN ISO 13849-1 provides a simplified method in the form of look-up tables. Various typical diagnostic techniques are listed together with the DC percentage that their use is deemed to achieve. In some cases rational judgment is still required, for example in some techniques the achieved DC is proportional to how often the test is performed. It is sometimes argued that this approach is too vague. However the estimation of DC can depend on many different variables and whichever technique is used the result can usually only truly be described as approximate. It is also important to understand that the tables in EN ISO 13849-1 are based on extensive research conducted by the BGIA into the results achieved by known actual diagnostic techniques used in real applications. In the interest of simplification the standard divides DC into four basic ranges :

<60% = none

60% to <90% = low

90% to <99% = medium

99%+ = high

This approach of dealing with ranges instead of individual percentage values can also be considered to be more realistic in terms of achievable accuracy. The SISTEMA tool uses the same look-up tables as the standard. As the use of complex electronics increases in safety-related devices DC becomes a more important factor. It is likely that future work on the standards will look further into clarification of this issue. In the meantime the use of engineering judgment and common sense should be sufficient to lead to the correct choice of DC range.

Common-Cause Failure

In most dual channel [i.e. single fault tolerant] systems or subsystems the diagnostic principle is based on the premise that there will not be dangerous failures of both channels at the same time. The term “at the same time” is more accurately expressed as “within the diagnostic test interval.” If the diagnostic test interval is reasonably short [e.g. less than eight hours] it is a reasonable assumption that two separate and unrelated faults are highly unlikely to occur within that time. However the standard makes it clear that we need to think carefully about whether the fault possibilities really are separate and unrelated. For example, if a fault in one component can foreseeably lead to failures of other components then the resulting totality of faults are deemed to be a single failure.

It is also possible that an event that causes one component to fail may also cause the failure of other components. This is termed “common cause failure” (CCF). The degree of propensity for CCF is normally described as the beta [ß] factor. It is very important that subsystem and system designers are aware of the possibilities of CCF. There are many different types of CCF and, correspondingly, many different ways of avoiding it. EN ISO 13849-1 plots a rational course between the extremes of complexity and over simplification. In common with EN/IEC 62061 it adopts an approach that is essentially qualitative. It provides a list of measures known to be effective in avoiding CCF.

Table 11 shows a summary of the scoring process.

No.	Measure Against CCF	Score
1	Separation/Segregation	15
2	Diversity	20
3	Design/Application/ Experience	20
4	Assessment/Analysis	5
5	Competence/Training	5
6	Environmental	35

Table 11: Scoring for Common-Cause Failure

A sufficient number of these measures must be implemented in the design of a system or subsystem. It could be claimed, with some justification, that the use of this list alone may not be adequate to prevent all possibility of CCF. However, if the intent of the list is properly considered it becomes clear that the spirit of its requirement is to make the designer analyse the possibilities for CCF and to implement appropriate avoidance measures based on the type of technology and the characteristics of the intended application. Use of the list enforces consideration of some of the most fundamental and effective techniques such as diversity of failure modes and design competencies. The BGIA SISTEMA tool also requires the implementation of the standard's CCF look up tables and makes them available in a convenient form.

Mission Time

Mission time represents the maximum period of time for which a subsystem (or system) can be used. After this time, it must be replaced. Mission time must be declared by the manufacturer of the components. Mission time will usually be the same as the “proof test interval” or “lifetime” (whichever is the smaller) as used in IEC/EN62061. The safety system designer must then consider the mission time of the components to determine the mission time of each safety function. For mechanistic components the T10d value gives this usable lifetime value in terms of the number of operations. The T10d value is derived as part of the B10d calculation.

Systematic Faults

We have already discussed quantified safety reliability data in the form of MTTFd and the probability of dangerous failure. However, this is not the whole story. When we referred to those terms we were really thinking about failures that appear to be random in nature. Indeed IEC/EN 62061 specifically refers to the abbreviation of PFH_D as the probability of random hardware failure. But there are some types of failures collectively known as “systematic failure” that can be attributed to errors committed in the design or manufacturing process. The classic example of this is an error in software code. The standard provides measures in Annex G to avoid these errors [and therefore the failures]. These measures include provisions such as the use of suitable materials and manufacturing techniques, reviews, analysis and computer simulation. There are also foreseeable events and characteristics that can occur in the operating environment that could cause failure unless their effect is controlled. Annex G also provides measures for this. For example it is easily foreseeable that there may be occasional losses of power. Therefore the de-energization of components must result in a safe state for the system. These measures may seem to be just common sense, and indeed they are, but they are nevertheless essential. All the rest of the requirements of the standard will be meaningless unless due consideration is given to the control and avoidance of systematic failure. This will also sometimes require the same types of measures used for the control of random hardware failure [in order to achieve the required PFH_D] such as automatic diagnostic test and redundant hardware.

Fault Exclusion

One of the primary analysis tools for safety systems is failure analysis. The designer and user must understand how the safety system performs in the presence of faults. Many techniques are available to perform the analysis. Examples include Fault Tree Analysis; Failure Modes, Effects and Criticality Analysis; Event Tree Analysis; and Load-Strength reviews.

During the analysis, certain faults may be uncovered that cannot be detected with automatic diagnostic testing without undue economic costs. Further, the probability that these faults might occur may be made extremely small, by using mitigating design, construction and test methods. Under these conditions, the faults may be excluded from further consideration. Fault exclusion is the ruling out of the occurrence of a failure because the probability of that specific failure of the SRCS is negligible.

ISO13849-1:2006 allows fault exclusion based on the technical improbability of occurrence, generally accepted technical experience and the technical requirements related to the application. ISO13849-2:2003 provides examples and justifications for excluding certain faults for electrical, pneumatic, hydraulic and mechanical systems. Fault exclusions must be declared with detailed justifications provided in the technical documentation.

It is not always possible to evaluate Safety-related Control System without assuming that certain faults can be excluded. For detailed information on fault exclusions, see ISO 13849-2.

As the level of risk gets higher, the justification for fault exclusion gets more stringent. In general, where PLe is required for a safety function to be implemented by a safety-related control system it is not normal to rely upon fault exclusions alone to achieve this level of performance. This is dependent upon the technology used and the intended operating environment. Therefore it is essential the designer takes additional care on the use of fault exclusions as that PL requirement increases.

For example, a door interlocking system that has to achieve PLe will need to incorporate a minimum fault tolerance of 1 (e.g. two conventional mechanical position switches) in order to achieve this level of performance since it is not normally justifiable to exclude faults, such as, broken switch actuators. However, it may be acceptable to exclude faults, such as short circuits in wiring within a control panel designed in accordance with relevant standards.

Performance Level (PL)

The performance level is a discrete level that specifies the ability of the safety-related parts of the control system to perform a safety function.

In order to assess the PL achieved by an implementation of any of the five designated architectures, the following data is required for the system (or subsystem):

- $MTTF_d$ (mean-time-to-dangerous failure of each channel)
- DC (diagnostic coverage)
- Architecture (the category)

Table 12 shows the PL achieved by various combinations. Refer to Annex K of the standard for more precise determination.

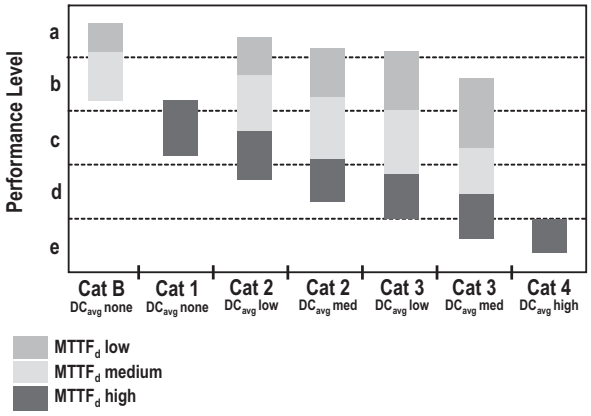


Figure 133: Graphical Determination of PL

Table 12 shows the PL achieved by various combinations. Refer to Annex K of the standard for more precise determination. For example, an application uses the Category 3 designated architecture. If the DC is between 60% and 90%, and if the MTTFd of each channel is between 10 and 30 years, then according to Figure 133, PL_d is achieved.

Other factors must also be realized to satisfy the required PL. These requirements include the provisions already discussed such as for common cause failures, systematic failure, and mission time.

If the PFH_D of the system or subsystem is known, Table 12 (Annex K of the standard) can be used to derive the PL.

System Design According to EN ISO 13849 and SISTEMA

$MTTF_d$ for each channel	Average probability of a dangerous failure per hour (1/h) and corresponding performance level (PL)															
	Cat. B	PL	Cat. 1	PL	Cat. 2	PL	Cat. 2	PL	Cat. 3	PL	Cat. 3	PL	Cat. 4	PL		
Years	DC_{avg} = none		DC_{avg} = none		DC_{avg} = low		DC_{avg} = medium		DC_{avg} = low		DC_{avg} = medium		DC_{avg} = high			
3	$3,80 \times 10^{-5}$	a			$2,58 \times 10^{-5}$	a	$1,99 \times 10^{-5}$	A	$1,26 \times 10^{-5}$	a	$6,09 \times 10^{-6}$	b				
3,3	$3,46 \times 10^{-5}$	a			$2,33 \times 10^{-5}$	a	$1,79 \times 10^{-5}$	A	$1,13 \times 10^{-5}$	a	$5,41 \times 10^{-6}$	b				
3,6	$3,17 \times 10^{-5}$	a			$2,13 \times 10^{-5}$	a	$1,62 \times 10^{-5}$	a	$1,03 \times 10^{-5}$	a	$4,86 \times 10^{-6}$	b				
3,9	$2,93 \times 10^{-5}$	a			$1,95 \times 10^{-5}$	a	$1,48 \times 10^{-5}$	a	$9,37 \times 10^{-6}$	b	$4,40 \times 10^{-6}$	b				
4,3	$2,65 \times 10^{-5}$	a			$1,76 \times 10^{-5}$	a	$1,33 \times 10^{-5}$	a	$8,39 \times 10^{-6}$	b	$3,89 \times 10^{-6}$	b				
4,7	$2,43 \times 10^{-5}$	a			$1,60 \times 10^{-5}$	a	$1,20 \times 10^{-5}$	a	$7,58 \times 10^{-6}$	b	$3,48 \times 10^{-6}$	b				
5,1	$2,24 \times 10^{-5}$	a			$1,47 \times 10^{-5}$	a	$1,10 \times 10^{-5}$	a	$6,91 \times 10^{-6}$	b	$3,15 \times 10^{-6}$	b				
5,6	$2,04 \times 10^{-5}$	a			$1,33 \times 10^{-5}$	a	$9,87 \times 10^{-6}$	b	$6,21 \times 10^{-6}$	b	$2,80 \times 10^{-6}$	c				
6,2	$1,84 \times 10^{-5}$	a			$1,19 \times 10^{-5}$	a	$8,80 \times 10^{-6}$	b	$5,53 \times 10^{-6}$	b	$2,47 \times 10^{-6}$	c				
6,8	$1,68 \times 10^{-5}$	a			$1,08 \times 10^{-5}$	a	$7,93 \times 10^{-6}$	b	$4,98 \times 10^{-6}$	b	$2,20 \times 10^{-6}$	c				
7,5	$1,52 \times 10^{-5}$	a			$9,75 \times 10^{-6}$	b	$7,10 \times 10^{-6}$	b	$4,45 \times 10^{-6}$	b	$1,95 \times 10^{-6}$	c				
8,2	$1,39 \times 10^{-5}$	a			$8,87 \times 10^{-6}$	b	$6,43 \times 10^{-6}$	b	$4,02 \times 10^{-6}$	b	$1,74 \times 10^{-6}$	c				
9,1	$1,25 \times 10^{-5}$	a			$7,94 \times 10^{-6}$	b	$5,71 \times 10^{-6}$	b	$3,57 \times 10^{-6}$	b	$1,53 \times 10^{-6}$	c				
10	$1,14 \times 10^{-5}$	a			$7,18 \times 10^{-6}$	b	$5,14 \times 10^{-6}$	b	$3,21 \times 10^{-6}$	b	$1,36 \times 10^{-6}$	c				
11	$1,04 \times 10^{-5}$	a			$6,44 \times 10^{-6}$	b	$4,53 \times 10^{-6}$	b	$2,81 \times 10^{-6}$	c	$1,18 \times 10^{-6}$	c				
12	$9,51 \times 10^{-6}$	b			$5,84 \times 10^{-6}$	b	$4,04 \times 10^{-6}$	b	$2,49 \times 10^{-6}$	c	$1,04 \times 10^{-6}$	c				
13	$8,78 \times 10^{-6}$	b			$5,33 \times 10^{-6}$	b	$3,64 \times 10^{-6}$	b	$2,23 \times 10^{-6}$	c	$9,21 \times 10^{-7}$	d				
15	$7,61 \times 10^{-6}$	b			$4,53 \times 10^{-6}$	b	$3,01 \times 10^{-6}$	b	$1,82 \times 10^{-6}$	c	$7,44 \times 10^{-7}$	d				
16	$7,31 \times 10^{-6}$	b			$4,21 \times 10^{-6}$	b	$2,77 \times 10^{-6}$	c	$1,67 \times 10^{-6}$	c	$6,76 \times 10^{-7}$	d				
18	$6,34 \times 10^{-6}$	b			$3,68 \times 10^{-6}$	b	$2,37 \times 10^{-6}$	c	$1,41 \times 10^{-6}$	c	$5,67 \times 10^{-7}$	d				
20	$5,71 \times 10^{-6}$	b			$3,26 \times 10^{-6}$	b	$2,06 \times 10^{-6}$	c	$1,22 \times 10^{-6}$	c	$4,85 \times 10^{-7}$	d				
22	$5,19 \times 10^{-6}$	b			$2,93 \times 10^{-6}$	c	$1,82 \times 10^{-6}$	c	$1,07 \times 10^{-6}$	c	$4,21 \times 10^{-7}$	d				
24	$4,76 \times 10^{-6}$	b			$2,65 \times 10^{-6}$	c	$1,62 \times 10^{-6}$	c	$9,47 \times 10^{-7}$	d	$3,70 \times 10^{-7}$	d				
27	$4,23 \times 10^{-6}$	b			$2,32 \times 10^{-6}$	c	$1,39 \times 10^{-6}$	c	$8,04 \times 10^{-7}$	d	$3,10 \times 10^{-7}$	d				
30			$3,80 \times 10^{-6}$	b	$2,06 \times 10^{-6}$	c	$1,21 \times 10^{-6}$	c	$6,94 \times 10^{-7}$	d	$2,65 \times 10^{-7}$	d	$9,54 \times 10^{-8}$	e		
33			$3,46 \times 10^{-6}$	b	$1,85 \times 10^{-6}$	c	$1,06 \times 10^{-6}$	c	$5,94 \times 10^{-7}$	d	$2,30 \times 10^{-7}$	d	$8,57 \times 10^{-8}$	e		
36			$3,17 \times 10^{-6}$	b	$1,67 \times 10^{-6}$	c	$9,39 \times 10^{-7}$	d	$5,16 \times 10^{-7}$	d	$2,01 \times 10^{-7}$	d	$7,77 \times 10^{-8}$	e		
39			$2,93 \times 10^{-6}$	c	$1,53 \times 10^{-6}$	c	$8,40 \times 10^{-7}$	d	$4,53 \times 10^{-7}$	d	$1,78 \times 10^{-7}$	d	$7,11 \times 10^{-8}$	e		
43			$2,65 \times 10^{-6}$	c	$1,37 \times 10^{-6}$	c	$7,34 \times 10^{-7}$	d	$3,87 \times 10^{-7}$	d	$1,54 \times 10^{-7}$	d	$6,37 \times 10^{-8}$	e		
47			$2,43 \times 10^{-6}$	c	$1,24 \times 10^{-6}$	c	$6,49 \times 10^{-7}$	d	$3,35 \times 10^{-7}$	d	$1,34 \times 10^{-7}$	d	$5,76 \times 10^{-8}$	e		
51			$2,24 \times 10^{-6}$	c	$1,13 \times 10^{-6}$	c	$5,80 \times 10^{-7}$	d	$2,93 \times 10^{-7}$	d	$1,19 \times 10^{-7}$	d	$5,26 \times 10^{-8}$	e		
56			$2,04 \times 10^{-6}$	c	$1,02 \times 10^{-6}$	c	$5,10 \times 10^{-7}$	d	$2,52 \times 10^{-7}$	d	$1,03 \times 10^{-7}$	d	$4,73 \times 10^{-8}$	e		
62			$1,84 \times 10^{-6}$	c	$9,06 \times 10^{-7}$	d	$4,43 \times 10^{-7}$	d	$2,13 \times 10^{-7}$	d	$8,84 \times 10^{-8}$	e	$4,22 \times 10^{-8}$	e		
68			$1,68 \times 10^{-6}$	c	$8,17 \times 10^{-7}$	d	$3,90 \times 10^{-7}$	d	$1,84 \times 10^{-7}$	d	$7,68 \times 10^{-8}$	e	$3,80 \times 10^{-8}$	e		
75			$1,52 \times 10^{-6}$	c	$7,31 \times 10^{-7}$	d	$3,40 \times 10^{-7}$	d	$1,57 \times 10^{-7}$	d	$6,62 \times 10^{-8}$	e	$3,41 \times 10^{-8}$	e		
82			$1,39 \times 10^{-6}$	c	$6,61 \times 10^{-7}$	d	$3,01 \times 10^{-7}$	d	$1,35 \times 10^{-7}$	d	$5,79 \times 10^{-8}$	e	$3,08 \times 10^{-8}$	e		
91			$1,25 \times 10^{-6}$	c	$5,88 \times 10^{-7}$	d	$2,61 \times 10^{-7}$	d	$1,14 \times 10^{-7}$	d	$4,94 \times 10^{-8}$	e	$2,74 \times 10^{-8}$	e		
100			$1,14 \times 10^{-6}$	c	$5,28 \times 10^{-7}$	d	$2,29 \times 10^{-7}$	d	$1,01 \times 10^{-7}$	d	$4,29 \times 10^{-8}$	e	$2,47 \times 10^{-8}$	e		

Table 12: Precise $MTTF_d$ to Determine PL

Source of Table 12 is Table K.1 of ISO/EN 13849-1:2006

Subsystem Design and Combinations

If the PLs of all the subsystem are known, they can be combined simply into a system using Table 13. The rational behind this table is clear. First, that the system can only be as good as its weakest link (subsystem). Second, the more subsystems there are, the greater the possibility for failure.

PL_{low}	N_{low}	PL
a	>3	Not allowed
	=<3	a
b	>2	a
	=<2	b
c	>2	b
	=<2	c
d	>3	c
	=<3	d
e	>3	d
	·3	e

Table 13: PL calculation for series combined subsystems

In the system shown in Figure 135, the lowest Performance Levels are at Subsystems 1 and 2. Both are PLb. Therefore, using Table 13, we can read across b (in the PLlow column), through 2 (in the Nlow column) and find the achieved system PL as b (in the PL column). If all three subsystems were PLb the achieved PL would be PLa.

Note: The application of this table is not mandatory. The use of Annex K of the standard (or SISTEMA) is the preferred method. This table is only intended to provide a very simple approach for small systems.

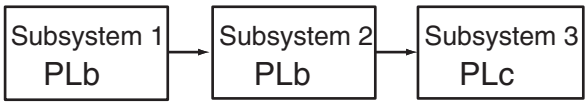


Figure 134: Combination of series subsystems as a PLb system

Validation

Validation plays an important role throughout the safety system development and commissioning process. ISO/EN 13849-2:2003 sets the requirements for validation. It calls for a validation plan and discusses validation by testing and analysis techniques such as Fault Tree Analysis and Failure Modes, Effects and Criticality Analysis. Most of these requirements will apply to the manufacturer of the subsystem rather than the subsystem user.

Machine Commissioning

At the system or machine commissioning stage, validation of the safety functions must be carried out in all operating modes and should cover all normal and foreseeable abnormal conditions. Combinations of inputs and sequences of operation must also be taken into consideration. This procedure is important because it is always necessary to check that the system is suitable for actual operational and environmental characteristics. Some of those characteristics may be different from the ones anticipated at the design stage.

System Design According to IEC/EN 62061

IEC/EN 62061, "Safety of machinery: Functional safety of electrical, electronic and programmable electronic control systems," is the machinery specific implementation of IEC/EN 61508. It provides requirements that are applicable to the system level design of all types of machinery safety-related electrical control systems and also for the design of non-complex subsystems or devices.

The risk assessment results in a risk reduction strategy which in turn, identifies the need for safety-related control functions. These functions must be documented and must include:

- Functional requirements specification
- Safety integrity requirements specification

The functional requirements include details like frequency of operation, required response time, operating modes, duty cycles, operating environment, and fault reaction functions. The safety integrity requirements are expressed in levels called safety integrity levels (SIL). Depending on the complexity of the system, some or all of the elements in Table 14 must be considered to determine whether the system design meets the required SIL.

Element for SIL Consideration	Symbol
Probability of Dangerous Failure per Hour	PFH_D
Hardware Fault Tolerance	No Symbol
Safe Failure Fraction	SFF
Proof Test Interval	T_1
Diagnostic Test Interval	T_2
Susceptibility to Common Cause Failures	ß
Diagnostic Coverage	DC

Table 14: Elements for SIL Consideration

Subsystems

The term "subsystem" has a special meaning in IEC/EN 62061. It is the first level subdivision of a system into parts which, if they fail, would cause a failure of the safety function. Therefore if two redundant switches are used in a system neither individual switch is a subsystem. The subsystem would comprise both switches and any associated fault diagnostic function.

Probability of Dangerous Failure per Hour (PFH_D)

IEC/EN 62061 uses the same basic methods as discussed in the section on EN ISO 13849-1 to determine failure rates at the component level. The same provisions and methods apply for "mechanistic" and electronic components. In IEC/EN 62061 there is no consideration of MTTFd in years. The failure rate per hour (λ) is either calculated directly or obtained or derived from the B10 value by the following formula:

$\lambda = 0.1 \times C/B10$ (where C = the number of operating cycles per hour)

There is a significant difference between the standards in the methodology for determining the total PFH_D for a subsystem or system. An analysis of the components must be undertaken to determine the probability of failure of the subsystems. Simplified formulae are provided for the calculation of common subsystem architectures (described later in text). Where these formulae are not appropriate it will be necessary to use more complex calculation methods such as Markov models. The Probability of Dangerous Failure (PFH_D) of each subsystem are then added together to determine the total PFH_D for the system. Table 15 (Table 3 of the standard) can then be used to determine which Safety Integrity Level (SIL) is appropriate to that range of PFH_D.

$\lambda_{DssB} = (1\text{-}ß)2 \times \lambda_{De1} \times \lambda_{De2} \times T_1 + ß \times (\lambda_{De1} + \lambda_{De2}) / 2$

The formulae for this architecture take into account the parallel arrangement of the subsystem elements and add the following two elements from Table 14:

ß (Beta) is the susceptibility to common cause failures.

SIL (Safety Integrity Level)	PFH_D (Probability of Dangerous Failure per Hour)
3	$\geq 10^{-8} \ldots < 10^{-7}$
2	$\geq 10^{-7} \ldots < 10^{-6}$
1	$\geq 10^{-6} \ldots < 10^{-5}$

Table 15: Probabilities of Dangerous Failure for SILs

The PFH_D data for a subsystem will usually be provided by the manufacturer. Data for Rockwell Automation safety components and systems is available in a number of forms including: http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx

This website will be periodically updated as more data for other Rockwell Automation components and systems will become available over time.

IEC/EN 62061 also makes it clear that reliability data handbooks can be used if and where applicable.

For low complexity electromechanical devices, the failure mechanism is usually linked to the number and frequency of operations rather than just time. Therefore for these components the data will derived from some form of testing (e.g. B10 testing as described in the chapter on EN ISO 13849-1). Application based information such as the anticipated number of operations per year is then required in order to convert the B10d or similar data to PFH_D.

NOTE: In general the following is true (taking into account a factor to change years to hours):

$PFH_D = 1/MTTFd$

However, it is important to understand that, for a dual channel system (with or without diagnostics), it is not correct to use 1/ PFH_D to determine the MTTFd that is required by EN ISO 13849-1. That standard calls for the MTTFd of a single channel. This is a very different value to the MTTFd of the combination of both channels of a two channel subsystem.

Architectural Constraints

The essential characteristic of IEC/EN 62061 is that the safety system is divided into subsystems. The hardware safety integrity level that can be claimed for a subsystem is limited not only by the PFH_D but also by the hardware fault tolerance and the safe failure fraction of the subsystems. Hardware fault tolerance is ability of the system to execute its function in the presence of faults. A fault tolerance of zero means that the function is not performed when a single fault occurs. A fault tolerance of one allows the subsystem to perform its function in the presence of a single fault. Safe Failure Fraction is the portion of the overall failure rate that does not result in a dangerous failure. The combination of these two elements is known as the architectural constraint and its output is the SIL Claim Limit (SIL CL) Table 16 shows the relationship of the architectural constraints to the SILCL. A subsystem (and therefore its system) must satisfy both the PFH_D requirements and the Architectural Constraints together with the other relevant provisions of the standard.

Safe Failure Fraction (SFF)	Hardware Fault Tolerance		
	0	1	2
<60%	Not allowed unless specific exceptions apply	SIL1	SIL2
60%…<90%	SIL1	SIL2	SIL3
90%…<99%	SIL2	SIL3	SIL3
≥99%	SIL3	SIL3	SIL3

Table 16: Architectural Constraints on SIL

For example, a subsystem architecture that possesses single fault tolerance and has a safe failure fraction of 75% is limited to no higher than a SIL2 rating, regardless of the probability of dangerous failure.

When combining subsystems, the SIL achieved by the SRCS is constrained to be less than or equal to the lowest SIL CL of any of the subsystems involved in the safety-related control function.

System Realization

To compute the probability of dangerous failure, each safety function must be broken down into function blocks, which are then realized as subsystems. A system design implementation of a typical safety function would include a sensing device connected to a logic device connected to an actuator. This creates a series arrangement of subsystems. As we have already seen, if we can determine the probability of dangerous failure for each subsystem and know its SIL CL, then the system probability of failure is easily calculated by adding the probability of failures of the subsystems. This concept is shown in Figure 136.

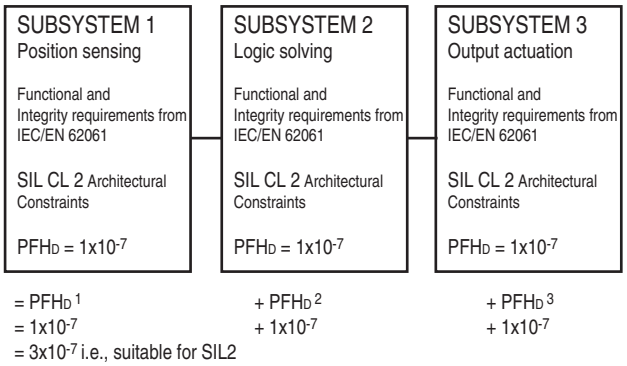


Figure 135: Example combination of subsystems

If, for example, we want to achieve SIL 2, each subsystem must have a SIL CL of at least SIL 2, and the sum of the PFH_D for the system must not exceed the limit allowed in Table 15.

Subsystem Design: IEC/EN 62061

If a system designer uses components ready “packaged” into subsystems according to IEC/EN 62061 life becomes much easier because the specific requirements for the design of subsystems do not apply. These requirements will, in general, be covered by the device (subsystem) manufacturer and are much more complex than those required for system level design.

IEC/EN 62061 requires that complex subsystems such as safety PLCs comply with IEC 61508 or other appropriate standards. This means that, for devices using complex electronic or programmable components, the full rigor of IEC 61508 applies. This can be a very rigorous and involved process. For example, the evaluation of the PFH_D achieved by a complex subsystem can be a very complicated process using techniques such as Markov modeling, reliability block diagrams or fault tree analysis.

IEC/EN 62061 does give requirements for the design of lower complexity subsystems. Typically this would include relatively simple electrical components such as interlock switches and electromechanical safety monitoring relays. The requirements are not as involved as those in IEC 61508 but can still be quite complicated.

IEC/EN 62061 supplies four subsystem logical architectures with accompanying formulae that can be used to evaluate the PFH_D achieved by a low complexity subsystem. These architectures are purely logical representations and should not be thought of as physical architectures. The four subsystem logical architectures with accompanying formulae are shown in Figures 136 through 139.

For a basic subsystem architecture shown in Figure 136, the probabilities of dangerous failures are simply added together.

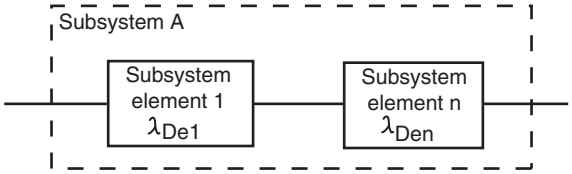


Figure 136: Subsystem logical architecture A

$\lambda_{DssA} = \lambda_{De1} + \ldots + \lambda_{Den}$

$PFH_{DssA} = \lambda_{DssA} \times 1h$

λ, (Lambda) is used to designate the failure rate. The units of the failure rate are failures per hour. λD is the dangerous failure rate. λDssA, is the dangerous failure rate of subsystem A. It is the sum of the failure rates of the individual elements, e1, e2, e3, up to and including en. The probability of dangerous failure is multiplied by 1 hour to create the probability of failure within one hour.

Figure 137 shows a single fault tolerant system without a diagnostic function. When the architecture includes single fault tolerance, the potential for common cause failure exists and must be considered. The derivation of the common cause failure is briefly described later in this section.

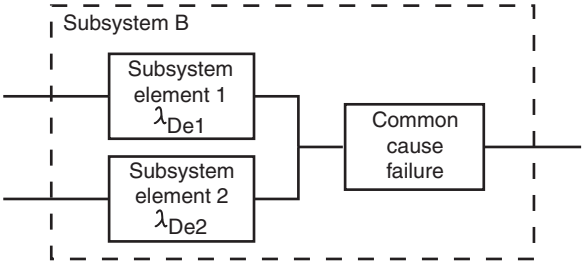


Figure 137: Subsystem logical architecture B

$\lambda_{DssB} = (1-ß)2 \times \lambda_{De1} \times \lambda_{De2} \times T_1 + ß \times (\lambda_{De1} + \lambda_{De2}) / 2$

$PFH_{DssB} = \lambda_{DssB} \times 1h$

The formulae for this architecture take into account the parallel arrangement of the subsystem elements and add the following two elements from Table 14:

ß (Beta) is the susceptibility to common cause failures.

T1 is the proof test interval or lifetime, whichever is smaller. The proof test is designed to detect faults and degradation of the safety subsystem so that the subsystem can be restored to a perfect operating condition. In practical terms this usually means replacement (like the equivalent term “mission time” in EN ISO 13849-1).

Figure 139 shows the functional representation of a zero fault tolerant system with a diagnostic function. Diagnostic coverage is used to decrease the probability of dangerous hardware failures. The diagnostic tests are performed automatically. The definition of diagnostic coverage is the same as given in EN ISO 13849-1 i.e. the ratio of the rate of detected dangerous failures compared to the rate of all dangerous failures.

These formulae include the diagnostic coverage, DC, for each of the subsystem elements. The failure rates of each of the subsystems are reduced by the diagnostic coverage of each subsystem.

The fourth example of a subsystem architecture is shown in Figure 139. This subsystem is single fault tolerant and includes a diagnostic function. The potential for common cause failure must also be considered with single fault tolerant systems.

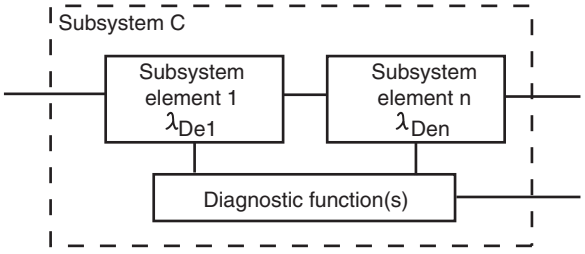


Figure 138: Subsystem logical architecture C

Figure 138 shows the functional representation of a zero fault tolerant system with a diagnostic function. Diagnostic coverage is used to decrease the probability of dangerous hardware failures. The diagnostic tests are performed automatically. The definition of diagnostic coverage is the same as given in EN ISO 13849-1 i.e. the ratio of the rate of detected dangerous failures compared to the rate of all dangerous failures.

These formulae include the diagnostic coverage, DC, for each of the subsystem elements. The failure rates of each of the subsystems are reduced by the diagnostic coverage of each subsystem.

$\lambda_{DssC} = \lambda_{De1} (1-DC_1) + \ldots + \lambda_{Den} (1-DC_n)$

$PFH_{DssC} = \lambda_{DssC} \times 1h$

The fourth example of a subsystem architecture is shown in Figure 139 This subsystem is single fault tolerant and includes a diagnostic function. The potential for common cause failure must also be considered with single fault tolerant systems.

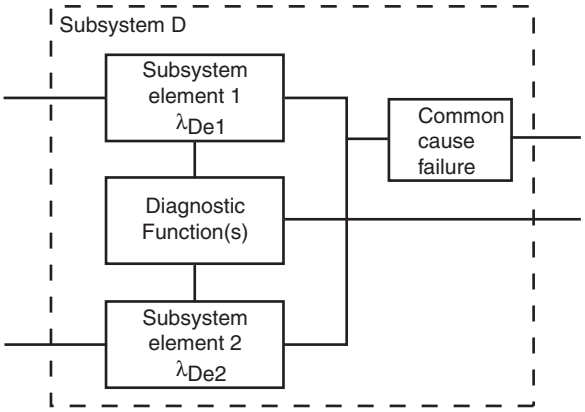


Figure 139: Subsystem logical architecture D

If the subsystem elements are different in each channel, the following formula is used:

$\lambda_{DssD} = (1 - \beta)^2 \{ \lambda_{De1} \times \lambda_{De2} \times (DC_1 + DC_2) \times T_2 / 2 + \lambda_{De1} \times \lambda_{De2} \times (2 - DC_1 - DC_2) \times T_1 / 2 \} + \beta \times (\lambda_{De1} + \lambda_{De2}) / 2$

$PFH_{DssD} = \lambda_{DssD} \times 1h$

If the subsystem elements are the same in each channel the following formula is used:

$\lambda_{DssD} = (1 - \beta)^2 \{ [\lambda_{De2} \times 2 \times DC] \times T_2 / 2 + [\lambda_{De2} \times \lambda_{De2} \times (1-DC)] \times T_1 \} + \beta \times (\lambda_{De}$

$PFH_{DssD} = \lambda_{DssD} \times 1h$

Notice that both formulae use one additional parameter, **T2** the diagnostic test interval. This is just a periodic check of the function. It is a less comprehensive test than the Proof Test.

As an example, assume the following values for the example where the subsystem elements are different:

β = 0.05
$\lambda_{De} = 1 \times 10^{-6}$ failures/hour
T1 = 87600 hours (10 years)
T2 = 2 hours
DC = 90%

PFH_{DssD} = 5.791E-08 dangerous failures per hour. This would be within the range required for SIL 3.

Affect of the Proof Test Interval

IEC/EN 62061 states that a Proof Test Interval (PTI) of 20 years is preferred (but not mandatory) Let us look at the affect the proof test interval has on the system. If we re-calculate the formula with T1 at 20 years it gives the result PFH_{DssD} = 6.581E-08. It is still within the range required for SIL 3. The designer must keep in mind that this subsystem must be combined with other subsystems to calculate the overall dangerous failure rate.

Affect of Common Cause Failure Analysis

Let's look at the affect the common cause failures have on the system. Suppose we take additional measures and our β (Beta) value improves to 1% (0,01), while the proof test interval remains at 20 years. The dangerous failure rate improves to 2.71E-08 which means that the subsystem is now more suitable for use in a SIL 3 system.

Common Cause Failure (CCF)

Common cause failure is when multiple faults resulting from a single cause produce a dangerous failure. Information on CCF will generally only be required by the subsystem designer, usually the manufacturer. It is used as part of the formulae given for estimation of the PFH_D of a subsystem. It will not usually be required at the system design level.

Annex F of IEC/EN62061 provides a simple approach for the estimation of CCF. Table 17 shows a summary of the scoring process.

No.	Measure Against CCF	Score
1	Separation/Segregation	25
2	Diversity	38
3	Design/Application/Experience	2
4	Assessment/Analysis	18
5	Competence/Training	4
6	Environmental	18

Table 17: Scoring for Measures Against Common Cause Failure

Points are awarded for employing specific measures against CCF. The score is added up to determine the common cause failure factor, which is shown in Table 18. The beta factor is used in the subsystem simplified architecture formulae to influence the failure rate as has already been shown.

Overall Score	Common Cause failure factor (ß)
<35	10% (0,1)
35…65	5% (0,05)
65…85	2% (0,02)
85…100	1% (0.01)

Table 18: Beta Factor for Common Cause Failure

Diagnostic Coverage (DC)

Automatic diagnostic tests are employed to decrease the probability of dangerous hardware failures. Being able to detect all dangerous hardware failures would be ideal, but in practice the maximum value is set at 99% (this can also be expressed as 0.99)

Diagnostic coverage is the ratio of the probability of detected dangerous failures to the probability all the dangerous failures.

Probability of Detected dangerous failures, λ_{DD}

$$DC = \frac{\text{Probability of Detected dangerous failures, } \lambda_{DD}}{\text{Probability of Total dangerous failures, } \lambda_{Dtotal}}$$

Hardware Fault Tolerance

Hardware fault tolerance represents the number of faults that can be sustained by a subsystem before it causes a dangerous failure. For example, a hardware fault tolerance of one means that two faults could cause a loss of the safety-related control function but one fault would not.

Management of Functional Safety

The standard gives requirements for the proper control of planning, project management and technical activities that are necessary for the achievement of a safety-related electrical control system.

Proof Test Interval

The proof test interval represents the time after which a subsystem must be either totally checked or replaced to ensure that it is in an "as new" condition. In practice, in the machinery sector, this is achieved by replacement. So the proof test interval is usually the same as lifetime. EN ISO 13849-1 refers to this as Mission Time.

A proof test is a check that can detect faults and degradation in a SRCS so that the SRCS can be restored as close as practical to an "as new" condition. The proof test must detect 100% of all dangerous failures. Separate channels must be tested separately.

In contrast to diagnostic functional tests, which are automatic, proof tests are usually performed manually and off line. Diagnostic functional testing is usually performed often (typically over a few hours) as compared to proof testing which is done infrequently (typically over many years). For example, the circuits going to an interlock switch on a guard can be functionally tested automatically for short and open circuit conditions with diagnostic (e.g., pulse) testing.

The proof test interval must be declared by the manufacturer. Sometimes the manufacturer will provide a range of different proof test intervals.

Safe Failure Fraction (SFF)

The safe failure fraction is similar to diagnostic coverage (DC) but also takes account of any inherent tendency to fail towards a safe state. For example, when a fuse blows, there is a failure but it is highly probable that the failure will be to an open circuit which, in most cases, would be a "safe" failure. SFF is (the sum of the rate of "safe" failures plus the rate of detected dangerous failures) divided by (the sum of the rate of "safe" failures plus the rate of detected and undetected dangerous failures). It is important to realize that the only types of failures to be considered are those which could have some affect on the safety function.

Most low complexity mechanical devices such as E-stop buttons and interlock switches will (on their own) have a relatively low SFF. Most electronic devices for safety have designed in redundancy and monitoring therefore an SFF of greater than 90% is common although this is usually completely due to the Diagnostic Coverage capability.

The SFF value will normally be supplied by the manufacturer.

The Safe Failure Fraction (SFF) can be calculated using the following equation:

$$SFF = (\Sigma\lambda_S + \Sigma\lambda_{DD}) / (\Sigma\lambda_S + \Sigma\lambda_D)$$

where

λ_S = the rate of safe failure,
$\Sigma\lambda_S + \Sigma\lambda_D$ = the overall failure rate,
λ_{DD} = the rate of detected dangerous failure
λ_D = the rate of dangerous failure.

Systematic Failure

The standard has requirements for the control and avoidance of systematic failure. Systematic failures differ from random hardware failures which are failures occurring at a random time, typically resulting from degradation of parts of hardware. Typical types of possible systematic failure are software design errors, hardware design errors, requirement specification errors and other operational procedures. Examples of steps necessary to avoid systematic failure include:

- Proper selection, combination, arrangements, assembly, and installation of components,
- Use of good engineering practice,
- Follow manufacturer's specifications and installation instructions,
- Ensuring compatibility between components,
- Withstanding environmental conditions,
- Use of suitable materials.

Safety-Related Control System Structure Considerations

Overview

This chapter looks at general structural considerations and principles that should be taken into account when designing a safety related control system to any standard. It uses much of language of the Categories from the outgoing EN 954-1 because the Categories primarily address the structure of control systems.

Note: Recent to the time of publication of this text, CEN (European Committee for Standardisation) announced that the final date for presumption of conformity of EN 954-1 will be extended to the end of 2011 to facilitate transition to the later standards. This replaces the original date of December 29, 2009.

For the latest information on the use and status of EN 954-1 visit: *http://discover.rockwellautomation.com/EN_Safety_Solutions.aspx*. In the meantime it is advised that the extension of the transition period is used to move over to the use of the later standards (EN ISO 13849-1 or IEC/EN 62061) in a timely manner.

Categories of Control Systems

The "Categories" of control systems originated in the outgoing EN 954-1:1996 (ISO13849-1:1999). However they are still often used to describe safety control systems and they remain an integral part of EN ISO13849-1 as discussed in "Introduction to Functional Safety of Control Systems" section.

There are five categories describing the fault reaction performance of a safety related control system. See Table 19 for a summary of these categories. The following notes apply to the table.

Note 1: Category B in itself has no special measures for safety but it forms the base for the other categories.

Note 2: Multiple faults caused by a common cause or as inevitable consequences of the first fault shall be counted as a single fault.

Note 3: The fault review may be limited to two faults in combination if it can be justified but complex circuits (e.g. microprocessor circuits) may require more faults in combination to be considered.

Category 1 is aimed at the prevention of faults. It is achieved through the use of suitable design principles, components and materials. Simplicity of principle and design together with stable and predictable material characteristics are the keys to this category.

Categories 2, 3 and 4 require that if faults cannot be prevented they must be detected and appropriate action taken.

Redundancy, diversity and monitoring are the keys to these categories. Redundancy is the duplication of the same technique. Diversity is using two different techniques. Monitoring is the checking the status of devices and then taking appropriate action based on results of the status. The usual, but not only, method of monitoring is to duplicate the safety critical functions and compare operation.

Summary of Requirements	System Behavior
Category B (see Note 1) Safety related parts of machine control systems and/or their protective equipment, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence. Basic safety principles shall be applied.	When a fault occurs, it can lead to a loss of the safety function.
CATEGORY 1 The requirements of category B apply together with the use of well tried safety components and safety principles.	As described for category B but with higher safety related reliability of the safety related function. (The higher the reliability, the less the likelihood of a fault).
CATEGORY 2 The requirements of category B and the use of well tried safety principles apply. The safety function(s) shall be checked at machine start-up and periodically by the machine control system. If a fault is detected a safe state shall be initiated or if this is not possible a warning shall be given. EN ISO 13849-1 assumes that the test rate is at least 100 times more frequent that the demand rate. EN ISO 13849-1 assumes that the MTTFd of the external test equipment is larger than half of the MTTFd of the functional equipment being tested.	The loss of safety function is detected by the check. The occurrence of a fault can lead to the loss of safety function between the checking intervals.
CATEGORY 3 (see Notes 2 & 3) The requirements of category B and the use of well tried safety principles apply. The system shall be designed so that a single fault in any of its parts does not lead to the loss of safety function. Where practicable, a single fault shall be detected.	When the single fault occurs the safety function is always performed. Some but not all faults will be detected. An accumulation of undetected faults can lead to the loss of safety function.
Category 4 (see Notes 2 & 3) The requirements of category B and the use of well tried safety principles apply. The system shall be designed so that a single fault in any of its parts does not lead to the loss of safety function. The single fault is detected at or before the next demand on the safety function. If this detection is not possible then an accumulation of faults shall not lead to a loss of safety function.	When the faults occur, the safety function is always performed. The faults will be detected in time to prevent the loss of safety functions.

Table 19: Categories of Safety Performance

Category B

Category B provides the basic requirements of any control system; whether it is a safety related control system or non-safety related. A control system must work in its expected environment. The concept of reliability provides a foundation for control systems, as reliability is defined as the probability that a device will perform its intended function for a specified interval under expected conditions.

Category B requires the application of basic safety principles. ISO 13849-2 tells us the basic safety principles for electrical, pneumatic, hydraulic and mechanical systems. The electrical principles are summarized as follows:

- Proper selection, combination, arrangements, assembly and installation (i.e., per manufacturer's instructions)
- Compatibility of components with voltages and currents
- Withstand environmental conditions
- Use of de-energization principle
- Transient suppression
- Reduction of response time
- Protection against unexpected start-up
- Secure fixing of input devices (e.g. mounting of interlocks)
- Protection of control circuit (per NFPA79 & IEC60204-1)
- Correct protective bonding

The designer must select, install, and assemble according to the manufacturer's instructions. These devices must work within the expected voltage and current ratings. The expected environmental conditions, like electromagnetic compatibility, vibration, shock, contamination, washdown, must also be considered. The de-energization principle is used. Transient protection is installed across the contactor coils. The motor is protected against overloads. The wiring and grounding meets the appropriate electrical standards.

Category 1

Category 1 requires the system to meet the terms of Category B and, in addition, to use well-tried components. EN ISO 13849-2 gives information about well tried components for mechanical, hydraulic, pneumatic and electrical systems. Annex D addresses electrical components.

Components are considered to be well-tried if they have been successfully used in many similar applications. Newly designed safety components are considered to be well-tried if they are designed and verified in compliance to appropriate standards. Table 20 lists some electrical components and their respective standards.

Well-Tried Component	Standard
Switch with positive mode actuation (direct opening action)	IEC 60947-5-1
Emergency stop device	ISO 13850, IEC60947-5-5
Fuse	IEC 60269-1
Circuit Breaker	IEC 60947-2
Contactors	IIEC 60947-4-1, IEC 60947-5-1
Mechanically linked contacts	IEC 60947-5-1
Auxiliary contactor (e. g. contactor, control relay, positive guided relays)	EN 50205 IEC 60204–1, IEC 60947–5–1
Transformer	IEC 60742
Cable	IEC 60204-1
Interlocks	ISO 14119
Temperature Switch	IEC 60947-5-1
Pressure Switch	IEC 60947-5-1 + pneumatic or hydraulic requirements
Control and protective switching device or equipment (CPS)	IEC 60947-6-2
Programmable Logic Controller	IEC 61508

Table 20: Standards for Well-Tried Components

Applying well-tried components to our Category B system, the limit switch would be replaced by a direct opening action tongue switch and the contactor would be over-dimensioned to further protect against welded contacts.

Figure 140 shows the changes to the simple Category B system to achieve Category 1. The interlock and the contactor play the key roles in removing energy from the actuator, when access to the hazard is needed. The tongue interlock meets the requirements of IEC 60947-5-1 for direct opening action contacts, which is shown by the symbol of the arrow within the circle. With the well-tried components, the probability of energy being removed is higher for Category 1 than it is for Category B. The use of well-tried components is intended to prevent a loss of the safety function. Even with these improvements, a single fault can still lead to the loss of the safety function.

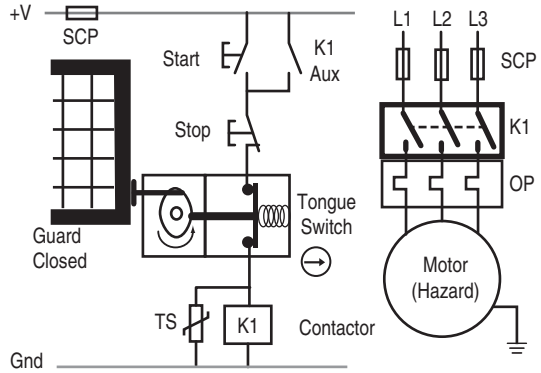


Figure 140: Category 1 of Simple Safety System

Categories B and 1 are prevention based. The design is intended to prevent a hazardous situation. When prevention by itself does not provide enough reduction in the risk, fault detection must be used. Categories 2, 3 and 4 are fault detection based, with increasingly stringent requirements to achieve higher levels of risk reduction.

Category 2

In addition to meeting the requirements of Category B and using well tried safety principles, the safety system must undergo testing to meet Category 2. The tests must be designed to detect faults within the safety related parts of the control system. If faults are not detected, the machine is allowed to run. If faults are detected, the test must initiate a command to bring the machine to a safe state.

Figure 141 shows a block diagram of a Category 2 system. The equipment performing the test can be an integral part of the safety system or a separate piece of equipment.

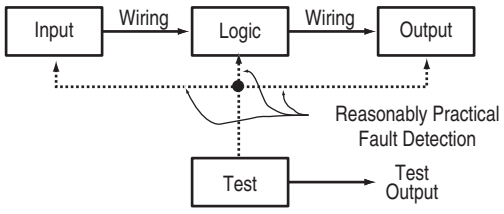


Figure 141: Category 2 Block Diagram

The testing must be performed:

- When the machine is initially powered,
- Prior to the initiation of a hazard, and
- Periodically if deemed necessary by the risk assessment.

Note: EN ISO 138491-1 assumes a test to safety function demand ration of 100:1. The example given here would not meet that requirement.

The words “whenever possible” and “reasonably practicable” indicate that not all faults are detectable. Since this is a single channel system (i.e., one wire connects input to logic to output), a single fault may lead to the loss of the safety function. In some cases, Category 2 cannot be fully applied to a safety system, because not all of the components can be checked.

Figure 140 shows the simple Category 1 system enhanced to meet Category 2. A monitoring safety relay (MSR) performs the testing. Upon power-up, the MSR checks its internal components. If no faults are detected, the MSR checks the tongue switch by monitoring the cycling of its contacts. If no faults are detected and the guard is closed, the MSR then checks the output device: the mechanically linked contacts of the contactor. If no faults are detected and the contactor is off, the MSR will energize its internal output and connect the coil of K1 to the Stop button. At this point, the non safety rated parts of the machine control system, the Start/Stop/Interlock circuit, can turn the machine on and off.

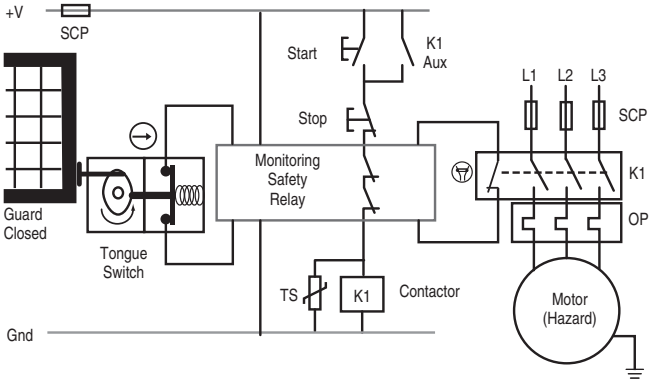


Figure 142: Category 2 Safety System

Opening the guard turns the outputs of the MSR off. When the guard is re-closed, the MSR repeats the safety system checks. If no faults are discovered, the MSR turn on is internal output. The MSR allows this circuit to meet Category 2 by performing tests on the input device, the logic device (itself) and the output device. The test is performed on initial power-up and before initiation of the hazard.

With its inherent logic capabilities, a Safety PLC (PLC safety-rated to IEC 61508) based safety system can be designed to meet category 2.

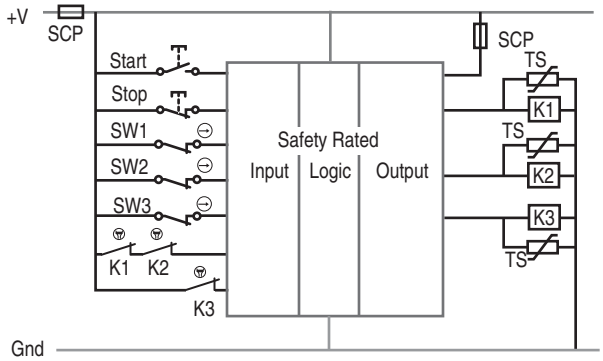


Figure 143: Complex Category 2 Safety System

Safety-Related Control System Structure Considerations

Figure 143 shows an example of a complex system using a safety rated PLC. A safety rated PLC meets the requirements of well-tried as it is designed to an appropriate standard. The mechanically linked contacts of the contactors are fed into the Input of the PLC for testing purposes. These contacts may be connected in series to one input terminal or to individual input terminals, depending on the program logic.

Although well-tried safety components are used, a single fault occurring between the checks can lead to the loss of the safety function. Therefore, Category 2 systems are used in lower risk applications. When higher levels of fault tolerance are needed, the safety system must meet Categories 3 or 4.

Category 3

In addition to meeting the requirements of Category B and well-tried safety principles, Category 3 requires successful performance of the safety function in the presence of a single fault. The fault must be detected at or before the next demand on the safety function, whenever reasonably practicable.

Here again we have the phrase “whenever reasonably practicable.” This covers those faults that may not be detected. As long as the undetectable fault does not lead to the loss of the safety function, the safety function can meet category 3. Consequently, an accumulation of undetected faults can lead to the loss of the safety function.

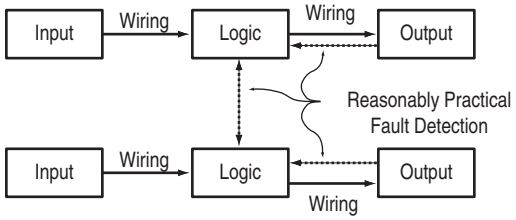


Figure 144: Category 3 Block Diagram

Figure 144 shows a block diagram to explain the principles of a Category 3 system. Redundancy combined with reasonably practicable cross monitoring and output monitoring are used to ensure the performance of the safety function

Figure 145 shows an example of a Category 3 system. A redundant set of contacts are added to the tongue interlock switch. Internally, the monitoring safety relay (MSR) contains redundant circuits that cross monitor each other. A redundant set of contactors remove power from the motor. The contactors are monitored by the MSR through the “reasonably practicable” mechanically linked contacts.

Fault detection must be considered for each part of the safety system, as well as the connections (i.e., the system). What are the failure modes of a dual channel tongue switch? What are the failure modes of the MSR? What are the failure modes of the contactors K1 and K2? What are the failure modes of the wiring?

The tongue interlock switch is designed with direct opening contacts. Therefore we know that opening the guard is designed to open a welded contact. This resolves one failure mode. Do other failure modes exist?

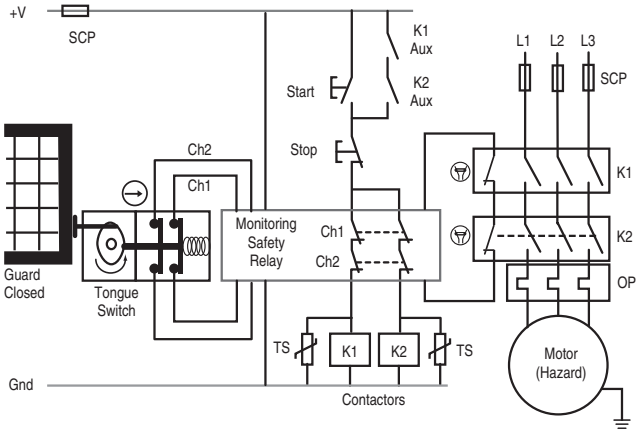


Figure 145: Category 3 System

The direct opening action switch is usually designed with a spring operate return. If the head is removed or broken off, the safety contacts spring back to the closed (safe) state. Many interlock switches are designed with removable heads to accommodate installation requirements of various applications. The head can be removed and rotated between two to four positions.

A failure could occur where the head mounting screws are not torqued properly. With this condition, the expected vibration of the machine may cause the head mounting screws to back out. The operating head, under spring pressure, removes the pressure from the safety contacts, and the safety contacts close. Subsequently, opening the guard does not open the safety contacts, and a failure to danger occurs.

Similarly, the operating mechanism within the switch must be reviewed. What is the probability that a failure of a single component will lead to the loss of the safety function? A common practice is to use tongue interlocks with dual contacts in Category 3 circuits. This usage must be based on excluding the single failure of the switch to open the safety contacts. This is considered “fault exclusion” and is discussed later in this chapter.

A monitoring safety relay (MSR) is often evaluated by a third party and assigned a category level (and/or a PL and SIL CL). The MSR often includes dual channel capability, cross channel monitoring, external device monitoring and short circuit protection. No specific standards are written to provide guidance on the design or usage of monitoring safety relays. MSRs are evaluated for their ability to perform the safety function per EN ISO 13849-1 or the outgoing EN 954-1. The rating of the MSR must be the same or higher than the required rating of the system in which it is used.

Two contactors help to ensure that the safety function is fulfilled by the output devices. With overload and short-circuit protection, the probability of the contactor failing with welded contacts is small but not impossible. A contactor can also fail due with its power switching contacts staying closed due to a stuck armature. If one contactor fails to a dangerous state, the second contactor will remove power from the hazard. The MSR will detect the faulted contactor upon the next machine cycle. When the gate is closed and the start button pressed, the mechanically linked contacts of the faulted contactor will remain open and the MSR will not be able to close its safety contacts, thereby, revealing the fault.

Undetected Faults

With a Category 3 system structure there may be some faults that cannot be detected but they must not, by themselves, lead to the loss of the safety function.

Where faults can be detected we need to know if, under some circumstances, they could be either masked or unintentionally cleared by the operation other devices within the system structure.

Figure 146 shows a widely used approach for connecting multiple devices to a monitoring safety relay. Each device contains two normally closed direct opening action contacts. These devices can be a mix of interlocks or e-stop buttons. This approach saves wiring costs as the input devices are daisy-chained. Assume a short circuit fault occurs across one of the contacts at Sw2 as shown. Can this fault be detected?

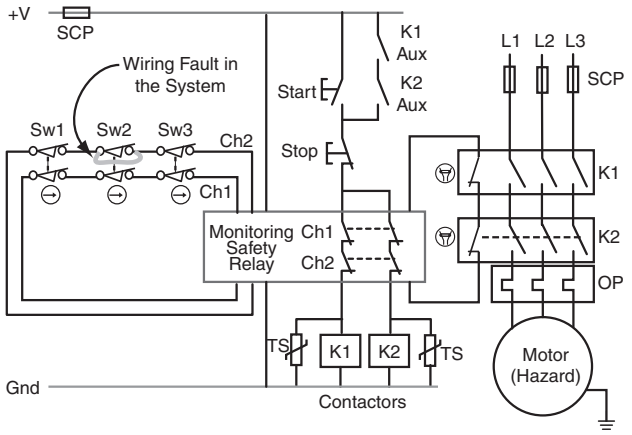


Figure 146: Series Connection of Inputs Devices

If switch Sw1 (or Sw3) is opened, both Ch1 and Ch2 are open circuit and the MSR removes power from the hazard. If Sw3 is then opened and then closed again the fault across its contacts will not be detected because there is no change of status at the MSR: both Ch1 and Ch2 remain open. If Sw1 (or Sw3) is then closed, the hazard can be restarted by pressing the start button. Under these circumstances the fault did not cause a loss of the safety function but it was not detected, it remains in the system and a subsequent fault (a short circuit across the second contact of Sw2) could lead to the loss of the safety function.

If Sw2 alone was opened and closed, with no operation of the other switches, Ch1 opens and Ch2 remains closed. The MSR de-energizes the hazard because Ch1 opened. When Sw2 closes, the motor cannot be started when the Start button is pressed, because Ch2 did not open. The fault is detected. However if for any reason, Sw1 (or Sw3) is then opened and closed, both Ch1 and Ch2 will be open then closed circuit. This sequence simulates the clearing of the fault and will result in unintentional reset at the MSR.

This raises the question of what DC could be claimed for the individual switches within this structure when using EN ISO 13849-1 or IEC 62061. At the time of publication of this text there is no specific definitive guidance on this but it is usual and reasonable to assume a DC of 60% under the condition that the switches are individually tested at suitable periods to reveal faults. If it is foreseeable that one (or more) of the switches will never be individually tested then it can be argued that its DC should be described as zero. At the time of publication of this text EN ISO 13849-2 is undergoing revision. When it is published it may provide more guidance on this issue.

The series connection of mechanical contacts is limited to Category 3 as it may lead to the loss of the safety function due to an accumulation of faults. In practical terms, the reduction of the DC (and therefore SFF) would limit the maximum achievable PL and SIL to PLd and SIL2.

It is interesting to note that these characteristics of a Category 3 structure have always required consideration but they are brought into sharp focus by the newer functional safety standards.

Figure 147 shows a category 3 circuit using a safety rated variable frequency drive. Recent developments in drive technology coupled with the updating of EN/IEC 60204-1 and NFPA79 standards allow safety rated drives to be used in e-stop circuits without the need for an electro-mechanical disconnect of the actuator (e.g., the motor).

Pressing the E-Stop opens the outputs of the MSR. This sends a stop signal to the drive, removes the enable signal and opens the gate control power. The drive executes a Category 0 Stop—immediate removal of power to the motor. This function is termed “Safe Torque Off.” The drive achieves category 3 because it has redundant signals to remove power to the motor: the enable and a positive guided relay. The positive guided relay provides reasonably practicable feedback to the actuator. The drive itself is analyzed to determine that a single fault does not lead to the loss of the safety function.

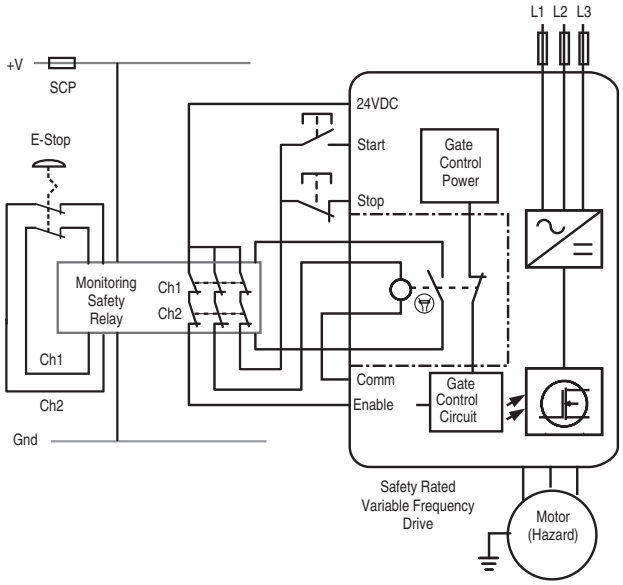


Figure 147: Safety Rated Drives with E-stop Rated to Category 3

Figure 148 shows an example of a wiring fault, a short circuit, from the MSR Channel 2 safety output to the coil of Contactor K1. All components are operating properly. This wiring fault can occur prior to machine commissioning or at some later date during maintenance or enhancements. Can this fault be detected?

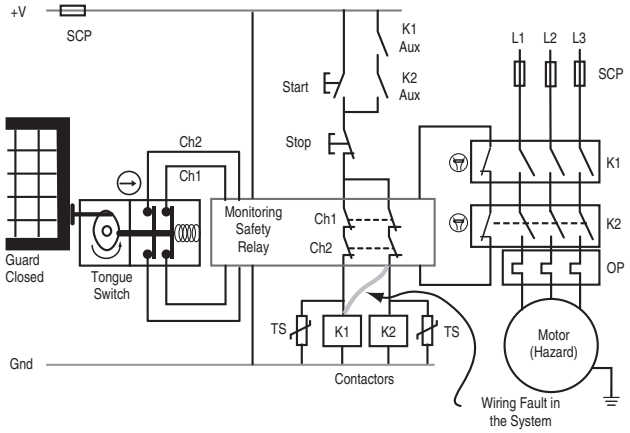


Figure 148: Example 1 of Wiring Fault

This fault cannot be detected by the safety system as shown. Fortunately it does not, on its own, lead to the loss of the safety function. This fault, as well as the fault from Ch1 to K2, must be detected during commissioning or checks following maintenance work. The list of possible fault exclusions given in EN ISO 13849-2 Annex D Table D4 clarifies that these types of faults can be excluded if the equipment is contained within an electrical enclosure and both the enclosure and wiring comply with the requirements of IEC/EN 60204-1. The Joint Technical report on EN ISO 13849-1 and IEC 62061 also clarifies that this fault exclusion can be considered up to and including PLe and SIL3. It can also be used at Category 4.

Figure 149 shows another wiring fault example. This fault occurs from the mechanically linked contact of K2 to the monitoring input of the MSR. Can this fault be detected?

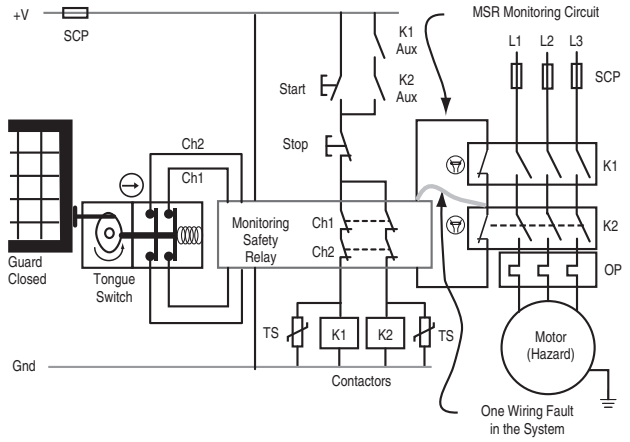


Figure 149 Monitored Manual Reset to Detect Fault

This fault cannot be detected by the safety system, as shown. The MSR monitoring circuit is a series circuit that must be closed prior to startup. As long as the circuit is closed, the MSR believes all monitored devices are in the off state and ready to go. In this example, a welded or stuck K1 contactor will not be detected; it will be masked by the short circuit fault. With two contactors, the safety function is performed by K2, if K1 is indeed faulted. An MSR with monitored manual reset could be substituted for the MSR with automatic reset to detect this type of fault. This type of MSR requires a change of state in terms of a rising or falling signal edge as discussed in the next example and also in the "Protective Measures and Complimentary Equipment" section.

Figure 150 shows the same situation as 149, except the monitoring circuit of the MSR has changed function from automatic to monitored manual. This is accomplished in the MSR by wiring changes or model changes. The monitored manual reset can detect this type of fault because the monitoring circuit must be open at the time that the guard is closed. After closing the guard, the reset button must be pressed. In many (but not all) relays, the MSR outputs energize when the reset button is released. This requirement for a change of state means that the relay cannot be "fooled" into reset by a permanent blocking down of the reset button or unintentionally reset by a short circuit fault.

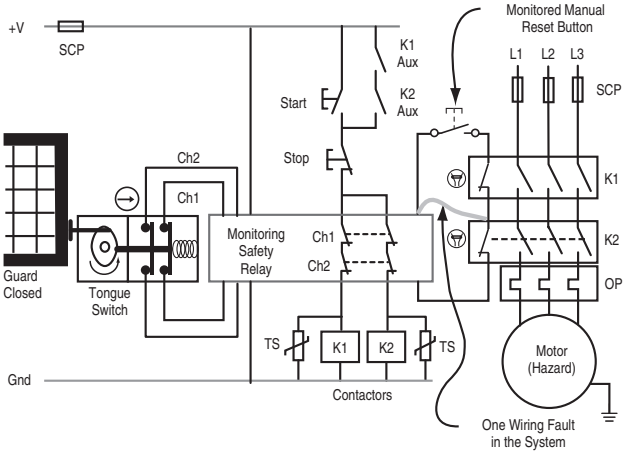


Figure 150: Monitored Manual Reset to Detect Fault

Figure 151 shows a cross channel input fault. A fault occurs from Channel 1 to Channel 2 at the input of the MSR. With eight connections for the two channels, there are numerous potential ways to create the cross channel fault. Can this fault be detected?

Detection of this fault is dependent upon the type of MSR. Microprocessor based MSRs use pulse testing fault detection techniques (see later explanation) and some MSRs utilize diverse inputs. One input is pulled up to +V, and the second input is pulled down to ground. In either case this wiring short will be detected immediately, and the safety input of the MSR will turn off, removing energy from the hazard.

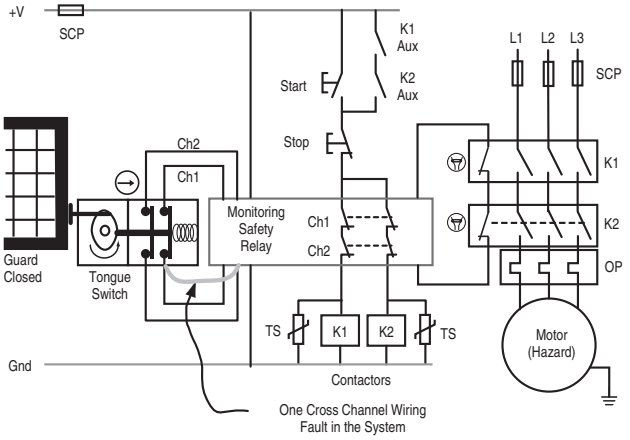


Figure 151: Cross Channel Input Fault

Pulse Testing Fault Detection

Safety circuits are designed to be carrying current when the safety system is active and the hazard is protected. Pulse testing is a technique where the circuit current drops to zero for a very short duration. The duration is too short for the safety circuit to respond and turn the hazard off, but is long enough for a microprocessor based system to detect. The pulses on the channels are offset from each other. If a cross fault short circuit occurs, the microprocessor detects the pulses on both channels and initiates a command to turn the hazard off.

Figure 152 illustrates this principle. This technique also detects shorts to the +V supply. Microprocessor based safety monitoring relays and safety PLC based systems use the pulse testing technique.

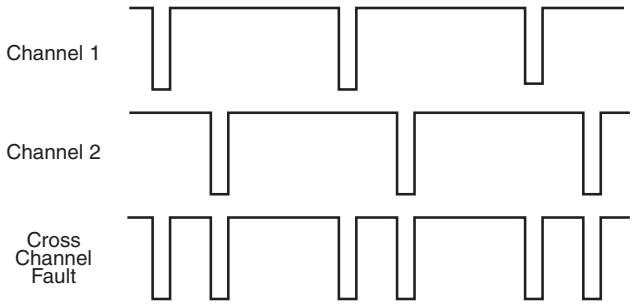


Figure 152: Cross Channel Fault with Pulse Testing

Figure 153 shows an arrangement where two outputs of the PLC are configured for pulse testing. Alternating pulses are connected to each channel operated by mechanical switches. This approach detects cross channel faults as well as faults to power and ground. This pulse testing is required by Category 3 because it is reasonably practicable to detect cross channel faults in this manner.

The faults described above are only a subset of all the faults that must be considered. Short circuits to +V, to Ground, shorts to other circuits, and open circuit conditions must be evaluated. In addition, the component ratings and performance must be considered.

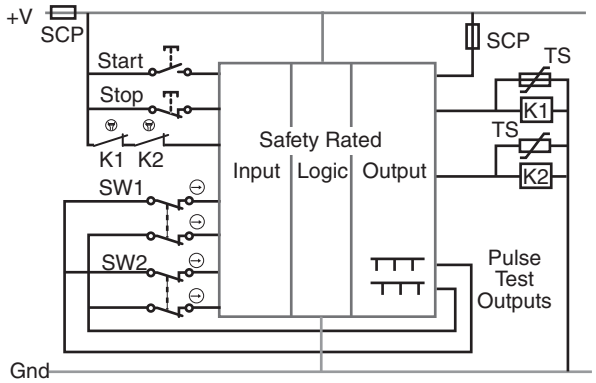


Figure 153: Safety PLC using Pulse Testing for Fault Detection

Figure 154 shows a variation of a Safety PLC arrangement. In some cases, connecting a non-safety rated device to a safety system is needed and beneficial. If the outputs are sourcing type, they can be connected directly to the input of the safety PLC. If they are dual channel, they can be considered to meet Category 3 reasonable requirements.

Another consideration for Safety PLC modules is the number of inputs. Occasionally, one or two additional inputs may be needed, but panel space does not allow for an additional block. In this case, input devices may be connected in series (e.g., SW1 and SW2) and still meet the requirements of Category 3. The tradeoff is the loss of information as to which switch is actuated, unless an additional contact is used and connected to the machine control system.

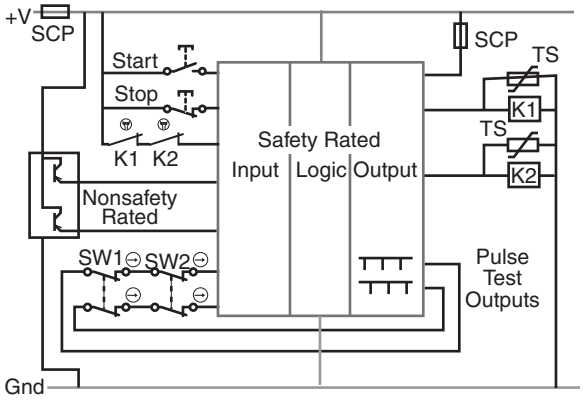


Figure 154: Complex Inputs Meeting Category 3 with a Safety PLC

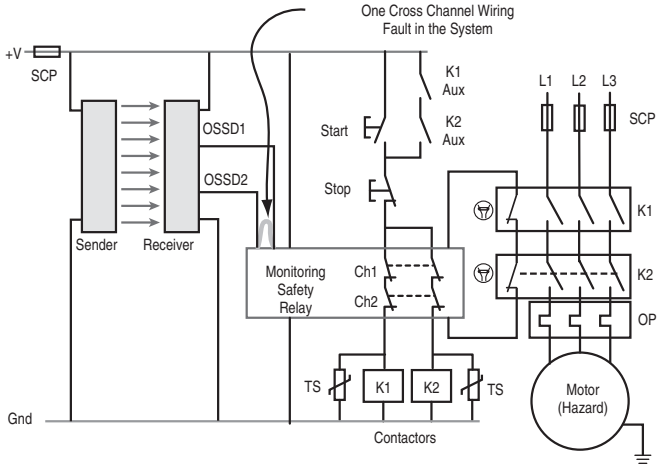


Figure 155: Cross Channel Wiring Fault with Light Curtains

Figure 155 shows an example safety system with light curtains (solid state OSSD outputs).

In this example, the wiring fault is detected by the pulse testing at the light curtain. The detection of the fault is immediate, and the light curtain turns off its output.

Category 4

Like Category 3, Category 4 requires the safety system to meet Category B, use safety principles and perform the safety function in the presence of a single fault. Unlike Category 3 where an accumulation of faults can lead to the loss of the safety function, Category 4 requires performance of the safety function in the presence of an accumulation of faults. In practice the consideration of two accumulated faults may be sufficient, although 3 faults may be necessary for some designs due to complexity.

Figure 156 shows the block diagram for Category 4. Monitoring of both output devices and cross monitoring is essentially required, not just when reasonably practicable. This helps differentiate Category 4 from Category 3.

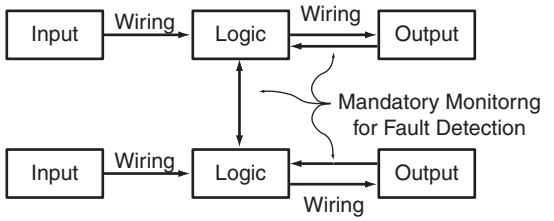


Figure 156: Category 4 Block Diagram

Figure 157 shows an example Category 4 circuit using a two channel non-contact interlock switch.

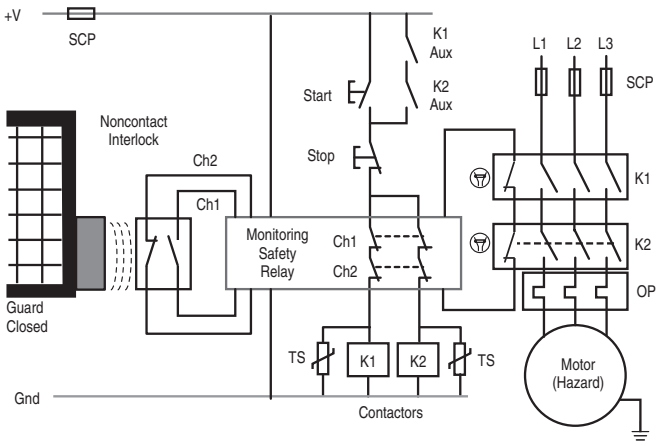


Figure 157: Non-contact Interlock Category 4 System

Up until relatively recently, tongue actuated interlock switches have sometimes been used for Category 4 circuits. In order to use a tongue interlock in a dual channel circuit it is necessary to exclude the possible single fault failure points on the mechanical actuation tongue and switch linkage. However, the Joint Technical Report on EN ISO 13849-1 and IEC 62061 has clarified that this type of fault exclusion should not be used in PLe or SIL 3 systems.

If the safety system designer prefers using tongue style interlocks, then two switches can be used to meet Category 4. Figure 158 shows an example with two tongue interlock switches with direct opening action contacts.

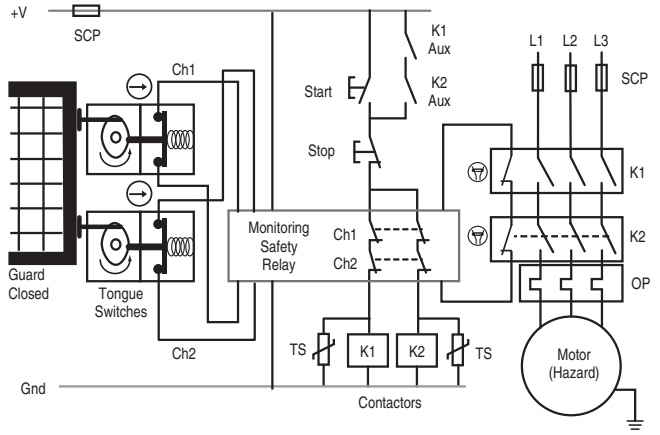


Figure 158: Category 4 with Redundant Tongue Interlocks

The Monitoring safety relay itself must be rated to meet Category 4, and both output contactors, using mechanically linked contacts, must be monitored.

Figure 159 shows a modular monitoring safety relay with one non-contact switch device connected to each input module. If the safety relay is rated for category 4, this arrangement of input devices meets Category 4. Notice that with the modular approach, the safety relay is microprocessor based and utilizes pulse checking to detect cross faults.

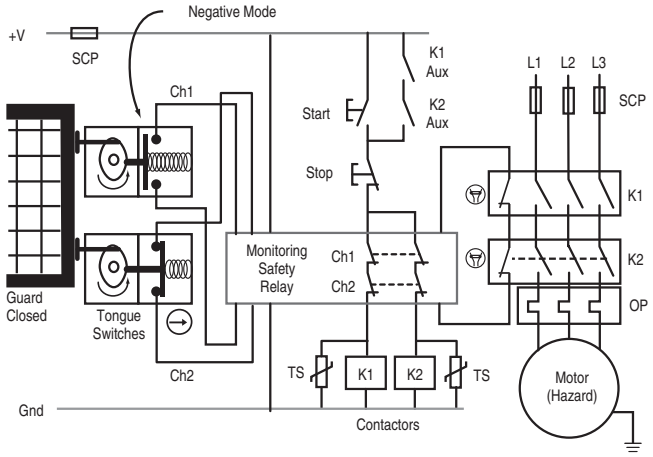


Figure 159: Modular Safety Relay Category 4 System

Component and System Ratings

Categories can be used as part of safety component (device) ratings as well as system ratings. This generates some confusion that can be clarified by understanding the components and their capabilities. By studying the preceding examples we find that a component such as an interlock switch rated to Category 1 can be used on its own in a Category 1 system, and it can be used in a Category 2 system if additional function monitoring is provided. It can also form part of a Category 3 or 4 system if two of the components are used together with a diagnostic function provided by a monitoring safety relay

Some components such as monitoring safety relays and programmable safety controllers have their own internal diagnostics and they check themselves to ensure proper performance. Therefore they can be rated as safety components to meet Categories 2, 3 or 4 without any additional measures.

Fault Considerations

Safety analysis requires extensive analysis of faults, and a thorough understanding of the performance of the safety system in the presence of faults is needed. ISO 13849-1 and ISO 13849-2 provide details on fault considerations and fault exclusions.

If a fault results in a failure of a subsequent component, the first fault and all the subsequent faults shall be considered one fault.

If two or more faults occur as a result of a single cause, the faults shall be considered a single fault. This is known as a common cause fault.

The occurrence of two or more faults at the same time is considered to be highly unlikely and is not considered in this analysis. There is a basic assumption is that only one fault will occur between demands placed on the safety function providing that the periods between the use of the function are not excessively long

Fault Exclusions

The outgoing EN 954-1, and the more recent EN ISO 13849-1 and IEC 62061 all permit the use of fault exclusions when determining a safety system classification if it can be shown that the occurrence of the fault is extremely unlikely. It is important that where fault exclusions are used that they are properly justified and are valid for the intended lifetime of the safety system. The greater the level of risk protected by the safety system then the more stringent becomes the justification required for the fault exclusion. This has always caused some confusion about when certain types of fault exclusion can or cannot be used. As we have seen already in this chapter, recent standards and guidance documents have clarified some aspects of this issue.

In general, where PLe or SIL3 is specified for a safety function to be implemented by a safety system it is not normal to rely upon fault exclusions alone to achieve this level of performance. This is dependent upon the technology used and the intended operating environment. Therefore it is essential that designer takes additional care on the use of fault exclusions as that PL or SIL increases. For example fault exclusion is not applicable to the mechanical aspects of electromechanical position switches and manually operated switches (e.g. an emergency stop device) in order to achieve a PLe or SIL3 system. Those fault exclusions that can be applied to specific mechanical fault conditions (e.g. wear/corrosion, fracture) are described in Table A.4 of ISO 13849-2. Therefore a guard interlocking system that has to achieve PLe or SIL3 will need to incorporate a minimum fault tolerance of 1 (e.g. two conventional mechanical position switches) in order to achieve this level of performance since it is not normally justifiable to exclude faults, such as, broken switch actuators. However, it may be acceptable to exclude faults, such as short circuit of wiring within a control panel designed in accordance with relevant standards.

Further information on the use of fault exclusions will be provided in the forthcoming revision of EN ISO 13849-2.

Stop Categories according to IEC/EN 60204-1 and NFPA 79

It is both unfortunate and confusing that the term “Category” in relation to safety related control systems has two different meanings. So far we have discussed the categories that originated in EN 954-1. They are a classification of the performance of a safety system under fault conditions.

There is also a classification known as “Stop Categories” that originated in IEC/EN 60204-1 and NFPA 79 There are three Stop Categories.

Stop Category 0 requires immediate removal of power to the actuators. This is sometimes considered as an uncontrolled stop because, in some circumstances, motion can take some time to cease because the motor may be free to coast to a stop.

Stop Category 1 requires that power is retained to apply braking until the stop is achieved and then remove power to the actuator.

Stop Category 2 allows that power need not be removed from the actuator.

Note that only Stop Categories 0 or 1 can be used as emergency stops. The choice of which of the two Categories to use should be dictated by a risk assessment.

All the circuit examples shown so far in this chapter have used a Stop Category 0. A Stop Category 1 is achieved with a time-delayed output for the final removal of power. An interlocked guard with guardlocking often accompanies a Category 1 stop system. This keeps the guard locked in a closed position until the machine has reached a safe (i.e., stopped) state.

Stopping a machine without taking proper account of the programmable controller may affect restarting and could result in severe tool and machine damage. A standard (non safety) PLC alone cannot be relied on for a safety related stopping task; therefore, other approaches need to be considered.

Two possible solutions are given below:

1. Safety Relay with Time Delayed Override Command

Figure 160 shows a hard wired system that has allows a correctly sequenced shut-down which protects the machine and program.

A safety relay with both immediate acting and delayed action outputs is used (e.g. MSR138DP). The immediate acting outputs are connected to inputs at the programmable device (e.g., PLC.) and the delayed acting outputs are connected to the contactor. When the guard interlock switch is actuated, the immediate outputs on the safety relay switch. This signals the programmable system to carry out a correctly sequenced stop. After short but sufficient time has elapsed to allow this process, the delayed output on the safety relay switches and isolates the main contactor.

Note: Any calculations to determine the overall stopping time must take the safety relay output delay period into account. This is particularly important when using this factor to determine the positioning of devices in accordance with the safety distance calculation.

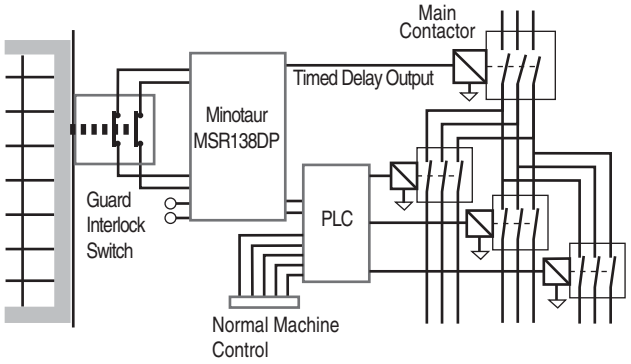


Figure 160: Delayed Outputs for Orderly Shutdown

2. Safety PLCs

The logic and timing functions required can be conveniently implemented by using a (safety) PLC with an appropriate safety integrity level. In practice this would be achieved by using a Safety PLC such as the SmartGuard or GuardLogix.

Safety-Related Control System Structure Considerations

U.S. Safety Control System Requirements

In the U.S., safety related control system requirements can be found in a number of different standards but two documents stand out: ANSI B11.TR3 and ANSI R15.06.

The technical report ANSI B11.TR3 sets out four levels characterized by the expected amount of risk reduction that each can provide: The requirements for each level follows.

Lowest

In ANSI B11.TR3, safeguards providing the lowest degree of risk reduction include electrical, electronic, hydraulic or pneumatic devices and associated control systems using a single-channel configuration. Implicit in the requirements is the requirement to use safety rated devices. This is closely aligned with Category 1 of ISO13849-1.

Low/Intermediate Risk Reduction

Safeguards, in ANSI B11.TR3 providing low/intermediate risk reduction include control systems having redundancy that may be manually checked to verify the performance of the safety system. Looking at the pure requirements, the system employs simple redundancy. Use of a checking function is not required. Without checking, one of the redundant safety components can fail, and the safety system would not realize it. This would result in a single channel system. This level of risk reduction aligns best with Category 2 when checking is used.

High/Intermediate Risk Reduction

Safeguards providing high/intermediate risk reduction in ANSI B11.TR3 include control systems having redundancy with self-checking upon startup to confirm the performance of the safety system. For machines that are started every day, the self-checking provides a significant improvement in the safety integrity over the purely redundant system. For machines running 24/7, the self-checking is a marginal improvement, at best. Employing periodic monitoring of the safety system aligns the requirements with Category 3.

Highest Degree of Risk Reduction

ANSI B11.TR3 provides a highest risk reduction by control systems having redundancy with continuous self-checking. The self checking must verify the performance of the safety system. The challenge to the safety system designer is to determine what is continuous. Many safety systems perform their checks at startup and when a demand is placed on the safety system.

Some components, on the other hand, perform continuous self-checking. Light curtains, for example, sequentially turn on and off their LEDs. If a fault occurs, the light curtain turns off its outputs, before a demand is place on the safety system, as it continuously checks itself. Microprocessor based relays and safety PLCs are other components that perform continuous self-checking.

The control system requirement for “continuous” self checking is not intended to limit the selection of components to light curtains and microprocessor based logic units. The checking should be performed at startup and after every demand on the safety system. This level of risk reduction is intended to align with Category 4 of ISO13849-1.

Robot Standards: U.S. and Canada

The robot standards in the U.S. (ANSI RIA R15.06) and Canada (CSA Z434-03) are quite similar. Both have four levels, which are similar to the categories of EN954-1:1996 and which are described below.

Simple

At this lowest level, simple safety control systems must be designed and constructed with accepted single channel circuitry, and these systems may be programmable.

In Canada, this level is further restricted for signaling and annunciation purposes only.

The challenge for the safety system designer is to determine what is “accepted”. What is an accepted single channel circuit? To whom is the system acceptable?

The simple category is most closely aligned with Category B of EN954-1:1996.

Single Channel

The next level is a single channel safety control system that:

- Is hardware based or is a safety rated software/firmware device
- Includes components that are safety rated; and
- Is used in accordance with manufacturers’ recommendations and
- Uses proven circuit designs.

An example of a proven circuit design is a single channel electromechanical positive break device that signals a stop in a de-energized state.

Being a single channel system, a single component failure can lead to the loss of the safety function.

The simple category most closely aligns with Category 1 of EN954-1:1996.

Safety Rated Software/Firmware Device

Although hardware based systems have been the preferred method providing safeguarding of robots, software/firmware devices are becoming a popular choice due to their ability to handle complex systems. Software/firmware devices (safety PLCs or safety controllers) are allowed provided these devices are safety rated. This rating requires that a single safety-related component or firmware failure does not lead to the loss of the safety function. When the fault is detected, subsequent automatic operation of the robot is prevented until the fault is cleared.

To achieve a safety rating, the software/firmware device must be tested to an approved standard by an approved lab. In the U.S., OSHA maintains a list of nationally recognized testing laboratories (NRTL). In Canada, the Standards Council of Canada (SCC) maintains a similar list.

Single Channel with Monitoring

Single channel safety control systems with monitoring must fulfill the requirements for single channel; be safety rated and utilize checking. The check of the safety function(s) must be performed at machine start-up, and periodically during operation. Automatic checking is preferred over manual checking.

The checking operation allows operation if no faults have been detected or generates a stop signal if a fault is detected. A warning must be provided if a hazard remains after cessation of motion. Of course, the check itself must not cause a hazardous situation. After detecting the fault, the robot must remain in a safe state until the fault is corrected.

Single Channel with Monitoring most closely aligns with Category 2 of EN954-1:1996.

Control Reliable

The highest level of risk reduction in the U.S. and Canadian robot standards is achieved by safety related control systems meeting the requirements of Control Reliable. Control reliable safety related control systems are dual channel architectures with monitoring. The stopping function of the robot must not be prevented by any single component failure, including the monitoring function.

The monitoring shall generate a stop command upon detection of a fault. If a hazard remains after motion stops, a warning signal must be provided. The safety system must remain in a safe state until the fault is corrected.

Preferably, the fault is detected at the time of the failure. If this cannot be achieved, then the failure must be detected at the next demand on the safety system.

Common mode failures must be taken into consideration if a significant probability of such a failure can occur.

The Canadian requirements differ from the U.S. requirement by adding two additional requirements. First, the safety related control systems shall be independent of the normal program control systems. Second, the safety system must not be easily defeated or bypassed without detection.

Control reliable systems align with Category 3 and 4 of EN 954-1:1996.

Comments on Control Reliable

The most fundamental aspect of Control Reliable is single fault tolerance. The requirements state how the safety system must respond in the presence of “a single fault,” “any single fault,” or “any single component failure.”

Three very important concepts must considered regarding faults: (1) not all faults are detected, (2) adding the word “component” raises questions about wiring, and (3) wiring is an integral part of the safety system. Wiring faults can result in the loss of a safety function.

The intent of Control Reliability is clearly the performance of the safety function in the presence of a fault. If the fault is detected, then the safety system must execute a safe action, provide notification of the fault, and prevent further operation of the machine until the fault is corrected. If the fault is not detected, then the safety function must still be performed upon demand.

Notes

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Presence Sensing Safety Devices

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- Remote Teach GuardShield
- Cascadable GuardShield System
- GuardShield with Integrated Laser Alignment System
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POC Type 2 Safety Light Curtains

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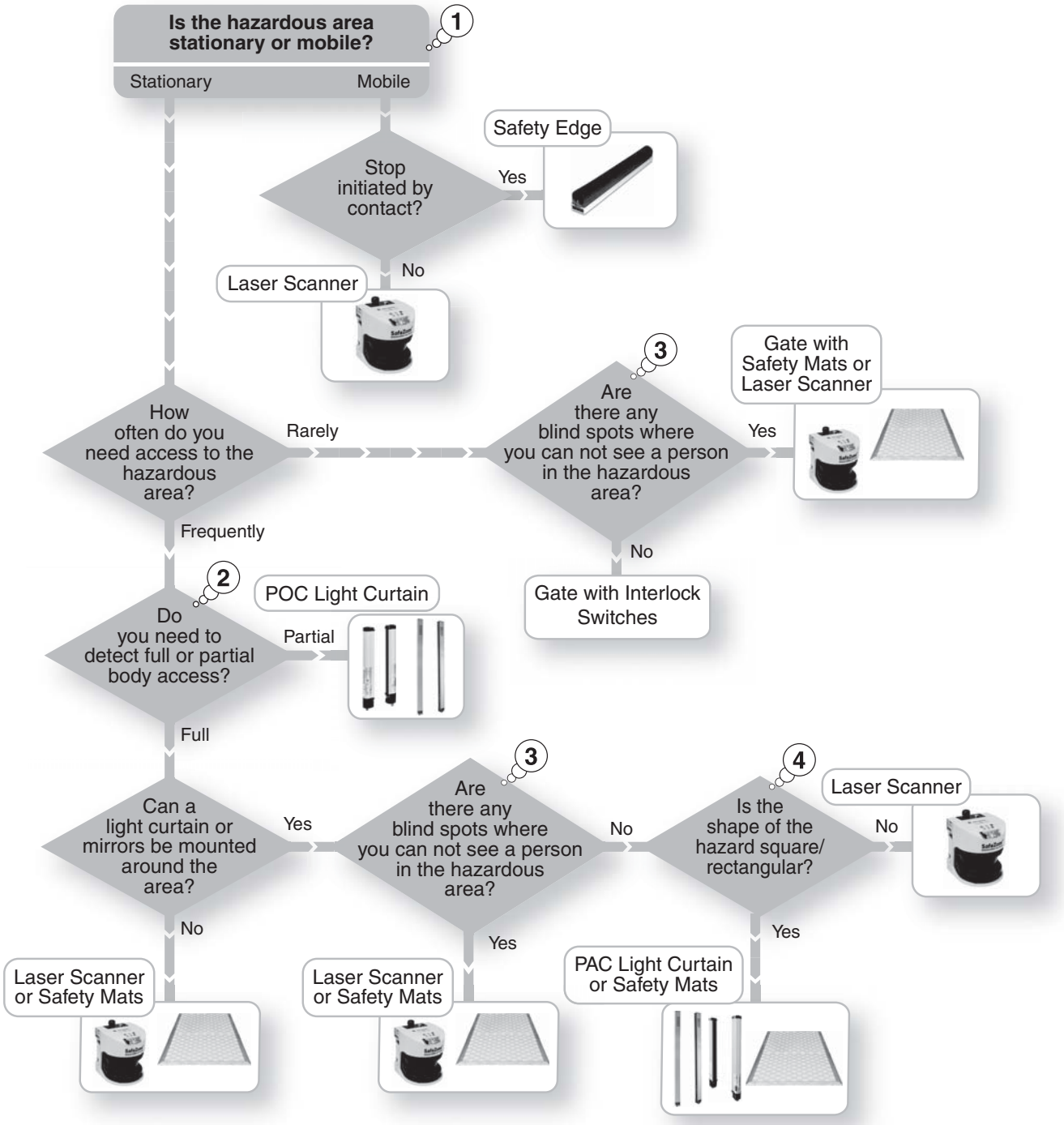
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Selection Flowchart



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Allen-Bradley
Guardmaster®

Selection Tips

1 Is the hazardous area stationary or mobile?

A stationary hazard refers to a fixed machine or work cell where one or more mechanical hazards exist. A mobile hazard is generally a fixed-rail linear transfer mechanism (e.g., a transfer cart or conveyor) or an Automatic Guided Vehicle (AGV). Use of a safety device on a mobile hazard generally relates to collision avoidance with personnel or surrounding machinery.

In the instance that the hazard moves toward the operator (such as with powered doors) as opposed to the operator moving toward the hazard, a pressure-sensitive safety edge can be mounted to the leading edge of the door. Any contact between the door and personnel will stop the machine before injury can occur.

2 What do we mean by full- versus partial-body access?

Full-body access generally refers to the requirement for a person to be standing or walking in (or have access to) the hazardous area around a machine that does not require frequent interaction between personnel and the hazard during regular operation; generally this is for maintenance and troubleshooting. Full-body perimeter or area access control (PAC or AAC, respectively) is achieved through the use of a vertical or horizontal safety field, either opto-electronic (i.e., a light curtain or scanner) or by contact (safety edges and mats).

Partial-body access, on the other hand, is required for applications where an operator must regularly reach into a machine hazard as part of the process at the point of operation (known as POC or Point of Operation Control). In the case of opto-electronic safety devices such as light curtains and area scanners, full- or partial-body detection is directly related to the resolution of the safety device. Below is the relationship of sensing field resolution to the type of detection:

Object to be Detected/Protected	Resolution
Finger (vertical field)	14 mm
Hand (vertical field)	30 mm
Limb (horizontal field for leg detection)	50 mm, 70 mm
Full Body (horizontal fields)	150 mm

3 Blind Spots

In some cases it may be possible for a person to enter the guarded area and be lost from view, potentially allowing the guard door to be shut and the machine started by another person. Often used in conjunction with hard guarding and a gate outfitted with an interlock switch, presence sensing safety devices such as pressure-sensitive safety mats, and laser scanners can be used to check for the presence of a person anywhere within the enclosed safety area.

4 Is the shape of the hazardous area rectangular?

When the hazardous area to be monitored is a rectangle (or a shape consisting of contiguous rectangles), access to the area can be easily—and cost-effectively—controlled with a standard safety mat. When the hazardous area is irregularly shaped, a custom mat is a viable option, but not necessarily the most cost-effective or readily available. In such a case, a safety scanner is the best option because its scanning field can be easily programmed to scan irregular areas and ignore obstacles (walls, columns) while detecting moving objects (people, AGVs, etc.) as required.

Other Application Considerations

		Safety Mats	Safety Scanner	Point of Operation Control	Perimeter Access Control
Partial Body Detection	Finger Detection			14 mm	
	Hand Detection		30 mm	30 mm	
	Limb Detection		50/70 mm		
Full Body Detection		✓	✓		✓
Uneven Floor			✓	Horizontally Mounted	
Corrosive Chemicals			✓	✓	✓
High-Pressure Washdowns		✓		IP67/IP69K Enclosure	IP67 Enclosure
Steam, Dust Environment		✓			
Reflections, Bright Ambient Light		✓			

Safety Light Curtains

Selection Navigator

GuardShield Light Curtain	Profile Size [mm]	Type According to IEC 61496	Finger (14 mm)	Hand (30 mm)	Full Body	Protective Height [mm]	Range	Response Time	IP Rating	Integrated Laser Alignment
Standard	40 x 50	Type 4	Yes	Yes	NA	160…1760	14 mm…7 m 30 mm…16 m	20…30 ms	IP65 (IP67)	Optional/Yes
Safe 4	30 x 40					120…1920	14 mm…9 m 30 mm…18 m	14 mm: 11…90 ms 30 mm: 8…48 ms	IP65	Yes
Micro 400	15 x 20					150…1200	5 m	14 mm: 15…42 ms 30 mm: 13…24 ms	Micro 400 IP54 (IP69K) MSR4x IP20	NA
PAC	40 x 50		NA	NA	2 and 3 beams	2 beams: 520 3 beams: 820	16 m	20 ms	IP65	Optional/Yes
Safe 4 PAC	30 x 40					2 beams: 600 3 beams: 840	5…30 m	2 beams: 11 ms 3 beams: 14 ms		Yes
Type 2	40 x 50	Type 2		Yes	NA	160…1760	16 m	20 ms		NA
Safe 2	30 x 40					120…1920	18 m	14 mm: 11…90 ms 30 mm: 8…48 ms		Yes

Integrated Controller	Operating Temperature [C (F)]	Beam Coding	Blanking	EDM	Aux. Output	Cascadable	Muting	Configuration	PL/SIL CL	GuardShield Light Curtain
Yes	-10…55° (14…131°)	Yes	Yes	Yes	1 PNP 0.5 A max.	Yes	Yes with MSR42 or MSR22LM	DIP Switch	PLe/SIL CL3	Standard
	0…55° (32…131°)	NA	NA	NA	NA	NA		NA		Safe 4
Requires MSR41 or MSR42			Yes with MSR42	Yes with MSR42	MSR41: 2 PNP 0.1 A max. MSR42: 2 PNP config.	Yes	Yes with MSR42	MSR42 Wiring or Software		Micro 400
Yes	-10…55° (14…131°)	Yes	NA	Yes	1 PNP 0.5 A max.	NA	Yes with MSR42 or MSR22LM	DIP Switch		PAC
	0…55° (32…131°)	NA		NA	NA			NA		Safe 4 PAC
	-10…55° (14…131°)			Factory Option	1 PNP 0.5 A max.			Factory	Pld/SIL CL2	Type 2
	0…55° (32…131°)			NA	NA			NA		Safe 2

Safedge™ Pressure-Sensitive Safety Edges



Features/Benefits

Pressure-sensitive safety edges are flexible strips that can be mounted to the edge of a moving part—such as a machine table or powered door—that poses a crushing or shearing risk. Contact of the edge with an object or personnel switches off the machine hazard. Safety edges are a cost-effective solution for constant safety monitoring in smaller areas, especially those applications requiring physical flexibility and a tight turn radius. Rated to Category 3, safety edges do not develop 'dead spots' like some other pressure-sensitive safety offerings. They are also easy to install and maintain, and can withstand high-pressure washdowns, making them suitable for a wide range of applications and environments. Multiple profile sizes and the availability of custom edge systems also lend to a high degree of application flexibility. It is important to note that Safedge requires a dedicated safety relay for monitoring and control, which can be connected to other safety systems.

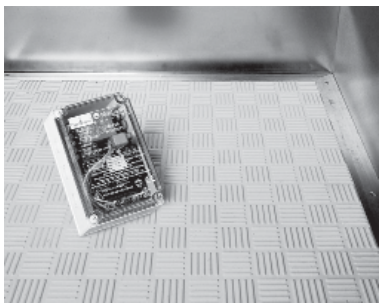
Applications

- Sliding doors
- Garage doors
- Pinch points

Common Misapplications

- Submersible applications
- Exposure to volatile chemicals (that can damage the rubber profile)
- Applications where physical contact can injure personnel

MatGuard™ Pressure-Sensitive Safety Mats



Features/Benefits

Pressure-sensitive safety mats provide constant guarding and monitoring of a floor area around a machine; 66 lbs. or more of pressure on the mat (e.g., an operator's footstep) causes the mat controller unit to switch off power to the hazard. Like safety edges, MatGuard safety mats are easy to apply and maintain, can withstand high pressure washdowns and are not susceptible to dead spots. An ideal solution for relatively small areas, MatGuard products also offer a high degree of application flexibility, offering reversible mats, direct micro quick connectivity to controllers, simple connection to standard and DeviceNet Safety I/O blocks, custom system configurations, and quick-delivery standard sizes. However, mats can be damaged by dropped objects, such as tool dies, and pose a potential trip hazard if trim is not used.

Applications

- Work cells
- Area detection

Common Misapplications

- Uneven floors
- Lack or improper use of uniting trim
- Presence of volatile chemicals

SafeZone™ Safety Laser Scanners



Features/Benefits

The SafeZone safety laser scanners are opto-electronic devices that create a user-configurable scanning field with one or more safety zones. If a person or object enters the warning field, the SafeZone scanner switches a single output that can be used to initiate a warning signal, such as an optical or acoustic alarm. If the inner safety field is breached, the scanner switches two independent safety outputs initiating a machine stop signal to halt dangerous machine motion. Offering warning fields up to 49 meters, the SafeZone is easy to install—either horizontally or vertically—and requires no dedicated controller for operation. Suited for Category 3, SIL2 PLd applications, the scanner is easily interfaced with other safety systems and the easy-to-use configuration software allows customization of the field shape.

Applications

- Work Cells
- Robot Cells
- Stationary or mobile application
- Rotary and index tables
- Moving automated vehicles (AGVs)
- Infeed machinery
- Overhead cranes

Common Misapplications

- Oil, mist, dust, or steam environments
- Outdoor applications
- Extreme temperatures

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Publication S117-CA001A-EN-P

Point of Operation Control (POC) Light Curtains



GuardShield



GuardShield Safe 4



GuardShield Micro 400

Features/Benefits

POC light curtains are placed close to the hazard, at the point of operation where personnel may frequently interact with the machine as part of a process. POC light curtains are designed for partial-body detection—finger, hand, and arm detection—and are offered in multiple resolutions and protective heights. An easy-to-install Category 4 SIL 3, PLe solution, these light curtains are easily connected to other safety systems, but usually do not require a separate controller and can therefore be operated as standalone units (i.e., without a safety relay). Since they are located at the machine's point of operation, POC light curtains eliminate the need for gates, allowing frequent and easy access to the hazardous area, and can be used as an ergonomic workstation control that increases safety while enhancing productivity. These light curtains can be mounted vertically or horizontally. However, it is important to note that these light curtains do not detect people or objects once they have passed through the light curtain.

POC light curtains are also suitable for use in washdown applications when used in conjunction with the IP67 or IP69K light curtain enclosures.

Applications

- Conveyors
- Electronic fences
- Forming operations
- Robot Cells
- Presses
- Workstations
- Washdown applications (use IP 67 tube accessory)

Common Misapplications

- Used on full revolution machinery
- Mounted too close to hazard

Perimeter Access Control (PAC) Light Curtains



GuardShield PAC



GuardShield Safe 4 PAC

Features/Benefits

PAC light curtains are an easy-to-install, Category 4 solution for full-body access detection. Designed to create a safety perimeter around a machine that does not require frequent interaction between personnel and the hazard during regular operation, PAC light curtains provide large object pass-through sensing with detection ranges up to 30 meters. PAC light curtains can be easily interfaced with other safety systems or used as standalone units without a dedicated control unit/safety relay. However, it is important to note that these light curtains do not detect people or objects once they have passed through the light curtain.

Applications

- Conveyor Systems with muting
- Robot cells
- Opto-electronic fence
- Washdown with IP 67 tube

Common Misapplications

- Used as POC device
- Used on machine that does not stop until completing a full revolution
- Horizontal installation

GuardShield™

Introduction

The Allen-Bradley Guardmaster GuardShield is offered as a Type 2 and a Type 4 POC safety light curtain as well as a Type 4 PAC safety light curtain. The Type 4 POC GuardShield is offered in both 14 mm and 30 mm resolutions while the Type 2 is offered in 30 mm resolution only. The GuardShield PAC is offered with multiple beam configurations with varying beam spacings. All GuardShield family safety light curtains meet the requirements of IEC/EN 61496.

POC safety light curtains are designed to detect the presence of an opaque object of a minimum resolution. These devices are usually positioned in front of the point of operation hazard, however, they may also be used for perimeter guarding applications.

PAC safety light curtains are typically used as opto-electronic fences or as whole body detection devices to detect personnel or large objects when they pass through the sensing field. These PAC safety light curtains are typically positioned around an area or in front of a process entry or exit area.

The Allen-Bradley Guardmaster GuardShield is a two-box safety light curtain, consisting of a nonmatched transmitter and receiver pair. Any GuardShield transmitter of the same family (POC, PAC) and same resolution will work with any receiver of the same family and resolution. The synchronization between transmitter and receiver is achieved optically. The first beam adjacent to the receiver LEDs is the synchronization channel. This synchronization beam cannot be blocked in a fixed or floating blanking application.

The GuardShield safety light curtain has two transistor type PNP safety outputs, referred to as OSSDs (Output signal switching devices). These outputs may be connected to a safety relay module or directly to the primary control element of a machine if the EDM connection within the GuardShield receiver is also connected and configured.

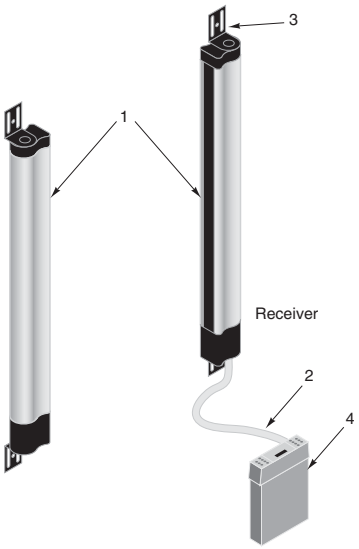
The standard GuardShield receiver also has an auxiliary nonsafety output which can be connected to a PLC for status of the OSSDs, to a stack light for signaling or to control an in-feed motor, etc.

The standard GuardShield requires separate transmitter and receiver cables. The transmitter cable utilizes a 4-pin micro quick-disconnect (M12) connector and is offered in lengths from 2 meters to 30 meters. The receiver cable has an 8-pin micro quick-disconnect (M12) connector and is also offered in lengths from 2 meters to 30 meters.

Typical System Configuration

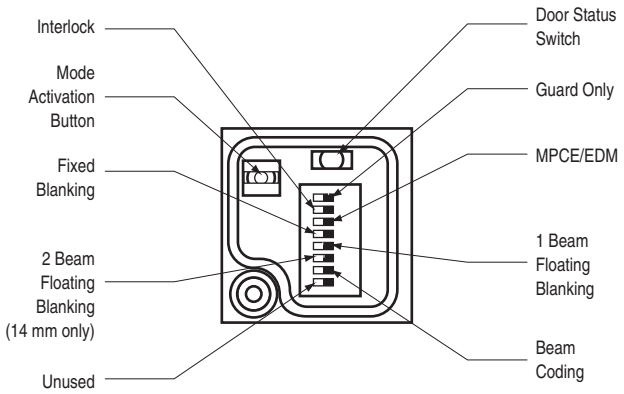
Components required for a "Guard only" system:

1. Optic heads (operate on 24V DC—ordered as a pair (transmitter/receiver)
2. Cable—two required per pair—specify transmitter cable and receiver cable
3. Mounting brackets—included
4. Safety Relay Module—optional (**Note:** A Category 3 system may be possible by connecting the GuardShield OSSDs directly to two safety contactors and connecting and configuring the EDM mode of operation in the GuardShield receiver.)



The Allen-Bradley Guardmaster GuardShield Type 4 is a two-box light curtain with DIP switch selectable operating modes.





Receiver DIP Switch Functions or GuardShield Type 4 POC

The standard GuardShield safety light curtain has DIP-switches located in both the transmitter and receiver endcaps. The DIP-switches are accessible through a hinged door that is secured to the endcap with a security screw.

The transmitter DIP-switches provide for the configuration and activation of Beam Coding and Machine Test Signal.

The receiver DIP-switches provide for configuration of all of the GuardShield safety light curtain's modes of operation.

GuardShield Safe 4

The GuardShield Safe 4 is a Type 4 safety light curtain offered in POC and PAC versions with basic ON/OFF functionality. The Safe 4 POC is offered in both 14 mm and 30 mm resolutions in protective heights ranging from 120 mm up to 1920 mm in increments of 120 mm.

The GuardShield Safe 4 PAC (Perimeter Access) is offered with two 120 mm modules providing 500 mm spacing and with three 120 mm modules providing 400 mm spacing. Both the two- and three-beam Safe 4 PAC versions have an operating range from 5 meters up to 30 meters.

The GuardShield Safe 4 POC and Safe 4 PAC are economical Type 4 safety light curtains with ON/OFF functionality and an integrated laser alignment system. The integrated laser alignment system consists of a constantly powered Class 2 visible laser located on the top of the transmitter and on the bottom of the receiver. The constantly powered integrated laser alignment systems allows a low level of laser light to be emitted. Simply touching a finger to the laser beneath the finger symbol reflects the low level of laser light back to a photo sensor which causes the laser light intensity to increase for five minutes or until a finger covers the laser reflecting the laser back to the photo sensor which signals a reduction of the intensity of the emitted laser light. This system assures that both the top and bottom of the Safe 4 pair are quickly and easily aligned or realigned if a light curtain or corner mirror is inadvertently moved during operation.



GuardShield Safe 4

GuardShield Safe 2

The GuardShield Safe 2 is a Type 2, SIL 2, PLd, safety light curtain offered with a 30 mm resolution in protected heights ranging from 120 to 1920 mm in 120 mm increments. The GuardShield Safe 2 is an economical, two-box safety light curtain with ON/OFF functionality and an integrated laser alignment system. The integrated laser alignment system consists of a Class 2 visible laser located at the top of the transmitter and the bottom of the receiver. Each laser has a target located opposite the laser on the transmitter and receiver. This integrated laser alignment system facilitates alignment at installation and during the course of usage if the Safe 2 pair is knocked out of alignment.

GuardShield Micro 400

The GuardShield Micro 400 is an economical three-box (transmitter, receiver and controller) Type 4 safety light curtain offered in a small profile (15 mm X 20 mm) housing. Designed for use in benign industrial environments (IP54), this medium/light duty safety light curtain system is targeted to the semi-conductor, microelectronic and small assembly machine markets.

The compact housing size allows the GuardShield Micro 400 to be mounted in areas where standard safety light curtains may not be able to be mounted due to space constraints.

The GuardShield Micro 400 requires a dedicated controller, either an MSR42 or MSR41. The MSR41 is a basic controller for simple ON/OFF functionality and the MSR42, in addition to providing operating functionality for the Micro 400, can be used as a multi-function safety module. This multi-functional safety module allows the connection of additional safety light curtains, safety laser scanner or a safety device with PNP type outputs as well as E-stops or override switches. The MSR42 can have limited functionality activated by wiring but requires configuration software for any advanced functionality.

The Micro 400 transmitter and receiver are offered with eight-pin M12 connectors at the end of 500 mm (19.8 in.) integrated cables. The patchcords to connect the transmitter and receiver to the controller are the same cat. no. and are offered in various lengths. These patchcords are configured on one end with M12 connectors that mate to the integrated pigtail connectors and RJ45 connectors on the opposite end, that plug into the MSR41 or MSR42 controller.

The Micro 400 is also offered in cascadable configurations. GuardShield Cascadable Micro 400 safety light curtains allow the interconnection of multiple segments of the Micro 400 safety light curtain with a common pair of safety outputs. This cascadable configurability of the GuardShield Micro 400 reduces overall system wiring and allows the GuardShield Micro 400 to be fitted into a variety of applications where the safety distances for mounting the light curtain may allow personnel to stand between the light curtain's sensing field and the hazard or where multiple-sided guarding is required and the use of corner mirrors is not possible.



GuardShield Micro 400



Micro 400 Cascading

Micro 400 Cascaded

Typical System Configurations

The Allen-Bradley Guardmaster GuardShield and GuardShield Safe 4 safety light curtains are two-box designs. This means the safety light curtain does not need a separate controller to operate. Therefore, the safety outputs of the light curtain (OSSDs) can be connected directly to any safety relay that will accept two PNP inputs.

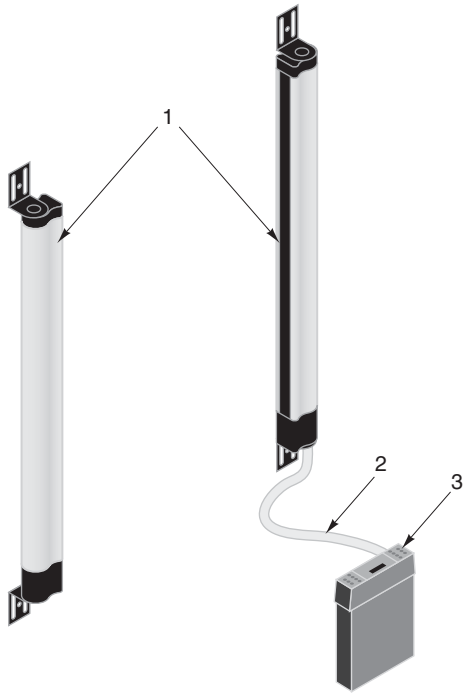
The following are some common configurations of light curtain systems. The numbers on the drawing indicate the ordering steps to follow to ensure that a complete system is specified.

Components required for a "Guard only" system:

1. Optic heads (operate on 24V DC)—ordered as a pair (transmitter/receiver)
2. Cables—two required per pair—specify length

Optional components (customer or Allen-Bradley Guardmaster supplied):

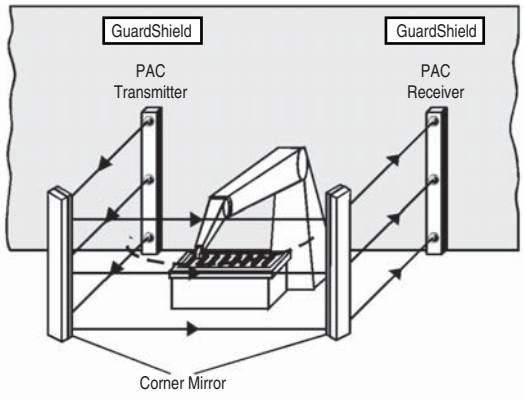
3. Safety Relays



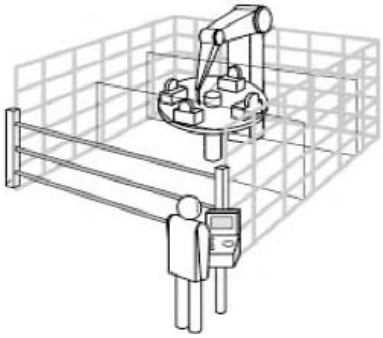
Perimeter Access Control (PAC)

Allen-Bradley Guardmaster PAC safety light curtains consist of two families, the GuardShield PAC family and the Safe 4 PAC family. The GuardShield PAC family is offered with multiple beams with various beam spacings for short range applications (16 meters or less). The Safe 4 PAC family is offered with multiple beams (2 or 3) with various beam spacings for long range (5…30 meters).

PAC safety light curtains are opto-electronic through-beam devices typically used to detect personnel around hazardous equipment or machinery. PAC safety light curtains are usually used as an opto-electronic fence and when used with corner mirrors, can provide two- or three-sided detection around the perimeter of hazardous machinery.



PAC safety light curtains are generally of resolutions that provide detection of limbs and bodies of personnel, i.e., 50 mm, 70 mm, 90 mm and up. It is also common for PAC safety light curtains to be offered with a limited number of infrared beams spaced at consistent distances from one another, such as 3 beams with 400 mm spacing between beams, or 2 beams with 500 mm beam spacing.

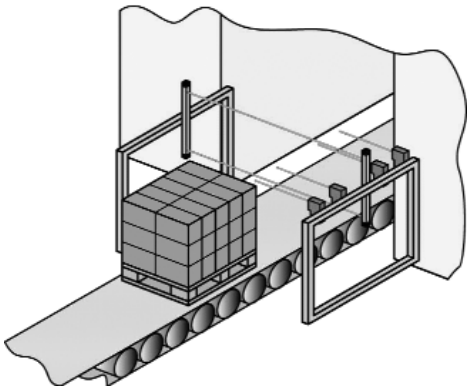


Muting

PAC safety light curtains are also used in conveyorized processes and very often are used in conjunction with a muting module. Muting is the temporary automatic suspension of the protective function of the safety light curtain.

Muting modules can be integrated into the light curtain's receiver or external to the light curtains. Rockwell currently offers external muting modules.

This muting function allows material to move through the safety light curtain's sensing field without stopping the machine, however, if a person attempts to pass through the safety light curtain, they will be detected and the machine will stop. The differentiation between material and personnel is determined by the use of muting sensors. These muting sensors create a particular switching sequence together with the safety light curtain as the material passes through the process.



Conveyorized muting

Muting sensors are typically used in pairs and depending upon the sensor configuration and muting module, allow either uni-directional or bi-directional travel of material through the safety light curtain.

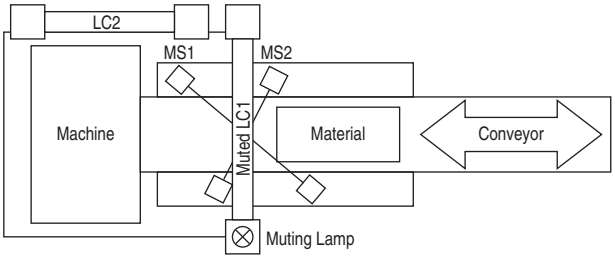


Figure 1: Two-sensor bi-directional muting

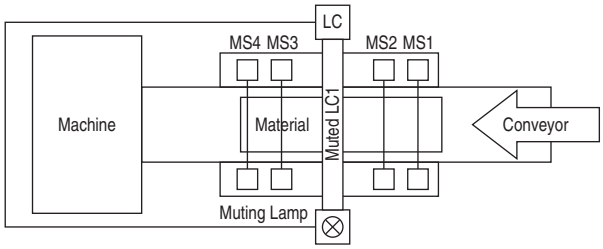


Figure 2: Four-sensor uni-directional muting

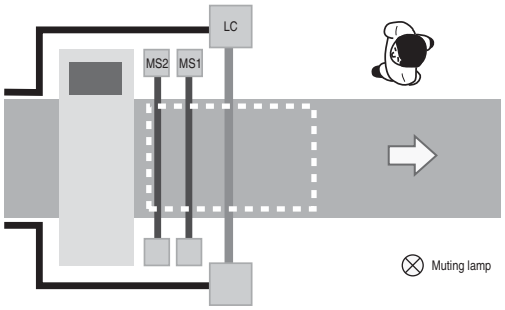


Figure 3: Two-sensor L-type with MSR42

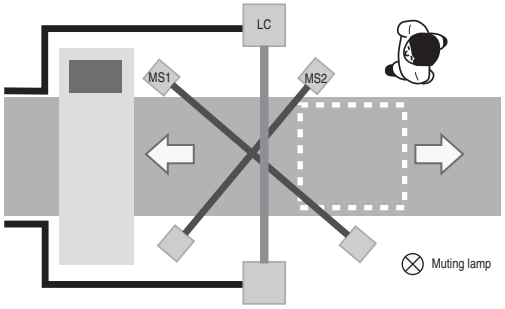


Figure 4: Two-sensor T-type with MSR42

Four-sensor muting for this particular muting module in Figure 2 allows a single direction of travel. A particular sequence is also required in this configuration; muting sensor 1 must be interrupted first followed by muting sensor 2 and then the safety light curtain, then muting sensor 3 and finally muting sensor 4. It is necessary with this particular muting module to have the light curtain's sensing field interrupted within 3 seconds of muting sensor two being interrupted. Also, the material must block muting sensor 3 and muting sensor 4 before clearing muting sensors 1 and 2 or the muting function is overridden and the safety light curtain would become active causing a nuisance shutdown of the machine if the material is within the light curtain sensing field.

An interruption of the safety light curtain sensing field would cause the machine or the hazardous motion to be turned off. The muting cycle is completed when the material clears muting sensor 4.

The muting sensors must be spaced appropriately from the safety light curtain and each other in order to ensure that the sensors cannot be interrupted by personnel, causing the activation of the muting function.

A requirement of muting in machine applications is for indication that the muting function is activated. This is typically accomplished by the use of a muting lamp. The various muting modules offered by Rockwell Automation have an output for the connection of a muting lamp.

GuardShield Perimeter Access Control (PAC)

The Allen-Bradley Guardmaster GuardShield PAC safety light curtain system is a two-box design. This means the safety light curtain does not need a separate controller to operate in a guard-only mode with manual reset. Therefore, the safety outputs of the light curtain (OSSDs) can be connected directly to any safety relay that will accept PNP inputs.

The following are some common configurations of light curtain systems. The numbers on the drawing indicate the ordering steps to follow to ensure that a complete system is specified.

Components required for a multiple-beam PAC system, see Figure 3:

- Optic heads (operate on 24V DC)—ordered as a pair (transmitter/receiver) mounting brackets included
- Cables—separate 4-pin transmitter and 8-pin receiver
- Safety relay if EDM is not used
- Corner mirrors (for multiple side protection)

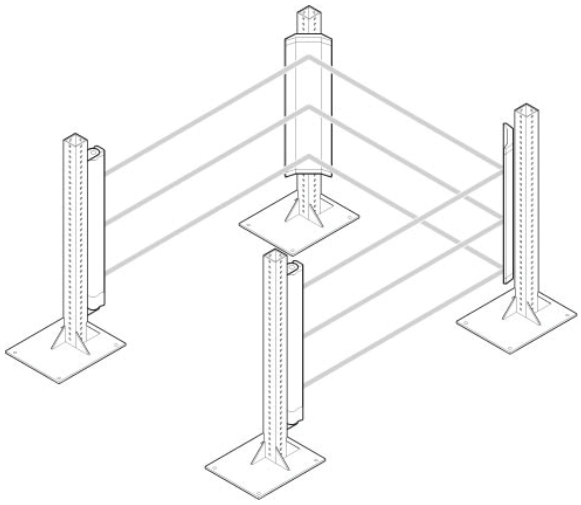
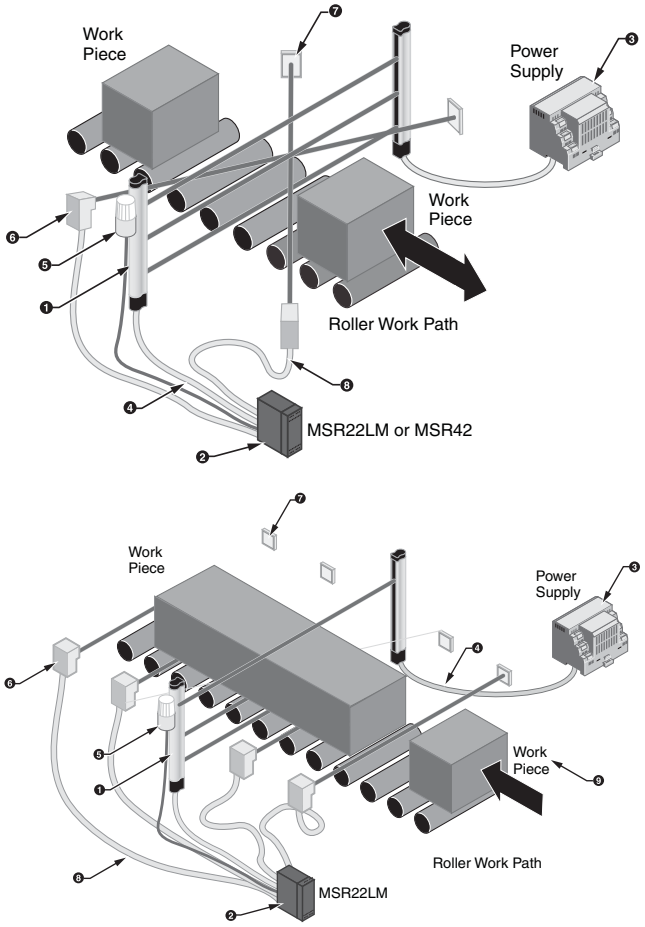


Figure 4

Components Required for PAC with Muting, see Figure 4:

1. Optic heads (operate on 24V DC) with muting module—ordered as a pair (transmitter/receiver)
2. It is also possible to use other Allen-Bradley Guardmaster muting modules such as the MSR42 or the MSR22LM muting module
3. Power supply
4. Cables for light curtains
5. Muting indication
6. Sensors for muting
7. Sensor accessories
8. Sensor cordsets



Perimeter Access Control Overview

Typical System Configurations

The Allen-Bradley Guardmaster Safe 4 PAC safety light curtain system is a two box design. This means the safety light curtain does not need a separate controller to operate in a guard-only mode. Therefore, the safety outputs of the light curtain (OSSDs) can be connected directly to any safety relay that will accept PNP inputs.

The following are some common configurations of light curtain systems. The numbers on the drawing indicate the ordering steps to follow to ensure that a complete system is specified.

Components required for a multiple-beam Safe 4 PAC, see Figure 5:

1. Optic heads (operate on 24V DC)—ordered as a pair (transmitter/receiver)
2. Cables—5-pin cables for transmitter and receiver
3. Safety relay
4. Power supply—120V AC to 24V DC
5. Mounting brackets—minimum of 4 per optic head pair
6. Corner mirror columns (for multiple side protection)
7. Mounting stand if required

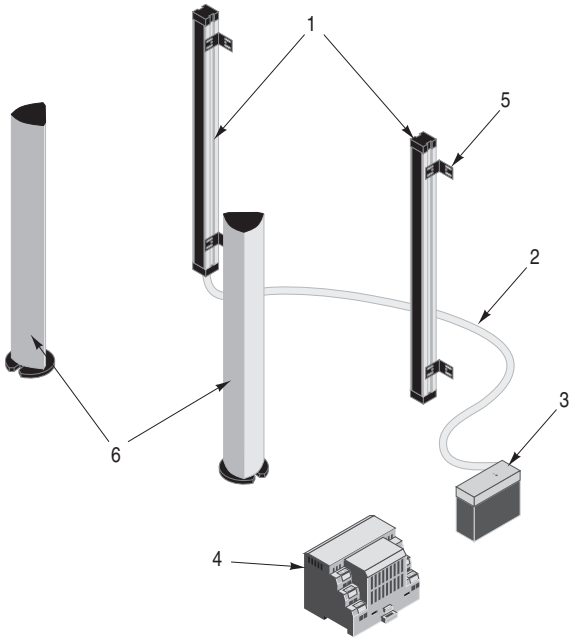


Figure 5





Description

Standard GuardShield

The Allen-Bradley Guardmaster GuardShield safety light curtain is an economical, fully featured, Type 4 safety light curtain in a uniquely styled housing. GuardShield safety light curtains are general-purpose presence sensing devices designed for use on hazardous machinery providing point of operation, as well as perimeter and access guarding. This self-contained, two-box, safety light curtain has DIP-switch selectable operating modes and is available in both 14 mm and 30 mm resolutions.

Modes of operation such as fixed and floating blanking, beam coding, start/restart interlock, external device monitoring (EDM), and machine test signal, are selected by DIP-switch settings. These DIP-switches are located beneath a security door, which are conveniently located on both the transmitter and receiver end caps.

The GuardShield's torsionally rigid, extruded aluminium, polyurethane powder-coated housing, combined with an environmental rating of IP65, allows the GuardShield to be used in guarding applications across a broad range of industries.



Remote Teach GuardShield

The GuardShield Remote Teach system provides a remote means of changing a fixed blanking configuration within the GuardShield safety light curtain. This keyswitch box eliminates the need to open the GuardShield receiver door and perform the Teach function.

The three-position key switch simulates the opening of the GuardShield receiver door, teaching the GuardShield light curtain the new fixed blanking area, closing the door and returning to the run mode of operation.

The IP65 rated key switch box is provided with a steel mounting back plate to facilitate mounting of the box in proximity to the GuardShield receiver. It is necessary to see the receiver LEDs when performing the teach function.

Cascadable GuardShield System

A cascadable GuardShield safety light curtain is a standard GuardShield safety light curtain in 14 and 30 mm resolutions with additional M12 connectors located on top of each safety light curtain. The connector on the top of the safety light curtains allow the interconnection of up to a total of three pair of GuardShield safety light curtains with a common pair of OSSDs. The ability to interconnect GuardShield pairs reduces overall system wiring and simplifies the safety circuit resulting in a lower overall cost of a multiple safety light curtain system. This product configurability also allows a GuardShield safety light curtain system to protect multiple sides of a machine or simply adds flexibility when positioning GuardShield in various applications.

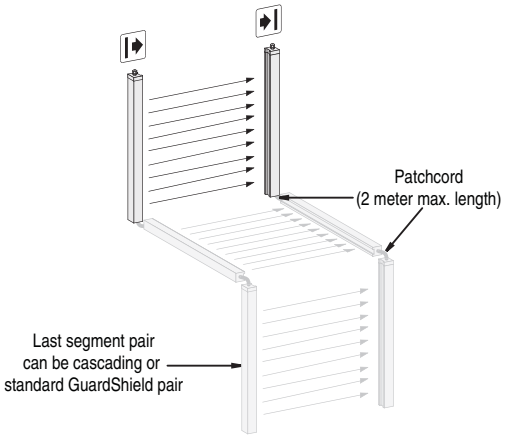
The complete cascading GuardShield system has the full functionality of a standard GuardShield (beam coding, EDM, start/restart interlock, fixed and floating blanking). There are a couple of operating modes which can not be configured in the middle and end segments (EDM and Start/Restart Interlock) and must only be configured in the host (first) pair. The system will still have these operating modes active if configured in the host or first GuardShield pair. This host or first pair is the pair of cascading GuardShield light curtains, which have the output cordsets connected and wired to the safety relay, safety PLC or FSDs. Configuring of the EDM operating mode in the end and middle segments will cause the system to go to a lock-out condition after the first interruption of the sensing field. Configuration of the start/restart interlock operating mode in the end and middle segments will cause the system to stay in a red condition awaiting reset after the interruption of the sensing field.

The cascading GuardShield safety light curtains are ordered as pairs (transmitter and receiver) and are shipped under one cat. no. After selecting the appropriate pair of cat. nos. for a cascading GuardShield system, select the interconnecting transmitter and receiver patchcord cat. nos. to connect the GuardShield pairs. The transmitter patchcord is a 4-pin M12 patchcord offered in lengths of 1/3 meter, 1 meter and 2 meters. The receiver patchcord is an 8-pin M12 patchcord offered in lengths of 1/3 meter, 1 meter, and 2 meters.

If the end pair of a cascading system is a cascading pair of GuardShield light curtains, it is necessary to attach a termination adaptor to the top M12 connector located on the receiver. Be sure to order all other required interfaces and accessories.

POC Type 4 Safety Light Curtains

GuardShield



Up to three GuardShield POC segments can be interconnected.

The upper and lower limit of the protective field is shown by markings on the housings.

The width of the protective field is derived from the length of the light path between transmitter and receiver and must not exceed the maximum rated width of the protective field: 7 m for 14 mm (22.9 ft for 0.55 in.), 18 m for 30 mm (59.0 ft for 1.18 in.).

Cascading segments are offered in protective heights from 320…1760 mm in both 14 mm and 30 mm resolutions. Cascading segments of 160 mm are not offered, however; a 160 mm GuardShield can be used as the last segment in a cascading system.

A maximum of three GuardShield light curtains can be interconnected with a common pair of OSSDs. The maximum number of beams allowed in a cascading system is 528 beams, which equates to three 1760 mm cascading GuardShields in 14 mm resolution. The individual segments can have mixed resolutions, e.g., 14 mm and 30 mm as long as the pairs have the same protective heights and resolutions.

The response time of a cascading GuardShield system is the longest response time of any pair in the cascading system. For example, if the response time of each pair in the cascading system is 20 ms, then the cascading system's response time is 20 ms.

Cascading segments can be used as standalone light curtain pairs or can have up to three segments interconnected. These cascading segments all function as independent light curtains.

IMPORTANT	When cascading segments are used as standalone pairs or as the last segment in a cascading system, it is necessary to use a termination plug on the top connector of the GuardShield cascading receiver. It is also possible to use a standard GuardShield Type 4 POC pair as the last segment in a cascading system.



GuardShield with Integrated Laser Alignment System

The GuardShield POC and GuardShield POC cascadable light curtains are offered with an integrated laser alignment system consisting of a Class 1, eye safe, constantly powered laser located in the top of the GuardShield transmitter and at the bottom of the GuardShield receiver. There are targets located across from each laser that help facilitate alignment of the light curtain when the laser is emitting visible light.

Each laser emits a low level of visible light. Simply placing a finger or opaque object in front of the laser reflects the laser light back to a photo sensor. This photo sensor causes the laser to switch state from a barely visible low level of emission to a higher level of emission of visible light. Interrupting the visible light below the finger symbol will cause the laser to change state back to a low level of light emission. The visible light will also change to a low level after five minutes.

The Integrated Laser Alignment system also quickly helps with the re-alignment of pairs when units are knocked out of alignment during the course of the work process or when corner mirrors are used.

The GuardShield and Cascadable GuardShield are offered in 14 and 30 mm resolutions in protective heights from 320 to 1600 mm. The 160 and 1760 mm protective heights are not offered with the integrated laser alignment systems.

ArmorBlock Guard I/O Connectivity

The GuardShield POC and GuardShield Cascadable light curtains are also offered with the Class 1, eye safe, integrated laser alignment system and connectivity to ArmorBlock Guard I/O. The receiver of these light curtains has a five-pin M12 quick-disconnect connector wired to connect to the 1732DS ArmorBlock I/O module, allowing the GuardShield's OSSDs to operate over a DeviceNet Safe network.

This version of the GuardShield has limited configurability, i.e., only beam coding, fixed and floating blanking can be configured by setting the appropriate DIP switches and performing the teach function. EDM, Start/Restart interlock, and the auxiliary output are not available in these models.

You can use the ArmorBlock Guard I/O with any safety controller that communicates on DeviceNet using CIP Safety for the control and monitoring of safety circuits. ArmorBlock Guard I/O detects circuit failures at each I/O point while providing detailed diagnostics directly to the controller. With CIP Safety, you can easily integrate safety and standard control systems by using safety and standard messages on the same wire.

The 1732DS ArmorBlock Guard I/O family consists of 24V DC digital I/O modules that communicate on DeviceNet networks.

Features

Standard GuardShield

- Fixed blanking—teachable
- Floating blanking
  - – One-beam floating blanking on 30 mm resolution
  - – Two-beam floating blanking on 14 mm resolution
- Beam coding
- External Device Monitoring (EDM)
- Start/restart interlock
- M12 quick-disconnect connectors
- 160 to 1760 mm in 160 mm increments
- Standard GuardShield can be used as last segment pair in a cascading system

Standard GuardShield with Integrated Laser Alignment

- Fixed blanking—teachable
- Floating blanking
- Beam coding
- M12 quick-disconnect connectors
- Ease of alignment at installation with visible laser alignment
- 320…1600 mm in 160 mm increments
- 14 and 30 mm resolutions

Remote Teach GuardShield

- Three-position momentary key switch
- IP65 rated key switch box
- Y connector for quick-disconnect connections
- Standard GuardShield cables
- Allows quick and efficient reteaching of fixed blanked areas
- 160 to 1760 mm in 160 mm increments

Cascadable GuardShield System

- Easy to interconnect light curtains up to three 1760 mm segment pairs
- No increase in system response time

ArmorBlock Guard I/O GuardShield

- Fixed blanking—teachable
- Floating blanking
- Up to three cascading pairs can connect to ArmorBlock Guard I/O
- Beam coding
- M12 quick-disconnect connectors
- DeviceNet safe network connectivity
- 320…1600 mm in 160 mm increments

Specifications

Safety Ratings	
Standards	IEC/EN 61496 Parts 1 & 2, UL 61496 Parts 1 & 2, UL 1998
Safety Classification	Type 4 per IEC/EN61496. Category 4 device per EN 954-1, SIL 3 per IEC 61508, PLe per EN/ISO 13849
Certifications	cULus, UL 61496, UL 1998, TÜV, and CE Marked for all applicable directives
Power Supply	
Input Power, Max.	24V DC ±20%
Maximum Residual Ripple	0.05 Vss
Power Consumption	0.4 A max (no load)
Outputs	
Safety Outputs	2 OSSD, 0.5 A, short-circuit protected
Non-Safety Outputs	Auxiliary output, 0.5 A max.
Output Voltage, Min.	(Uv) - 2V
Switching Current @ Voltage, Min.	500 mA @ 24V DC
Operating Characteristics	
Response Time	14 mm; 160 mm…1440 mm 20 ms, 1600 mm and 1760 mm, 25 ms. 30 mm; 20 ms. Add 10 ms when beam coding activated.
Status Indicators	ON State, OFF State, Blanking, Alignment, Interlock
Protected Height [mm (in.)]	See Product Selection tables.
Resolution [mm (in.)]	14 (0.55) or 30 (1.18)
Scanning Range/Resolution	0.3…7 m / 14 mm (0.98…22.9 ft / 0.55 in.) 0.3…16 m / 30 mm (0.98…52 ft / 1.18 in.)
Synchronization	Optical, first beam adjacent to LEDs.
Wavelength	870 nm
Environmental	
Enclosure Type Rating	IP65
Relative Humidity	15…95% (noncondensing)
Operating Temperature [C (F)]	-10…55° (14…131°)
Vibration	IEC60068-2-6: Frequency 10…55 Hz; Amplitude: 0.35 mm (0.01 in.)
Shock	IEC60068-2-29: Acceleration 10 g, pulse duration 16 ms 10…55 Hz
Physical Characteristics	
Mounting	End-cap brackets supplied
Weight	Varies by protective height
Housing Cross Section	40 mm x 50 mm (1.57 in. x 1.96 in.)
Connection Type	Transmitter: 4-pin M12 micro QD; Receiver: 8-pin M12 micro QD
Cable Length	30 m (100 ft) max.

POC Type 4 Safety Light Curtains

GuardShield

Product Selection

Standard System

The Allen-Bradley Guardmaster GuardShield safety light curtains are ordered as pairs—transmitter and receiver—and shipped under one cat. no. After selecting the appropriate light curtain pair, ensure that required interfaces and accessories are ordered.

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
160 (6.3)	14 (0.55)	16	440L-P4J0160YD	160 (6.3)	30 (1.18)	8	440L-P4K0160YD
320 (12.6)	14 (0.55)	32	**440L-P4J0320YD**	320 (12.6)	30 (1.18)	16	**440L-P4K0320YD**
480 (18.9)	14 (0.55)	48	440L-P4J0480YD	480 (18.9)	30 (1.18)	24	**440L-P4K0480YD**
640 (25.2)	14 (0.55)	64	**440L-P4J0640YD**	640 (25.2)	30 (1.18)	32	**440L-P4K0640YD**
800 (31.5)	14 (0.55)	80	**440L-P4J0800YD**	800 (31.5)	30 (1.18)	40	**440L-P4K0800YD**
960 (37.8)	14 (0.55)	96	440L-P4J0960YD	960 (37.8)	30 (1.18)	48	**440L-P4K0960YD**
1120 (44.1)	14 (0.55)	112	440L-P4J1120YD	1120 (44.1)	30 (1.18)	56	**440L-P4K1120YD**
1280 (50.4)	14 (0.55)	128	440L-P4J1280YD	1280 (50.4)	30 (1.18)	64	**440L-P4K1280YD**
1440 (56.7)	14 (0.55)	144	440L-P4J1440YD	1440 (56.7)	30 (1.18)	72	440L-P4K1440YD
1600 (63.0)	14 (0.55)	160	440L-P4J1600YD	1600 (63.0)	30 (1.18)	80	440L-P4K1600YD
1760 (69.1)	14 (0.55)	176	440L-P4J1760YD	1760 (69.1)	30 (1.18)	88	440L-P4K1760YD

Note: The GuardShield transmitter requires a 4-pin cable and the receiver requires an 8-pin cable.
Note: To select just a transmitter or receiver, replace the "P" in the above cat. nos. with a "T" for transmitter and an "R" for receiver.

Remote Teach System

The Allen-Bradley Guardmaster GuardShield remote teach system is ordered as a system. The system consists of a standard GuardShield transmitter in either 14 mm or 30 mm resolutions with mounting hardware, a GuardShield receiver with a 10 inch Y-connector cable, a metal key switch box, and a 4-pin 2 meter patchcord which connects between the key switch box and the Y-connector.

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
160 (6.3)	14 (0.55)	16	440L-S4J0160YR	160 (6.3)	30 (1.18)	8	440L-S4K0160YR
320 (12.6)	14 (0.55)	32	440L-S4J0320YR	320 (12.6)	30 (1.18)	16	440L-S4K0320YR
480 (18.9)	14 (0.55)	48	440L-S4J0480YR	480 (18.9)	30 (1.18)	24	440L-S4K0480YR
640 (25.2)	14 (0.55)	64	440L-S4J0640YR	640 (25.2)	30 (1.18)	32	440L-S4K0640YR
800 (31.5)	14 (0.55)	80	440L-S4J0800YR	800 (31.5)	30 (1.18)	40	440L-S4K0800YR
960 (37.8)	14 (0.55)	96	440L-S4J0960YR	960 (37.8)	30 (1.18)	48	440L-S4K0960YR
1120 (44.1)	14 (0.55)	112	440L-S4J1120YR	1120 (44.1)	30 (1.18)	56	440L-S4K1120YR
1280 (50.4)	14 (0.55)	128	440L-S4J1280YR	1280 (50.4)	30 (1.18)	64	440L-S4K1280YR
1440 (56.7)	14 (0.55)	144	440L-S4J1440YR	1440 (56.7)	30 (1.18)	72	440L-S4K1440YR
1600 (63.0)	14 (0.55)	160	440L-S4J1600YR	1600 (63.0)	30 (1.18)	80	440L-S4K1600YR
1760 (69.1)	14 (0.55)	176	440L-S4J1760YR	1760 (69.1)	30 (1.18)	88	440L-S4K1760YR
Remote Teach Keyswitch Box Assembly∗			440L-M8600	DC Micro Style Quick-Disconnect Patchcord, 4-Pin∗			889D-F4ACDM-2

Note: The GuardShield transmitter requires a 4-pin cable and the receiver requires an 8-pin cable.
Note: The GuardShield remote teach system light curtains can be ordered as pairs by replacing the "S" in the cat. no. a with "P."
∗ Included with each system cat. no.; can be ordered as a replacement part.

Cascadable Standard System

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
320 (12.6)	14 (0.55)	32	440L-C4J0320YD	320 (12.6)	30 (1.18)	16	440L-C4K0320YD
480 (18.9)	14 (0.55)	48	440L-C4J0480YD	480 (18.9)	30 (1.18)	24	440L-C4K0480YD
640 (25.2)	14 (0.55)	64	440L-C4J0640YD	640 (25.2)	30 (1.18)	32	440L-C4K0640YD
800 (31.5)	14 (0.55)	80	440L-C4J0800YD	800 (31.5)	30 (1.18)	40	440L-C4K0800YD
960 (37.8)	14 (0.55)	96	440L-C4J0960YD	960 (37.8)	30 (1.18)	48	440L-C4K0960YD
1120 (44.1)	14 (0.55)	112	440L-C4J1120YD	1120 (44.1)	30 (1.18)	56	440L-C4K1120YD
1280 (50.4)	14 (0.55)	128	440L-C4J1280YD	1280 (50.4)	30 (1.18)	64	440L-C4K1280YD
1440 (56.7)	14 (0.55)	144	440L-C4J1440YD	1440 (56.7)	30 (1.18)	72	440L-C4K1440YD
1660 (63.0)	14 (0.55)	160	440L-C4J1600YD	1600 (63.0)	30 (1.18)	80	440L-C4K1600YD
1760 (69.3)	14 (0.55)	176	440L-C4J1760YD	1760 (69.3)	30 (1.18)	88	440L-C4K1760YD

Note: Cascadable systems are sold in pairs represented by the "C" in the cat. no. To order the cascadable transmitter or receiver, replace the "C" with a "G" for the transmitter or "F" for the receiver.

GuardShield with Integrated Laser Alignment

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
320 (12.6)	14 (0.55)	32	440L-P4JL0320YD	320 (12.6)	30 (1.18)	16	440L-P4KL0320YD
480 (18.9)	14 (0.55)	48	440L-P4JL0480YD	480 (18.9)	30 (1.18)	24	440L-P4KL0480YD
640 (25.2)	14 (0.55)	64	440L-P4JL0640YD	640 (25.2)	30 (1.18)	32	440L-P4KL0640YD
800 (31.5)	14 (0.55)	80	440L-P4JL0800YD	800 (31.5)	30 (1.18)	40	440L-P4KL0800YD
960 (37.8)	14 (0.55)	96	440L-P4JL0960YD	960 (37.8)	30 (1.18)	48	440L-P4KL0960YD
1120 (44.1)	14 (0.55)	112	440L-P4JL1120YD	1120 (44.1)	30 (1.18)	56	440L-P4KL1120YD
1280 (50.4)	14 (0.55)	128	440L-P4JL1280YD	1280 (50.4)	30 (1.18)	64	440L-P4KL1280YD
1440 (56.7)	14 (0.55)	144	440L-P4JL1440YD	1440 (56.7)	30 (1.18)	72	440L-P4KL1440YD
1600 (63.0)	14 (0.55)	160	440L-P4JL1600YD	1600 (63.0)	30 (1.18)	80	440L-P4KL1600YD

Note: GuardShields are sold in pairs. To select a transmitter or receiver, replace the "P" in the cat. no. with a "T" for transmitter and an "R" for receiver.

Cascadable GuardShield with Integrated Laser Alignment

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
320 (12.6)	14 (0.55)	32	440L-C4JL0320YD	320 (12.6)	30 (1.18)	16	440L-C4KL0320YD
480 (18.9)	14 (0.55)	48	440L-C4JL0480YD	480 (18.9)	30 (1.18)	24	440L-C4KL0480YD
640 (25.2)	14 (0.55)	64	440L-C4JL0640YD	640 (25.2)	30 (1.18)	32	440L-C4KL0640YD
800 (31.5)	14 (0.55)	80	440L-C4JL0800YD	800 (31.5)	30 (1.18)	40	440L-C4KL0800YD
960 (37.8)	14 (0.55)	96	440L-C4JL0960YD	960 (37.8)	30 (1.18)	48	440L-C4KL0960YD
1120 (44.1)	14 (0.55)	112	440L-C4JL1120YD	1120 (44.1)	30 (1.18)	56	440L-C4KL1120YD
1280 (50.4)	14 (0.55)	128	440L-C4JL1280YD	1280 (50.4)	30 (1.18)	64	440L-C4KL1280YD
1440 (56.7)	14 (0.55)	144	440L-C4JL1440YD	1440 (56.7)	30 (1.18)	72	440L-C4KL1440YD
1600 (63.0)	14 (0.55)	160	440L-C4JL1600YD	1600 (63.0)	30 (1.18)	80	440L-C4KL1600YD

Note: Cascadable GuardShields are sold in pairs. To select a transmitter or receiver, replace the "C" with a "G" for cascadable transmitter and an "F" for a cascadable receiver.

POC Type 4 Safety Light Curtains

GuardShield

GuardShield with Integrated Laser Alignment and ArmorBlock Guard I/O Connectivity

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
320 (12.6)	14 (0.55)	32	440L-P4JL0320YA	320 (12.6)	30 (1.18)	16	440L-P4KL0320YA
480 (18.9)	14 (0.55)	48	440L-P4JL0480YA	480 (18.9)	30 (1.18)	24	440L-P4KL0480YA
640 (25.2)	14 (0.55)	64	440L-P4JL0640YA	640 (25.2)	30 (1.18)	32	440L-P4KL0640YA
800 (31.5)	14 (0.55)	80	440L-P4JL0800YA	800 (31.5)	30 (1.18)	40	440L-P4KL0800YA
960 (37.8)	14 (0.55)	96	440L-P4JL0960YA	960 (37.8)	30 (1.18)	48	440L-P4KL0960YA
1120 (44.1)	14 (0.55)	112	440L-P4JL1120YA	1120 (44.1)	30 (1.18)	56	440L-P4KL1120YA
1280 (50.4)	14 (0.55)	128	440L-P4JL1280YA	1280 (50.4)	30 (1.18)	64	440L-P4KL1280YA
1440 (56.7)	14 (0.55)	144	440L-P4JL1440YA	1440 (56.7)	30 (1.18)	72	440L-P4KL1440YA
1600 (63.0)	14 (0.55)	160	440L-P4JL1600YA	1600 (63.0)	30 (1.18)	80	440L-P4KL1600YA

Note: GuardShields are sold in pairs. To select a transmitter or receiver, replace the "P" in the cat. no. with an "R" for a receiver. The GuardShield standard transmitter is used in the pair. To order a transmitter, replace the "P" with a "T" and the "A" with a "D."

Cascadable GuardShield with Integrated Laser Alignment and ArmorBlock Guard I/O Connectivity

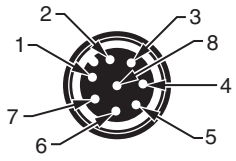
Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
320 (12.6)	14 (0.55)	32	440L-C4JL0320YA	320 (12.6)	30 (1.18)	16	440L-C4KL0320YA
480 (18.9)	14 (0.55)	48	440L-C4JL0480YA	480 (18.9)	30 (1.18)	24	440L-P4KL0480YA
640 (25.2)	14 (0.55)	64	440L-C4JL0640YA	640 (25.2)	30 (1.18)	32	440L-C4KL0640YA
800 (31.5)	14 (0.55)	80	440L-C4JL0800YA	800 (31.5)	30 (1.18)	40	440L-C4KL0800YA
960 (37.8)	14 (0.55)	96	440L-C4JL0960YA	960 (37.8)	30 (1.18)	48	440L-C4KL0960YA
1120 (44.1)	14 (0.55)	112	440L-C4JL1120YA	1120 (44.1)	30 (1.18)	56	440L-C4KL1120YA
1280 (50.4)	14 (0.55)	128	440L-C4JL1280YA	1280 (50.4)	30 (1.18)	64	440L-C4KL1280YA
1440 (56.7)	14 (0.55)	144	440L-C4JL1440YA	1440 (56.7)	30 (1.18)	72	440L-C4KL1440YA
1600 (63.0)	14 (0.55)	160	440L-C4JL1600YA	1600 (63.0)	30 (1.18)	80	440L-C4KL1600YA

Note: Cascadable GuardShields are sold in pairs. To select a transmitter or receiver replace the "C" with an "F" for a cascadable receiver. The cascadable GuardShield standard transmitter is used in these pairs. To order a cascadable transmitter, replace the "C" with a "G" and the "A" with a "D" to specify the appropriate transmitter cat. no.

Recommended Logic Interfaces

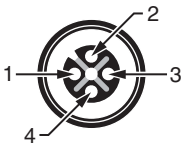
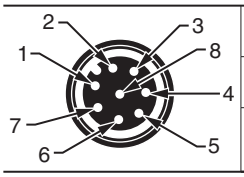
Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR211	2 N.O.	1 N.C.	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-84	440R-H23177
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

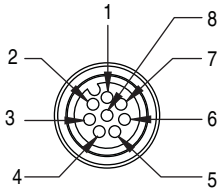
Standard and Remote Teach Cordsets—Two Required (one for transmitter and one for receiver)

Female Connector (Sensor End)		Cable			
Face View of Female	Connector Style	Pin/Wire Color	Wire Rating	Length [m (ft)]	Cat. No.
Transmitter					
	Straight Female	1 Brown 2 White 3 Blue 4 Black	22 AWG 300V 4 A	2 (6.56)	889D-F4AC-2
				5 (16.4)	889D-F4AC-5
				10 (32.8)	889D-F4AC-10
				15 (49.2)	889D-F4AC-15
				20 (65.6)	889D-F4AC-20
				30 (98.4)	889D-F4AC-30
Receiver					
	Straight Female	1 White 2 Brown 3 Green 4 Yellow 5 Grey 6 Pink 7 Blue 8 Red	24 AWG 30V AC/36V DC 1.5 A	2 (6.56)	889D-F8AB-2
				5 (16.4)	889D-F8AB-5
				10 (32.8)	889D-F8AB-10
				15 (49.2)	889D-F8AB-15
				20 (65.6)	889D-F8AB-20
				30 (98.4)	889D-F8AB-30

Cascadable System Patchcords—to connect cascadable GuardShield system

The GuardShield transmitter host patchcord has 4-pin DC micro over-molded quick-disconnect connectors offered in lengths of 1/3 m, 1 m, and 2 m. The GuardShield receiver host patchcord has 8-pin DC micro over-molded quick-disconnect connectors offered in lengths of 1/3 m, 1 m, and 2 m.

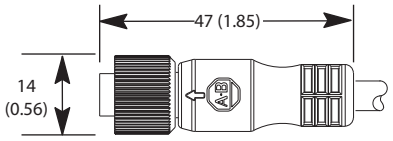
Face View of Female	Description	Cat. No.
Transmitter Patchcord		
	4-pin M12 patchcord, 0.3 m (12 in.)	889D-F4ACDM-0M3
	4-pin M12 patchcord, 1 m (39.37 in.)	889D-F4ACDM-1
	4-pin M12 patchcord, 2 m (78.74 in.)	889D-F4ACDM-2
Receiver Patchcord		
	8-pin M12 patchcord, 0.3 m (12 in.)	889D-F8ABDM-0M3
	8-pin M12 patchcord, 1 m (39.37 in.)	889D-F8ABDM-1
	8-pin M12 patchcord, 2 m (78.74 in.)	889D-F8ABDM-2

Face View of Female	Description	Cat. No.
Receiver Termination Plug		898D-81CU-DM
	Termination plug 8-pin M12 quick disconnect Required for connection to top connector of cascadable receiver if cascade light curtain is used as a standalone system or as the last segment pair in a cascaded system.	

Note: A termination plug is not necessary for the cascadable transmitter.

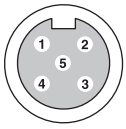
Cordsets Approximate Dimensions [mm (in.)]

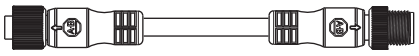
Dimensions are not intended to be used for installation purposes.



Straight Female M12 Quick Disconnect

ArmorBlock Guard I/O

Top View	Color	No. of Pins	Signal Receiver
	Brown	1	+24V
	White	2	OSSD 2
	Blue	3	0V
	Black	4	OSSD 1
	Grey	5	NC

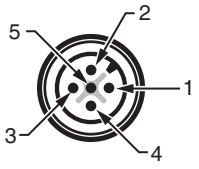


Interconnecting Patchcords—ArmorBlock I/O Connection

Cat. No.	Description
889D-F5ACDM-0M3	Five-pin M12 patchcord, 0.3 m (12 in.)
889D-F5ACDM-1	Five-pin M12 patchcord, 1 m (39.37 in.)
889D-F5ACDM-2	Five-pin M12 patchcord, 2 m (78.74 in.)
889D-F5ACDM-5	Five-pin M12 patchcord, 5 m (196.85 in.)
889D-F5ACDM-10	Five-pin M12 patchcord, 10 m (393.7 in.)

Note: The GuardShield pairs with ArmorBlock Guard I/O Connectivity have a 5-pin M12 quick-disconnect connector on the receiver wired to allow connection to the ArmorBlock 5-pin connector. The transmitter in that GuardShield pair is a standard GuardShield transmitter with integrated laser alignment system offered with a 4-pin M12 quick-disconnect connector. It is possible to connect either a standard 4-pin M12 cordset or the 5-pin M12 quick-disconnect connector cordset or patchcord to this transmitter.

Termination Connector for Cascadable GuardShield Receiver (if it's a standalone pair) with ArmorBlock Guard I/O Connectivity

Face View of Female	Description	Cat. No.
	5-pin M12 Termination Adaptor	898D-418U-DM

Note: The cascadable GuardShield with ArmorBlock Guard I/O connectivity can be used as a standalone pair if the top connector on the receiver has a termination adaptor connected. The cascadable transmitter does not require a termination adaptor.

Optional Accessories

Description		Cat. No.
	Steel L-shaped end cap mounting bracket (4 per package) **Note:** 4 brackets supplied with each GuardShield pair.	440L-AF6101
	Aluminum middle mounting bracket for vibratory applications	**440L-AF6108**
	Power supply: Output—24V DC, 3 Amps, 72 W	1606-XLP72E
	Laser alignment tool	**440L-ALAT**
	GuardShield laser alignment tool bracket	**440L-AF6109**
	Mounting stand	**440L-AMSTD**
	Vertical shock mount kit	**440L-AF6120**
	Horizontal shock mount kit	440L-AF6121
	Middle vertical mount kit	440L-AF6122
	Middle horizontal mount kit	440L-AF6123
	GuardShield weld shield (cat. no. is for a pair of light curtains)	440L-AGWS0160
		440L-AGWS0320
		440L-AGWS0480
		440L-AGWS0640
		440L-AGWS0800
		440L-AGWS0960
		440L-AGWS1120
		440L-AGWS1280
		440L-AGWS1440
		440L-AGWS1600
		440L-AGWS1760
	GuardShield Washdown Enclosure Kit **Note**: Only for use with standard GuardShield light curtain.	440L-AGST320
		440L-AGST480
		440L-AGST640
		440L-AGST800
		440L-AGST960
	8-pin M12 Receiver Termination Plug (Required for top receiver connector if a cascaded pair is used as a standalone or if it is the last pair in a cascaded system.)	898D-81CU-DM

Corner Mirror for Multi-Sided Guarding

Specially constructed glass mirrors for 2- and 3-sided safeguarding applications.

Note: Each mirror reduces maximum scan range by up to 15% per mirror. Each corner mirror suppled with two endcap mounting brackets.

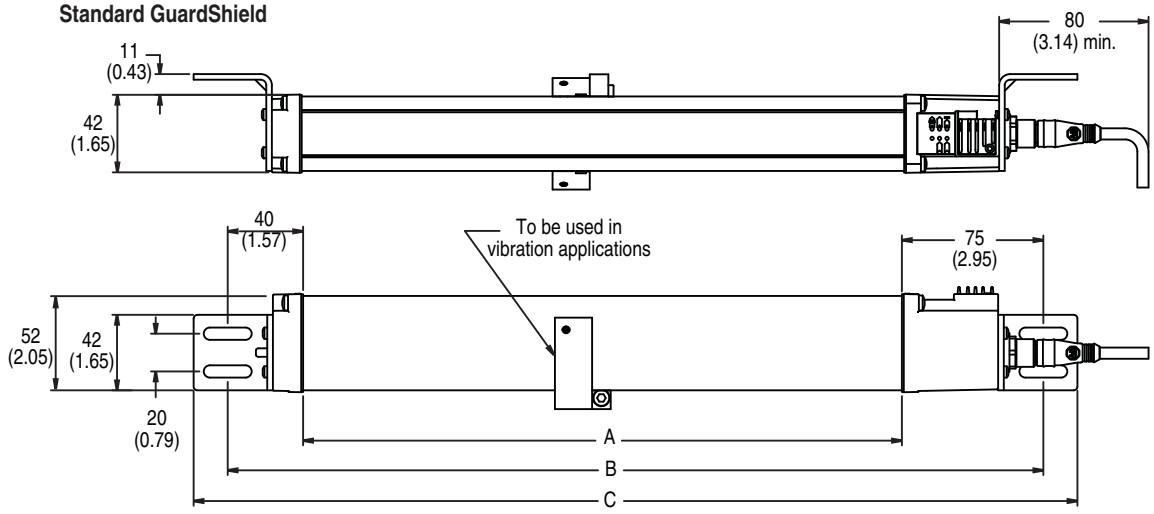
GuardShield Light Curtain Cat. No.	Narrow Mirror Short-Range 0…4 m	Cat. No.	Wide Mirror Long-Range 4…15 m	Cat. No.
440L-P4∗0160Y❄ 440L-P2K‡0160YD		440L-AM0750300		440L-AM1250300
440L-P4∗0320Y❄ 440L-P2K‡0320YD		440L-AM0750450		440L-AM1250450
440L-P4∗0480Y❄ 440L-P2K‡0480YD 440L-P4A2500YD		440L-AM0750600		440L-AM1250600
440L-P4∗0640Y❄ 440L-P2K‡0640YD		440L-AM0750750		440L-AM1250750
440L-P4∗0800Y❄ 440L-P2K‡0800YD		440L-AM0750900		440L-AM1250900
440L-P4∗0960Y❄ 440L-P2K‡0960YD 440L-P4A3400YD		440L-AM0751050		440L-AM1251050
440L-P4∗1120Y❄ 440L-P2K‡1120YD		440L-AM0751200		**440L-AM1251200**
440L-P4∗1280Y❄ 440L-P2K‡1280YD		440L-AM0751350		440L-AM1251350
440L-P4∗1440Y❄ 440L-P2K‡1440YD		440L-AM0751500		440L-AM1251500
440L-P4∗1600Y❄ 440L-P2K‡1600YD		440L-AM0751650		440L-AM1251650
440L-P4∗1760Y❄ 440L-P2K‡1760YD		440L-AM0751800		440L-AM1251800

∗ = J or K;
❄ = D or R;
‡ = A or D

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

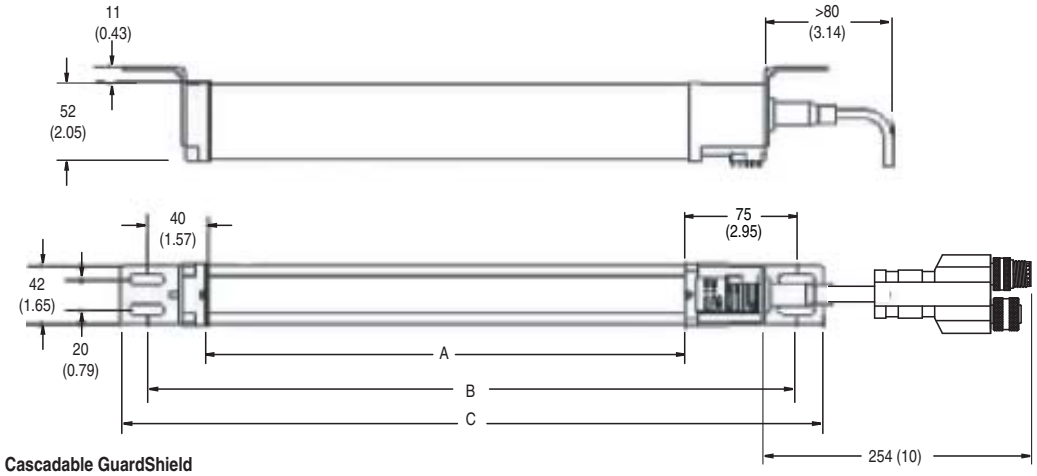
Standard GuardShield



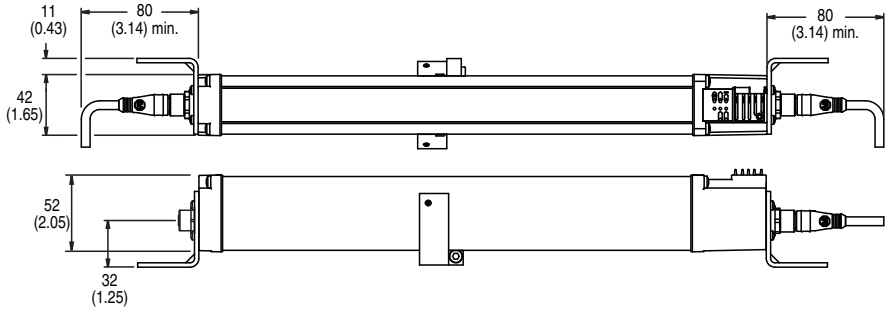
POC Type 4 Safety Light Curtains

GuardShield

Remote Teach GuardShield



Cascadable GuardShield

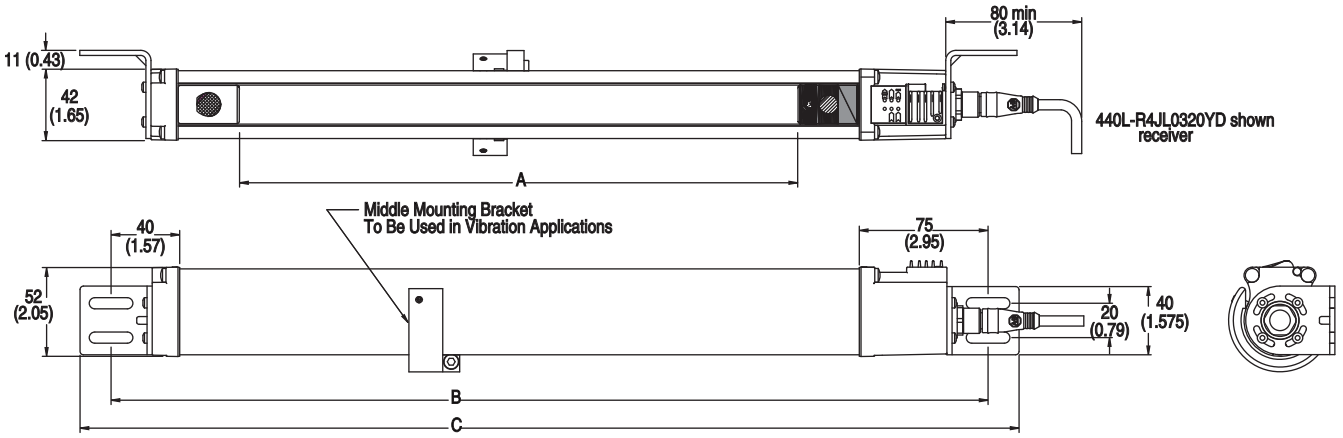


Note: Middle mounting bracket should be used in vibration applications on GuardShield light curtain protective heights of 1120 mm and larger.

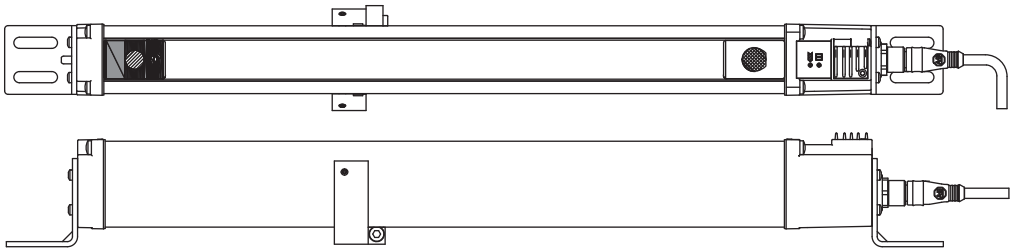
Type	A Protective Height [mm]	B Mounting Value [mm]	C Total Length [mm]
440L-✶4‡0160YD	160 ±0.5§	276	312 ±1.5
440L-❄4‡0320YD	320 ±0.5	436	472 ±1.5
440L-❄4‡0480YD	480 ±0.5	596	632 ±1.5
440L-❄4‡0640YD	640 ±0.5	756	792 ±1.5
440L-❄4‡0800YD	800 ±0.6	916	952 ±1.5
440L-❄4‡0960YD	960 ±0.6	1076	1112 ±1.5
440L-❄4‡1120YD	1120 ±0.6	1236	1272 ±1.8
440L-❄4‡1280YD	1280 ±0.7	1396	1432 ±1.8
440L-❄4‡1440YD	1440 ±0.7	1556	1592 ±1.8
440L-❄4‡1600YD	1600 ±0.8	1716	1752 ±2.0
440L-❄4‡1760YD	1760 ±0.8	1876	1912 ±2.0

✶ P = Pair, T = Transmitter, R = Receiver
❄ P = Pair, T = Transmitter, R = Receiver, C = Host Pair, G = Host Transmitter, F = Host Receiver
‡ J = 14 mm resolution or K = 30 mm resolution
§ 160 mm is not available for cascading GuardShield light curtains.

Standard GuardShield Receiver with Integrated Laser Alignment



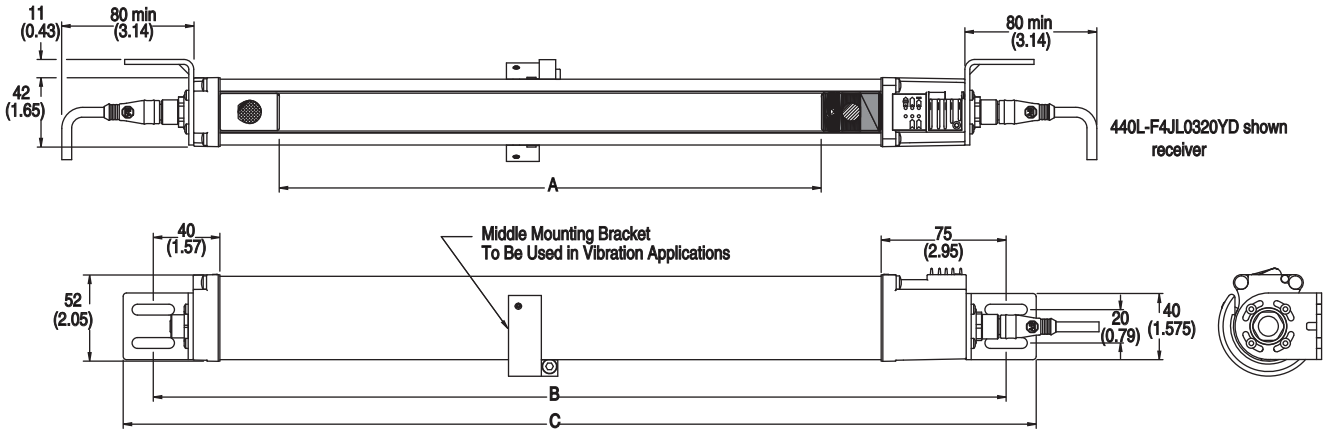
Standard GuardShield Transmitter with Integrated Laser Alignment



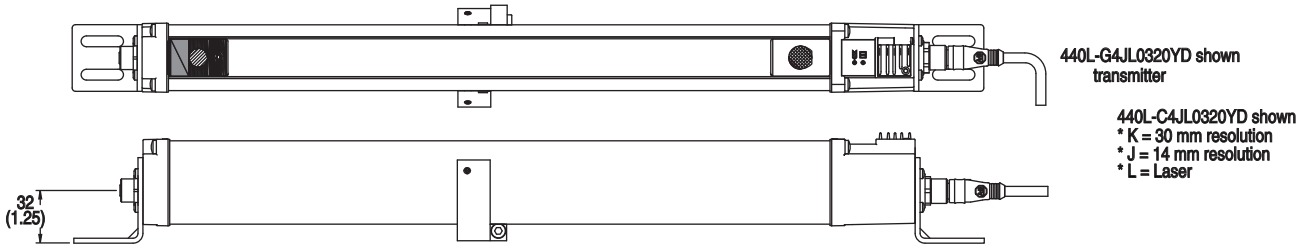
Type	A Protective Height	B Mounting	C Total Length	D Mounting
440L-P4*L0320YD	320±0.5	516	552±1.5	426
440L-P4*L0480YD	480±0.5	676	712±1.5	586
440L-P4*L0640YD	640±0.5	836	872±1.5	746
440L-P4*L0800YD	800±0.5	996	1032±1.5	906
440L-P4*L0960YD	960±0.5	1156	1192±1.5	1066
440L-P4*L1120YD	1120±0.5	1316	1352±1.5	1226
440L-P4*L1280YD	1280±0.5	1476	1512±1.5	1386
440L-P4*L1440YD	1440±0.5	1636	1672±1.5	1546
440L-P4*L1600YD	1600±0.5	1796	1832±1.5	1706

J = 14 mm resolution, K = 30 mm resolution

Cascadable GuardShield Receiver with Integrated Laser Alignment



Cascadable GuardShield Transmitter with Integrated Laser Alignment

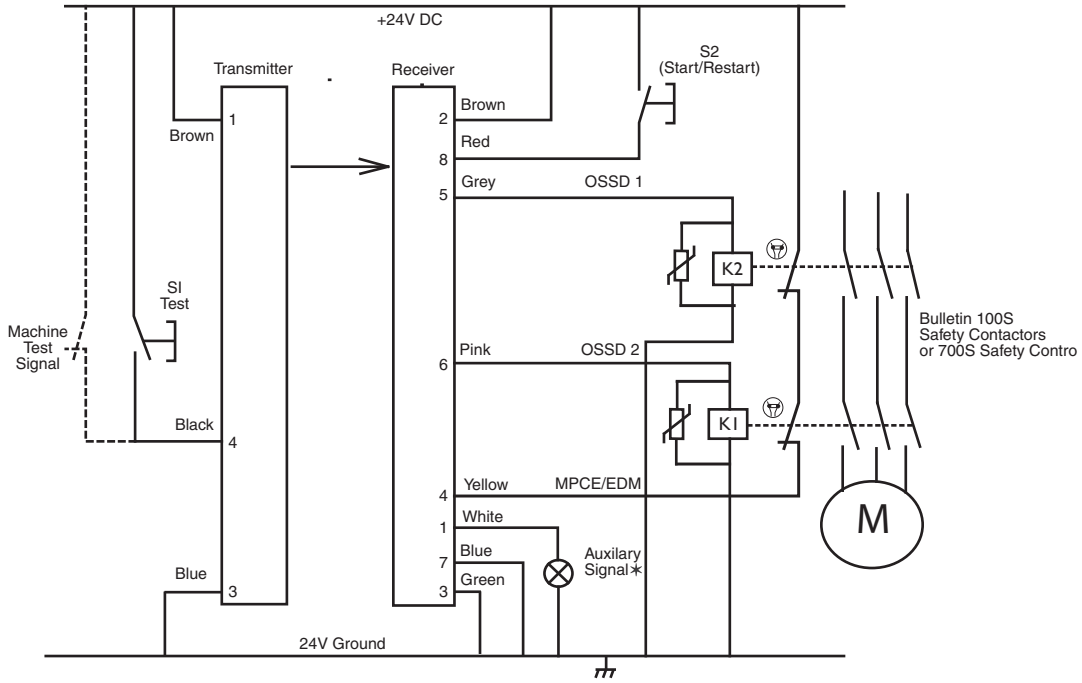


Type	A Protective Height	B Mounting	C Total Length	D Mounting
440L-C4*L0320YD	320±0.5	516	552±1.5	426
440L-C4*L0480YD	480±0.5	676	712±1.5	586
440L-C4*L0640YD	640±0.5	836	872±1.5	746
440L-C4*L0800YD	800±0.5	996	1032±1.5	906
440L-C4*L0960YD	960±0.5	1156	1192±1.5	1066
440L-C4*L1120YD	1120±0.5	1316	1352±1.5	1226
440L-C4*L1280YD	1280±0.5	1476	1512±1.5	1386
440L-C4*L1440YD	1440±0.5	1636	1672±1.5	1546
440L-C4*L1600YD	1600±0.5	1796	1832±1.5	1706

J = 14 mm resolution, K = 30 mm resolution

Wiring Diagram for Connection of OSSDs Directly to Contactors (FSDs) with Restart Interlock

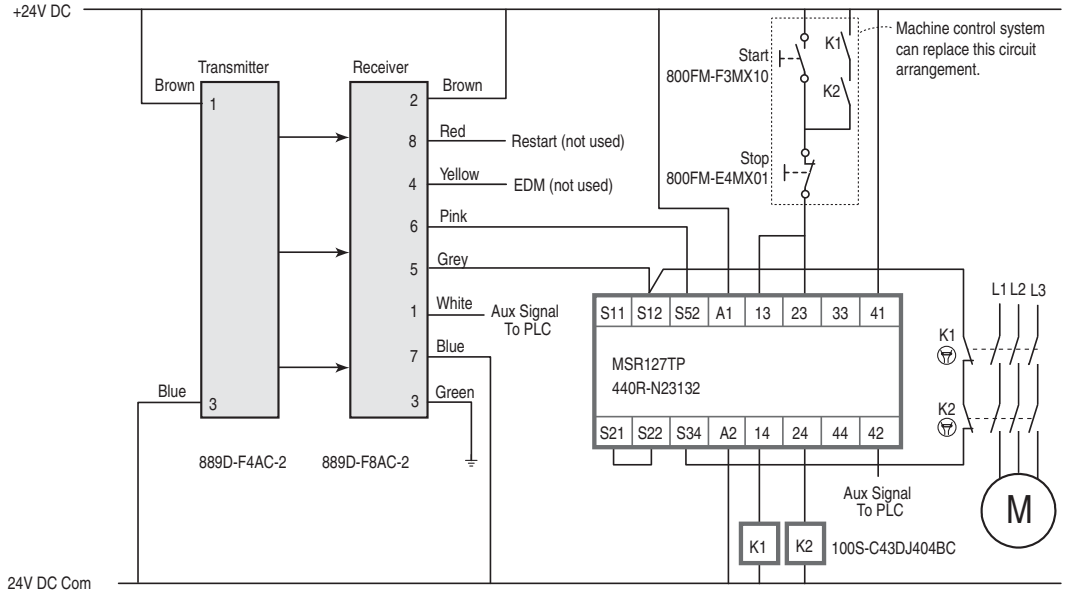
Wiring diagram is not intended to be used for installation purposes.



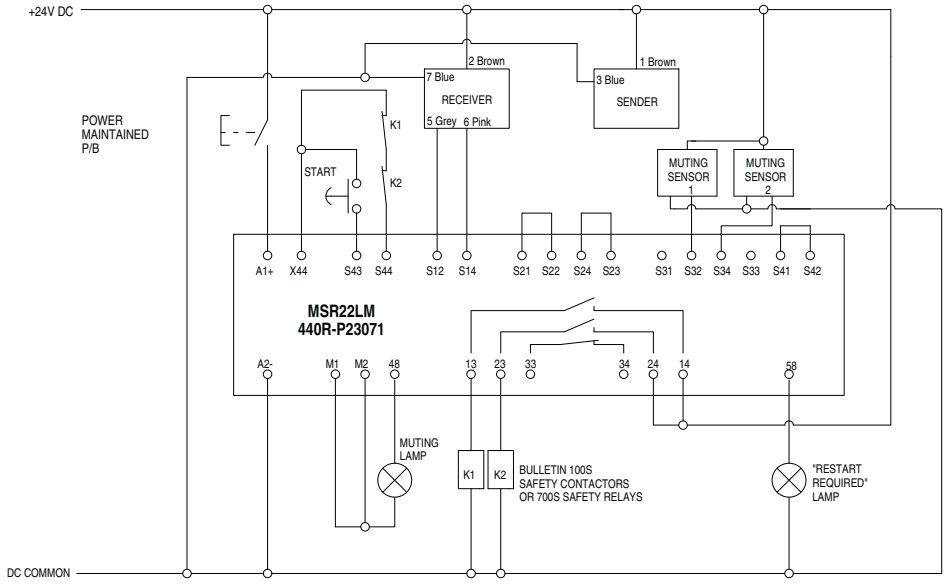
* Auxiliary output is nonsafety. Can be connected to a lamp, motor or status to a PLC.

K1, K2	Safety relay or safety contactor for OSSD 1 and OSSD 2 connection
S1	Switch for external system test (optional)
S2	Switch for reset of light curtain from start/restart interlock

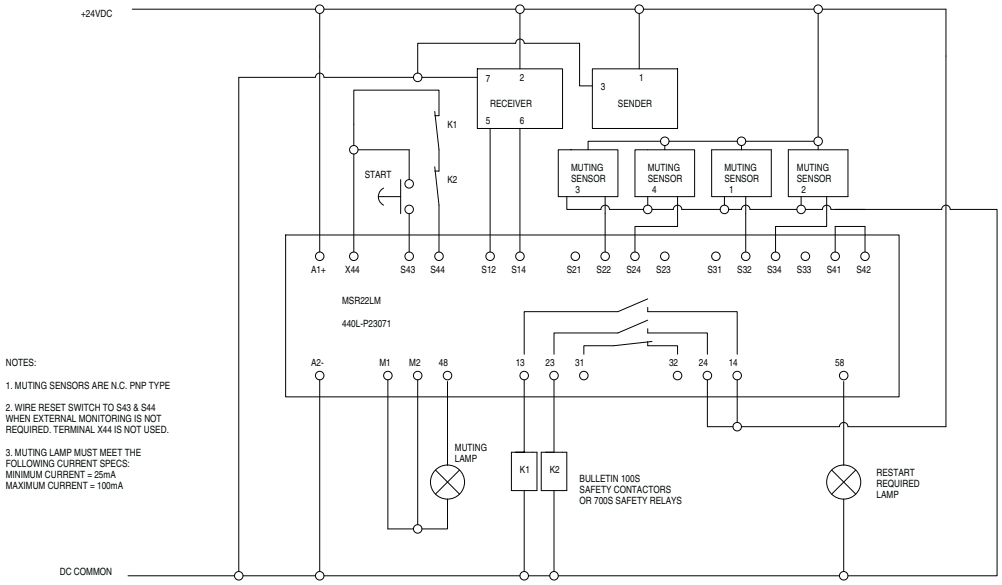
Wiring Diagram for Connection of OSSDs Directly to a Safety Relay Module



GuardShield Light Curtain Connected to MSR22LM with Two Sensor Muting



GuardShield Light Curtain Connected to MSR22LM with Four Sensor Muting





Description

The Allen Bradley Guardmaster GuardShield Safe 4 is an economical two box, Type 4 safety light curtain with ON/OFF functionality. This basic, guard-only operating mode, safety light curtain has an Integrated Laser Alignment system that simplifies the alignment of each pair of light curtains. Visible laser beams are activated by touching the laser at the finger symbol on front face of the light curtains. Positioning of the transmitter and receiver laser beams to their respective targets facilitates optimal alignment of each Safe 4 pair. The Integrated Laser Alignment system also quickly helps with the re-alignment of pairs when units are knocked out of alignment during the course of the work process or when corner mirrors are used.

The GuardShield Safe 4 is designed to be used in a variety of applications across a broad range of industries in medium to heavy industrial environments. Offered with shock isolator kits for shock and vibration applications and protective heights from 120…1920 mm in 120 mm increments assures that the correct size of safety light curtain is available to suit the application requirement.

The GuardShield Safe 4, with an environmental rating of IP65, meets all applicable global standards and can be used on or around industrial machinery and equipment anywhere in the world.

Features

- M12 connectors
- Optically synchronized
- Integrated laser alignment system
- IP65 enclosure rating
- Simple installation
- cULus Listed and CE Marked for all applicable directives

Applications

- Metal working
- Shears
- Punch presses
- Robot cells
- Automated processes

Specifications

Safety Ratings	
Standards	EN/IEC 61496 Parts 1 and 2, UL 61496 Parts 1 and 2, UL1998
Safety Classification	Type 4 per IEC/EN61496. Category 4 device per EN 954-1, SIL 3 per IEC 61508, PLe per EN/ISO 13849, EN/IEC 61496-1, -2, UL 61496-1, -2, UL 1998
Certifications	cULus Listed and CE Marked for all applicable directives
Power Supply	
Input Power, Max.	24V DC ± 20%
Maximum Residual Ripple	< 10% of U_{sp}
Power Consumption	<500 mA (no load)
Outputs	
Safety Outputs	2 PNP OSSD. 0.3 A, short-circuit protected
Output Voltage	>U_{sp} (at load = 0.1 A)
Switching Current @ Voltage, Min.	300 mA @ 24V DC
Operating Characteristics	
Response Time	Varies by protective height, see Installation Manual
Indicator LEDs	ON -State, OFF-State, internal error
Protected Height [mm (in.)]	120…1920 mm (4.7…75.6 in.) in 120 mm (4.7 in.) increments
Resolution [mm (in.)]	14 mm (0.55 in.) 30 mm (1.18 in.)
Scanning Range	14 mm: 0…9 m (0…29.7 ft) 30 mm: 0…18 m (0…59 ft)
Synchronization	Optical, first beam adjacent to LEDs
Wavelength	950 nm
Environmental	
Enclosure Type Rating	IP65
Relative humidity	15…95% (noncondensing)
Operating Temperature [C (F)]	0…55° (0…131°)
Vibration	IEC 60068-2-6 frequency 10…55 Hz; amplitude 0.35 mm (0.01 in.)
Shock	IEC 60068-2-29; acceleration 10 g, pulse duration 16 ms 10…55 Hz; amplitude 0.35 mm (0.01 in.)
Physical Characteristics	
Mounting	Rear mounting, standard and adjustable (180°)
Weight	Varies by protective height, see Installation Manual
Housing Cross Section	30 x 40 mm (1.18 x 1.57 in.)
Connection Type	Transmitter: 5-pin M12 micro QD Receiver: 5-pin M12 micro QD
Cable Length	30 m (98.4 ft) max.
ILAS Laser Class	Class 2, IEC 60825-1

POC Type 4 Safety Light Curtains

GuardShield Safe 4

Product Selection

Standard System

The Allen-Bradley Guardmaster GuardShield Safe 4 safety light curtains are offered in 14 mm and 30 mm resolutions, are ordered as pairs—transmitter and receiver—and are shipped under one cat. no. Each GuardShield Safe 4 pair is shipped with standard mounting brackets. After selecting the appropriate Safe 4 protected height and resolution, ensure that the appropriate cordsets, interfaces, and accessories are ordered.

Protected Height [mm (in.)]	14 mm (0.55 in.) Number of Beams	30 mm (1.18 in.) Number of Beams	Pair Weight [kg (lbs)]	Cat. No.	
				14 mm (0.55 in.)	30 mm (1.18 in.)
120 (4.7)	16	8	1.0 (2.2)	445L-P4L0120YD	445L-P4S0120YD
240 (9.4)	32	16	1.4 (3.1)	**445L-P4L0240YD**	445L-P4S0240YD
360 (14.2)	48	94	1.8 (4.0)	445L-P4L0360YD	445L-P4S0360YD
480 (19.9)	64	94	2.2 (4.9)	445L-P4L0480YD	445L-P4S0480YD
600 (23.6)	80	94	2.6 (5.7)	445L-P4L0600YD	**445L-P4S0600YD**
720 (28.3)	96	94	3.0 (6.6)	445L-P4L0720YD	445L-P4S0720YD
840 (33.1)	112	94	3.5 (7.7)	445L-P4L0840YD	445L-P4S0840YD
960 (37.8)	128	94	4.0 (8.8)	445L-P4L0960YD	**445L-P4S0960YD**
1080 (42.5)	144	94	4.0 (8.8)	445L-P4L1080YD	445L-P4S1080YD
1200 (47.2)	160	94	4.5 (9.9)	445L-P4L1200YD	**445L-P4S1200YD**
1320 (52.0)	176	94	5.0 (11.0)	445L-P4L1320YD	445L-P4S1320YD
1440 (56.7)	172	94	5.5 (12.1)	445L-P4L1440YD	445L-P4S1440YD
1560 (61.4)	188	102	6.0 (13.2)	445L-P4L1560YD	445L-P4S1560YD
1680 (66.1)	204	102	6.5 (14.3)	445L-P4L1680YD	445L-P4S1680YD
1800(70.9)	220	110	7.0 (15.4)	445L-P4L1800YD	445L-P4S1800YD
1920 (75.6)	236	118	7.5 (16.5)	445L-P4L1920YD	445L-P4S1920YD

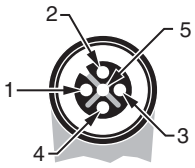
Note: The cat. nos. listed above are pair cat. nos., to specify a transmitter or receiver only, replace the "P" in the cat. no. with a "T" for transmitter or an "R" for receiver.

Required Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

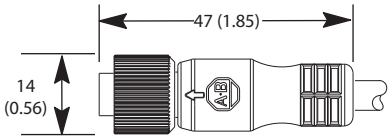
Cordsets—Transmitters and receivers both use 5-pin M12 cordsets

Note: Unshielded cordsets are most commonly used for safety light curtains, however, shielded cordsets are also offered to increase immunity to electrical interference.

Female Connector (Sensor End)		Cable			
Face View of Female	Connector Style	Pin/Wire Color	Wire Rating	Length [m (ft)]	Cat. No.
	Straight Female Nonshielded	1 Brown 2 White 3 Blue 4 Black 5 Grey	22 AWG 250V 4 A	2 (6.56)	889D-F5AC-2
				5 (16.4)	889D-F5AC-5
				10 (32.8)	889D-F5AC-10
				15 (49.2)	889D-F5AC-15
				20 (65.6)	889D-F5AC-20
				30 (98.4)	889D-F5AC-30
	Straight Female Shielded	1 Brown 2 White 3 Blue 4 Black 5 Grey	22 AWG 22 AWG 300V 4 A	2 (6.56)	889D-F5EC-2
				5 (16.4)	889D-F5EC-5
				10 (32.8)	889D-F5EC-10
				15 (49.2)	889D-F5EC-15
				20 (65.6)	889D-F5EC-20
				30 (98.4)	889D-F5EC-30

Cordsets Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Straight Female

Optional Accessories

	Description	Cat. No.
	Standard kit (4 pieces — supplied with each pair)	445L-AF6140
	180° Adjustable kit (two kits required per pair)	**445L-AF6141**
	Shock Mount Kit (2 kits required per pair of light curtains)	445L-AF6142
	Vertical mounting kit (two kits required per pair)	445L-AF6144
	MSR42 Multifunction Module (requires Cat. No. 440L-AF6150 to program)	**440R-P226AGS-NNR**
	MSR45E — Safety relay expansion module for MSR42	**440R-P4NANS**
	USB optical interface software configuration tool used to configure the MSR42 (Used to configure the MSR42 module or get diagnostic information from the Safe 4.)	**445L-AF6150**
	Ribbon cable — to connect one MSR45E to an MSR42	**440R-ACABL1**
	Ribbon cable — to connect two MSR45Es to an MSR42	440R-ACABL2
	Ribbon cable — to connect three MSR45Es to an MSR42	440R-ACABL3
	Mounting stand (Comes with hardware to level base and two GuardShield mounting brackets.)	**440L-AMSTD**

Corner Mirror for Multi-Sided Guarding

Specially constructed glass mirrors for 2- and 3-sided safeguarding applications.

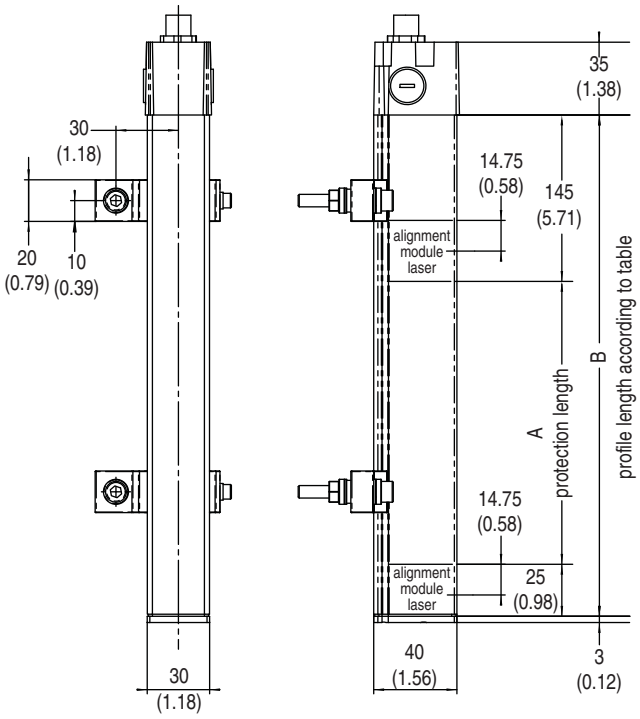
Note: Each mirror reduces maximum scan range by approximately 15% per mirror.

GuardShield Safe 2/Safe 4 Protected Height [mm (in.)]	Narrow Mirror Short-Range 0…4 m	Cat. No.	Wide Mirror Long-Range 4…15 m	Cat. No.
120/240 (4.7/9.4)		440L-AM0750300		440L-AM1250300
360 (14.2)		440L-AM0750450		440L-AM1250450
480 (19)		440L-AM0750600		440L-AM1250600
600 (24)		440L-AM0750750		440L-AM1250750
720/840 (28/33)		440L-AM0750900		440L-AM1250900
960 (38)		440L-AM0751050		440L-AM1251050
1080 (43)		440L-AM0751200		**440L-AM1251200**
1200 (47)		440L-AM0751350		440L-AM1251350
1320/1440 (52/57)		440L-AM0751500		440L-AM1251500
1560 (61)		440L-AM0751650		440L-AM1251650
1680 (66)		440L-AM0751800		440L-AM1251800
1800/1920 (70.9/75.6)		Not available		Not available

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Safe 4

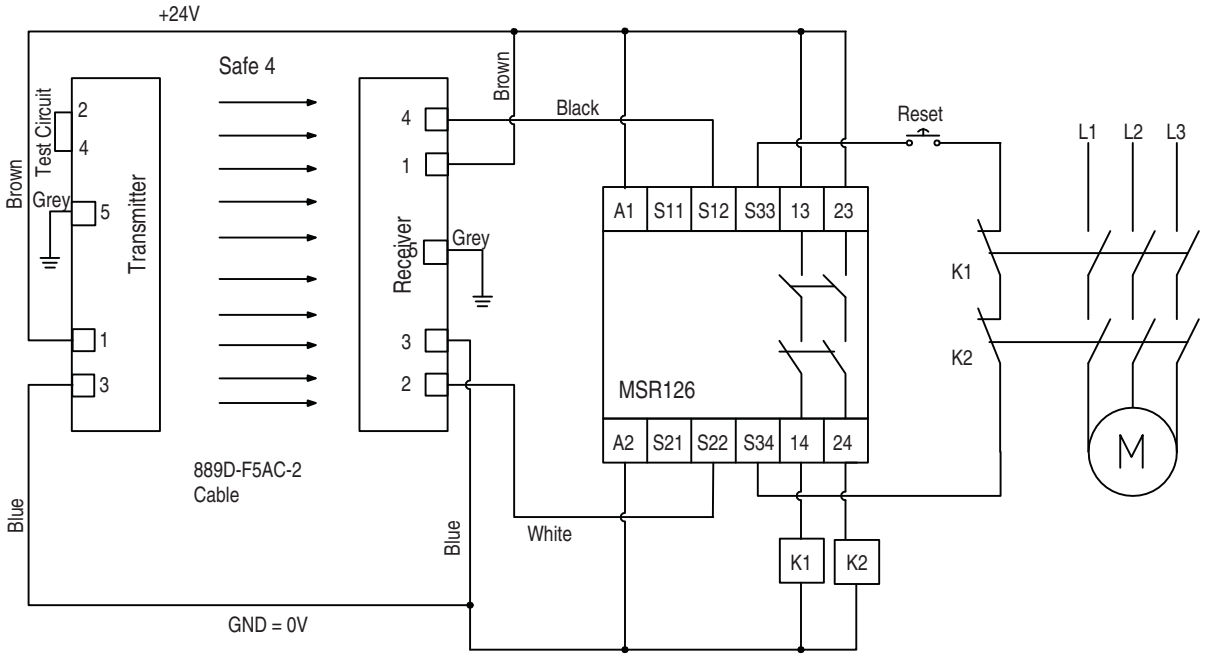


Type	A Protective Height [mm (in.)]	B Profile Length [mm (in.)]
445L-P4∗0120YD	120 (4.7)	290 (11.4)
445L-P4∗0240YD	240 (9.4)	410 (16.1)
445L-P4∗0360YD	360 (14.2)	530 (20.9)
445L-P4∗0480YD	480 (18.9)	650 (25.6)
445L-P4∗0600YD	600 (23.6)	771 (30.4)
445L-P4∗0720YD	720 (28.3)	891 (35.1)
445L-P4∗0840YD	840 (33.1)	1011 (39.8)
445L-P4∗0960YD	960 (37.8)	1131 (44.5)
445L-P4∗1080YD	1080 (42.5)	1252 (49.3)
445L-P4∗1200YD	1200 (47.2)	1372 (54.0)
445L-P4∗1320YD	1320 (51.9)	1492 (58.7)
445L-P4∗1440YD	1440 (56.7)	1612 (63.5)
445L-P4∗1560YD	1560 (61.4)	1733 (68.2)
445L-P4∗1680YD	1680 (66.1)	1853 (72.9)
445L-P4∗1800YD	1800 (70.8)	1973 (77.7)
445L-P4∗1920YD	1920 (75.6)	2093 (82.4)

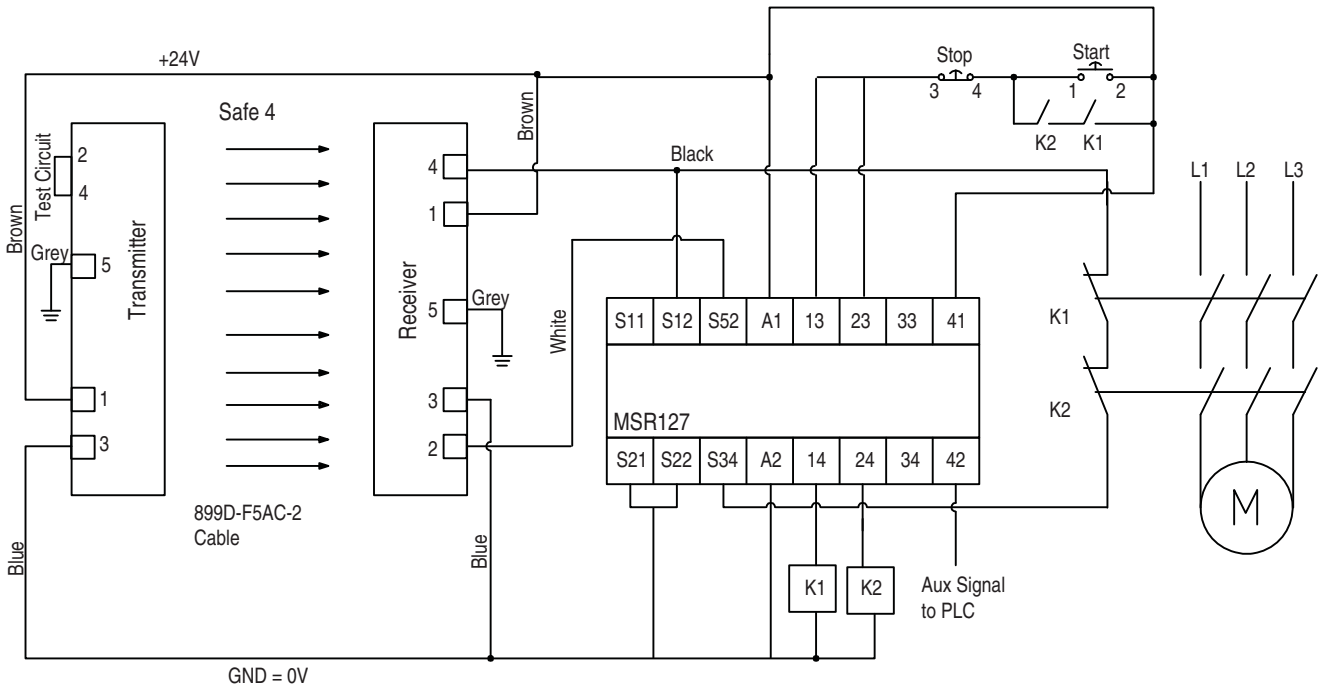
∗ For 14 mm resolution replace with an "L." For 30 mm resolution replace with an "S." Example: **Cat. No. 445L-P4S0480YD** (for 30 mm resolution).

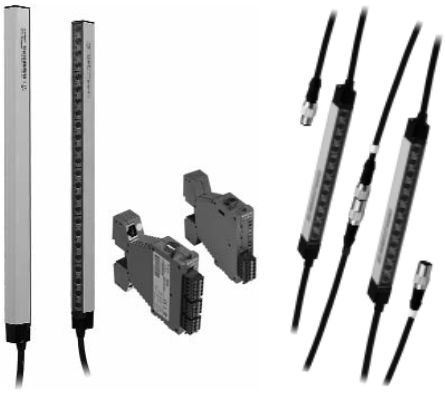
Wiring Diagram for Connection to MSR126

Wiring diagram is not intended to be used for installation purposes.



Wiring Diagram for Connection to MSR127





Description

The GuardShield Micro 400 is an economical three-box (transmitter, receiver and controller) Type 4 safety light curtain offered in a small profile (15 x 20 mm (0.59 x 0.79 in.)) housing. Designed for use in benign industrial environments (IP54), this light-duty safety light curtain system is targeted to the semi-conductor, micro electronic and small assembly machine markets.

Protective heights are offered from 150…1200 mm (5.91…47.2 in.) in 150 mm (5.91 in.) increments. The compact housing size allows the GuardShield Micro 400 to be mounted in areas where standard safety light curtains may not be able to be mounted due to space constraints. It is also possible to recess the GuardShield Micro 400 transmitter and receiver into machine frames.

The Micro 400 requires a dedicated controller. The MSR41 controller is used for on/off application and the MSR42 can also be used as a multi-function safety module, allowing the connection of additional safety light curtains, safety laser scanner, or any safety device with two Output Signal Switch Devices (OSSD) outputs, or two contacts, such as E-stops and enabling switches.

There are a number of operating modes that can be configured with the MSR42 controller. EDM, START/Restart interlock, fixed and floating blanking and muting are possible.

The Micro 400 transmitter and receiver are offered with 8-pin M12 connectors at the end of 500 mm (19.8 in.) integrated cables. The patchcords to connect the transmitter and receiver to the controller are the same and are offered in 3, 5, and 8 m (9.8, 16.4, and 26.2 ft) lengths. These patchcords are configured on one end with M12 connectors (which mate to the integrated pigtail connectors) and RJ45 connectors on the opposite end (which plug into the MSR42 controller).

Cascadable System

The GuardShield Micro 400 is also offered in a cascadable configuration. GuardShield Cascadable Micro 400 safety light curtains allow the interconnection of multiple segments of the Micro 400 safety light curtain with a common pair of safety outputs. This cascadable configurability of the GuardShield Micro 400 reduces overall system wiring and allows the GuardShield Micro 400 to be fitted into a variety of applications where the safety distances for mounting the light curtain may allow personnel to stand between the sensing field of the light curtain and the hazard or where multiple sided guarding is required and the use of corner mirrors is not possible.

A GuardShield Cascadable Micro 400 safety light curtain system is comprised of one or two pair of Cascadable Micro 400 light curtains as well as a standard Micro 400 pair as the last segment pair in the cascaded system.

GuardShield Micro 400 cascaded pairs are offered in both 14 mm and 30 mm resolutions in limited protected heights which are listed in the table below. It is possible to mix 14 mm and 30 mm resolution pairs in a cascaded Micro 400 system.

IMPORTANT	The standard GuardShield Micro 400 must always be the last segment in a cascaded Micro 400 system.

The cascadable Micro 400 safety light curtains are ordered as pairs (transmitter and receiver) and are shipped under one cat. no. After selecting the appropriate light curtain cat. nos. for a cascaded Micro 400 system, select the standard Micro 400 pair as the last segment in the cascaded system and also select interconnecting patchcords.

A cascadable pair of GuardShield Micro 400 light curtains has a 500 mm (19.8 in.) pigtail with a female M12 QD on the bottom of the Micro 400 light curtain and a 500 mm (19.8 in.) pigtail with a male M12 QD attached to the top of the Micro 400 transmitter and receiver.

The GuardShield Cascadable Micro 400 system operates as a single light curtain pair with a common set of OSSDs. Each segment pair is connected in series making the response time of the complete system the sum of each segment pair, plus the response time of the MSR41 or MSR42 and other safety devices in the stop circuit.

When connecting two cascadable segments together, the resultant cable length between segments is 1000 mm (39.6 in.).

If an additional length between segment pairs is required, Rockwell Automation offers an M12-to-M12 patchcord in 1 m (39.37 in.) and 3 m (118.1 in.) lengths (Cat. Nos. 445L-AC8PC1 or 445L-AC8PC3).

IMPORTANT	The maximum cascaded Micro 400 system length can not exceed 10 m as measured between the RJ45 connection at the MSR42 controller to the last beam in the standard Micro 400, including all cable lengths. The maximum number of beams in a cascaded Micro 400 system can not exceed 255 beams.

Features

- Very small profile 15 x 20 mm (0.59 x 0.79 in.)
- M12 connector on 20 inch pigtails
- Minimal dead space of optic heads

Applications

- Light assembly machines/equipment
- Semi-conductor
- Micro-electronics
- Pharmaceutical

Specifications

Safety Ratings	
Standards	IEC/EN61496 Parts 1 and 2. UL61496 Parts 1 and 2, UL1998
Safety Classification	Type 4 per IEC/EN61496. Category 4 device per EN 954-1, SIL 3 per IEC 61508, PLe per EN/ISO 13849
Certifications	cULus Listed, TÜV, CE Marked for all applicable directives
Power Supply	Input power from MSR41 or MSR42 controller
Input Power, Max.	24V DC ±15%
Maximum Residual Ripple	5% of Vss
Power Consumption	0.07 A max. (no load)
Outputs	
Micro 400 Outputs	Data output to controller (MSR41 or MSR42)
MSR41/MSR42 Outputs	Two 400 mA OSSD
Non-Safety Outputs	Auxiliary outputs from MSR41 or MSR42 controller—2 configurable 100 mA, outputs
Switching Current @ Voltage, Max.	400 mA @ 24V DC
Operating Characteristics	
Response Time	14 mm: 14…42 ms; 30 mm; 12…23 ms, varies by protective height and resolution
Indicator LEDs—light curtains	ON -State, OFF-State, Intensity
Protected Height [mm (in.)]	150…1200 mm (5.91…47.24 in.) in 150 mm increments
Resolution [mm (in.)]	14 (0.55), 30 (1.18)
Scanning Range/Resolution	14 mm (0.55 in.) resolution: 0…5 m (16.4 ft) 30 mm (1.18 in.) resolution: 0…5 m (16.4 ft)
Synchronization	Electrical through MSR41 or MSR42
Wavelength	940 nm
Environmental	
Enclosure Type Rating	Micro 400 is IP54; MSR41 and MSR42 are IP20
Relative Humidity	15…95% (noncondensing)
Operating Temperature [C (F)]	0…55 ° (14…131 °)
Vibration	IEC 60068-2-6; Frequency 10…55 Hz; Amplitude 0.35 mm (0.01 in.)
Shock	IEC 60068-2-29; Acceleration 10 g, pulse duration 16 ms 10…55 Hz; Amplitude 0.35 mm (0.01 in.)
Physical Characteristics	
Mounting	180° adjustable mounting brackets supplied
Weight	Varies by protective height
Housing Cross Section	15 mm x 20 mm (0.59…0.79 in.)
Connection Type	Transmitter/receiver: 8-pin M12 micro QD
Cable Length	For MSR41 and MSR42: 3, 5, and 8 m (9.8, 16.4, and 26.2 ft), max. Total system length can not exceed 10 m (32.8 ft).
Cascadable Patchcords	1 and 3 m (39.37 and 118.1 in.) M12 to M12 patchcords. Total system length cannot exceed 10 m (32.8 ft) including protective height of Micro 400 (500 mm (19.8 in.)), integrated cables and patchcords from M12 connector to MSR41 or MSR42.

Product Selection

IMPORTANT The maximum length of a GuardShield Micro 400 system is limited to 10 m. This total length includes the length from the last beam in the light curtain housing plus the length of the pigtail cable and the patchcord length.

Standard System

The Allen-Bradley Guardmaster GuardShield Micro 400 safety light curtains are offered in 14 and 30 mm resolution, are ordered as pairs (transmitter and receiver) and are shipped under one cat. no. Each GuardShield Micro 400 pair is shipped with 180° adjustable mounting brackets. After selecting the appropriate pair by cat. no., ensure that the dedicated safety controller (MSR42), required cables, interfaces and accessories are ordered as needed.

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
150 (5.9)	14 (0.55)	15	445L-P4C0150FP	150 (5.9)	30 (1.18)	6	445L-P4E0150FP
300 (11.8)	14 (0.55)	30	445L-P4C0300FP	300 (11.8)	30 (1.18)	12	445L-P4E0300FP
450 (17.7)	14 (0.55)	45	445L-P4C0450FP	450 (17.7)	30 (1.18)	18	445L-P4E0450FP
600 (23.6)	14 (0.55)	60	445L-P4C0600FP	600 (23.6)	30 (1.18)	24	445L-P4E0600FP
750 (29.5)	14 (0.55)	75	445L-P4C0750FP	750 (29.5)	30 (1.18)	30	445L-P4E0750FP
900 (35.4)	14 (0.55)	90	445L-P4C0900FP	900 (35.4)	30 (1.18)	36	445L-P4E0900FP
1050 (41.3)	14 (0.55)	105	445L-P4C1050FP	1050 (41.3)	30 (1.18)	42	445L-P4E1050FP
1200 (47.2)	14 (0.55)	120	445L-P4C1200FP	1200 (47.2)	30 (1.18)	48	445L-P4E1200FP

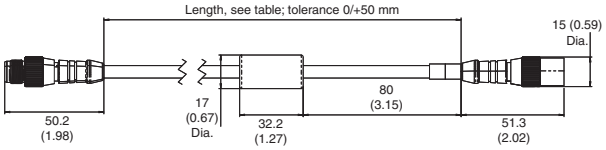
IMPORTANT The GuardShield Micro 400 requires a dedicated controller (MSR41 or MSR42) as well as transmitter and receiver patchcords.

Cascadable System

The Allen Bradley Guardmaster GuardShield Cascadable Micro 400 safety light curtains are offered in limited protective heights in 14 mm and 30 mm resolutions.They are most commonly ordered as pairs (cascadable transmitter and cascadable receiver) and are shipped under one part number. Each GuardShield Cascadable Micro 400 pair is shipped with mounting brackets. After selecting the appropiate cascadable pair cat. no., ensure that the dedicated safety controller (MSR41 or MSR42), appropiate cables, interfaces and accessories are ordered as well.

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.	Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
150 (5.9)	14 (0.55)	15	445L-C4C0150FP	150 (5.9)	30 (1.18)	6	445L-C4E0150FP
300 (11.8)	14 (0.55)	30	445L-C4C0300FP	300 (11.8)	30 (1.18)	12	445L-C4E0300FP
450 (17.7)	14 (0.55)	45	445L-C4C0450FP	600 (23.6)	30 (1.18)	24	445L-C4E0600FP
600 (23.6)	14 (0.55)	60	445L-C4C0600FP	900 (35.4)	30 (1.18)	36	445L-C4E0900FP
900 (35.4)	14 (0.55)	90	445L-C4C0900FP	1200 (47.2)	30 (1.18)	48	445L-C4E1200FP
1200 (47.2)	14 (0.55)	120	445L-C4C1200FP	—			

Micro 400 Patchcord for Interconnecting Cascaded Segments (if required)



Cascadable Patchcords

Description	Cat. No.
1 m (39.37 in.) patchcord	445L-AC8PC1
3 m (118.11 in.) patchcord	445L-AC8PC3
5 m (196.85 in.) patchcord	445L-AC8PC5

POC Type 4 Safety Light Curtains

GuardShield Micro 400

Micro 400 IP69K Light Curtains

The GuardShield Micro 400 is offered with the transmitter and receiver sealed in clear acrylic tubes with an environmental rating of IP69K. These IP69K Micro 400 light curtains are factory sealed and are ordered as pairs. They are offered in a 14 mm resolution in protected heights of 300 mm (11.8 in.), 600 mm (23.6 in.), 900 mm (35.4 in.) and 1200 mm (47.2 in.) with an operating range of five meters.

The required MSR 41 or MSR42 controllers maintain the IP20 rating and must be mounted in a suitable enclosure.

The Micro 400 IP69K transmitter and receiver are both offered with eight pin M12 connectors at the end of 500 mm (19.8 in.) integrated cables. The patchcords to connect the transmitter and receiver to the controller are the same cat. no. and are offered in 3 m (9.8 ft), 5 m (16.4 ft), and 8 m (26.2 ft) lengths.

These patchcords are configured on one end with M12 connectors, which mate to the integrated pigtail connectors and RJ45 connectors on the opposite end. These connectors plug into the MSR41 or MSR42 controller.

Areas of Use

- Light assembly machines/equipment
- Semi-conductor
- Micro-electronics
- Pharmaceutical
- Filling systems
- Clean rooms
- Food processing



Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Cat. No.
300 (11.8)	14 (0.55)	30	445L-P4C0300KD
600 (23.6)	14 (0.55)	60	445L-P4C0600KD
900 (35.4)	14 (0.55)	90	445L-P4C0900KD
1200 (47.2)	14 (0.55)	120	445L-P4C1200KD

Required Micro 400 Controller—Select One

	Mounting	Size	Cat. No.
 *MSR41—ON/OFF*	35 mm DIN Rail	22.5 mm	**440R-P221AGS**
 *MSR42—Multi-functional module*	35 mm DIN Rail	22.5 mm	**440R-P226AGS-NNR**

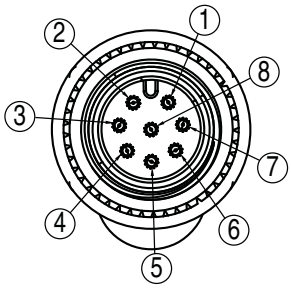
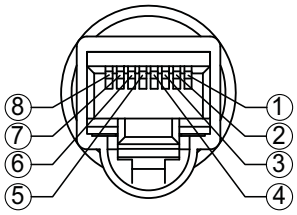
Optional Safety Relay Interfaces

Relay	Input Voltage	Reset	Outputs	Cat. No.
 MSR45E Safety Relay Expansion Model	Supplied by MSR41 or MSR42	Determined by MSR41 or MSR42	2 N.O.	**440R-P4NANS**

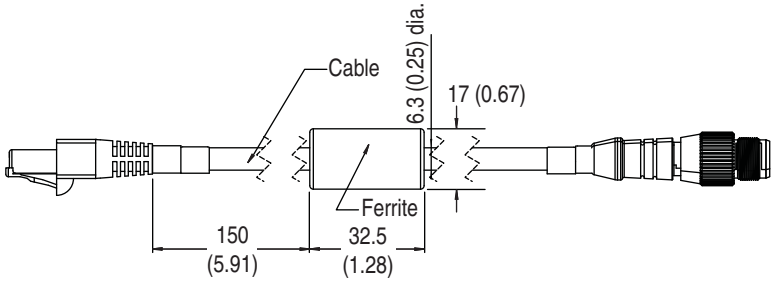
Possible Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**

Standard Micro 400 Patchcords—Required (Transmitters and receivers both use 8-pin M12 to RJ45 patchcords)

Face View M12 Connector	Face View RJ45 Connector	Description	Cat. No.
 Pinning table: 1: blue 2: grey 3: green 4: white 5: black 6: pink 7: brown 8: yellow Shield: Braid wires	Pinning table: 1: blue 2: grey 3: green 4: white 5: black 6: pink 7: brown 8: yellow Shield: Braid wires 	1 m patchcord, PVC jacket	445L-AC8RJ1
		2 m patchcord, PVC jacket	445L-AC8RJ2
		3 m patchcord, PVC jacket	445L-AC8RJ3
		5 m patchcord, PVC jacket	445L-AC8RJ5
		8 m patchcord, PVC jacket	445L-AC8RJ8

Patchcord [mm (in.)]



Optional Safety Relay Interface (accessories for MSR41 or MSR42 Controllers)

The MSR41 or MSR42 can have up to three MSR45E safety relays inter-connected. Each module requires a ribbon cable connector to make the interconnection. The table shows the cat. no. for each ribbon cable connector as well as the optical interface for the programming of the MSR42. Programming of the MSR42 is only necessary for advanced operating modes or connection of additional devices.

Description		Cat. No.
	Ribbon cable—for one MSR45E	**440R-ACABL1**
	Ribbon cable—for two MSR45Es	440R-ACABL2
	Ribbon cable—for three MSR45Es	440R-ACABL3
	USB optical interface software configuration tool used to configure the MSR42	**445L-AF6150**

Note: The configuration software can be downloaded at *www.ab.com/safety*.

Optional Accessories

Description		Cat. No.
	Adjustable 180° bracket kit (two per kit) supplied with each pair Two kits required per pair	445L-AF6143
	Flat bracket kit (two per kit) Two kits per pair	445L-AF6145
	Adjustable flat bracket (two per kit) Two kits required per pair	445L-AF6149
	IP69K mounting bracket kit (two kits per pair supplied with each pair)	445L-AF6160

Corner Mirror for Multi-Sided Guarding

Specially constructed glass mirrors for 2- and 3-sided safeguarding applications.

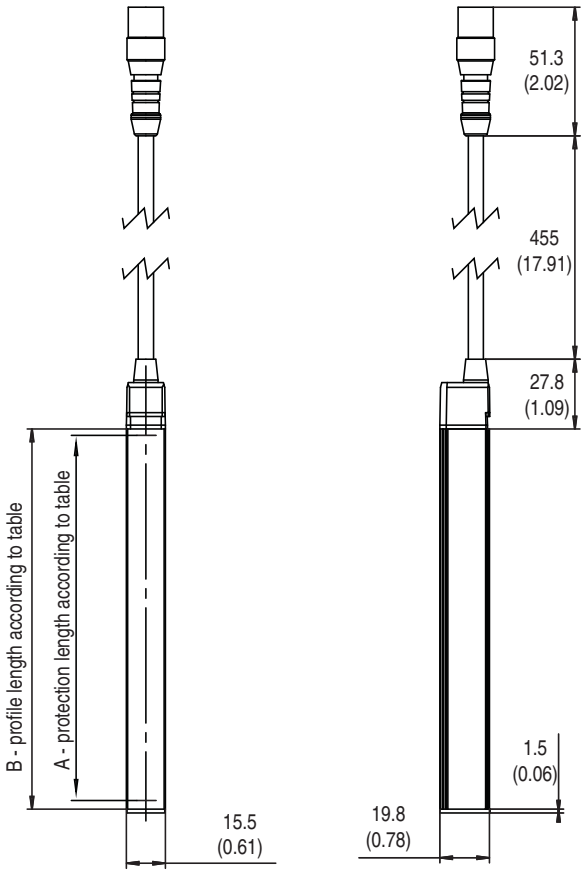
IMPORTANT Each mirror reduces maximum scan range by 10% per mirror.

GuardShield Micro 400 Protected Height [mm (in.)]	Narrow Mirror Short-Range 0…4 m	Cat. No.
150 (5.9)/300 (11.8)		440L-AM0750300
450 (17.7)		440L-AM0750450
600 (23.6)		440L-AM0750600
750 (29.5)		440L-AM0750750
900 (35.4)		440L-AM0750900
1050 (41.3)		440L-AM0751050
1200 (47.2)		440L-AM0751200

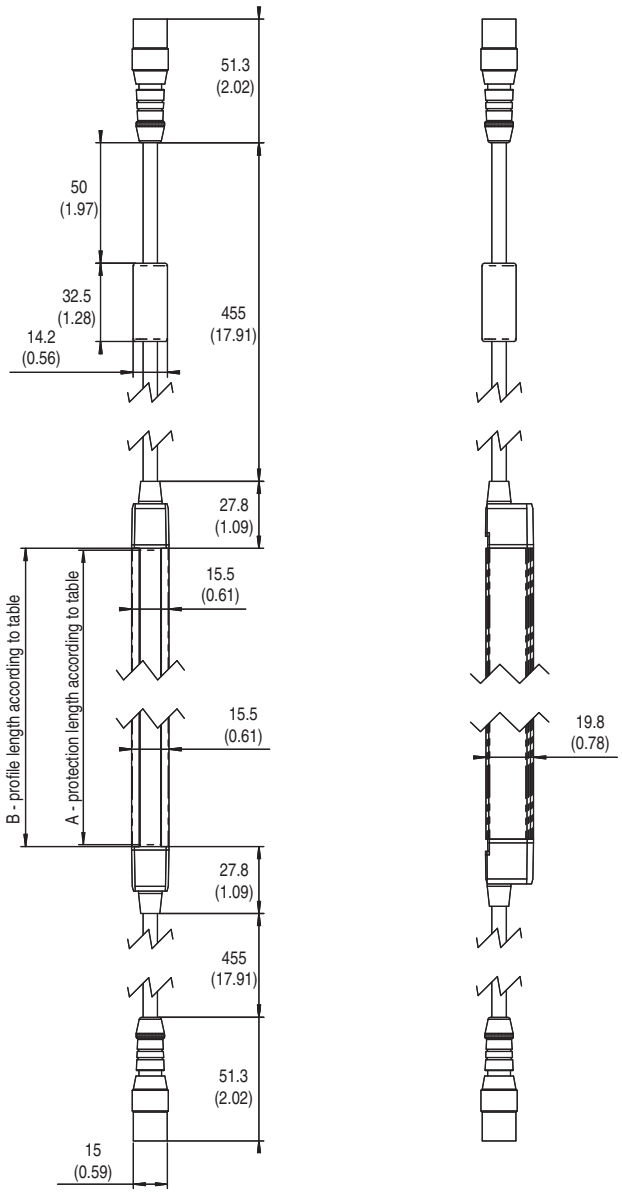
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Safety Light Curtains—Standard



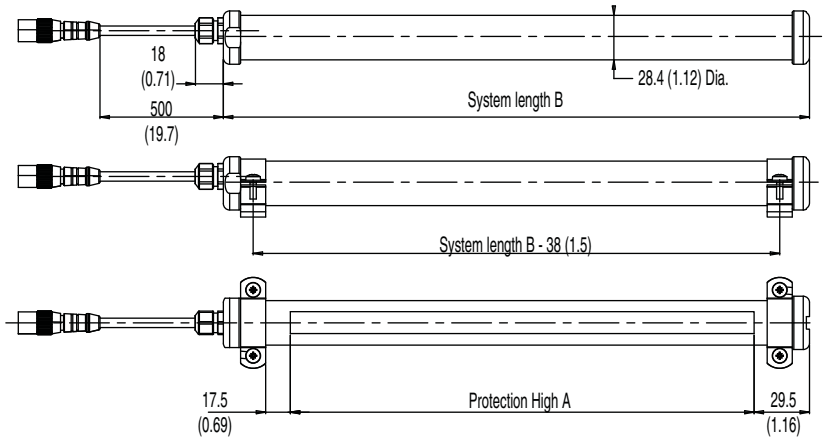
Safety Light Curtains—Cascadable



Type	A Protective Height [mm]	B Profile Length [mm]
445L-❄4‡0150FB	150	151.5 ±0.3
445L-❄4‡0300FB	300	301 ±0.3
445L-❄4‡0450FB	450	451 ±0.3
445L-❄4‡0600FB	600	601 ±0.3
445L-❄4‡0750FB	750	751 ±0.3
445L-❄4‡0900FB	900	901 ±0.3
445L-❄4‡1050FB	1050	1051 ±0.3
445L-❄4‡1200FB	1200	1201 ±0.3

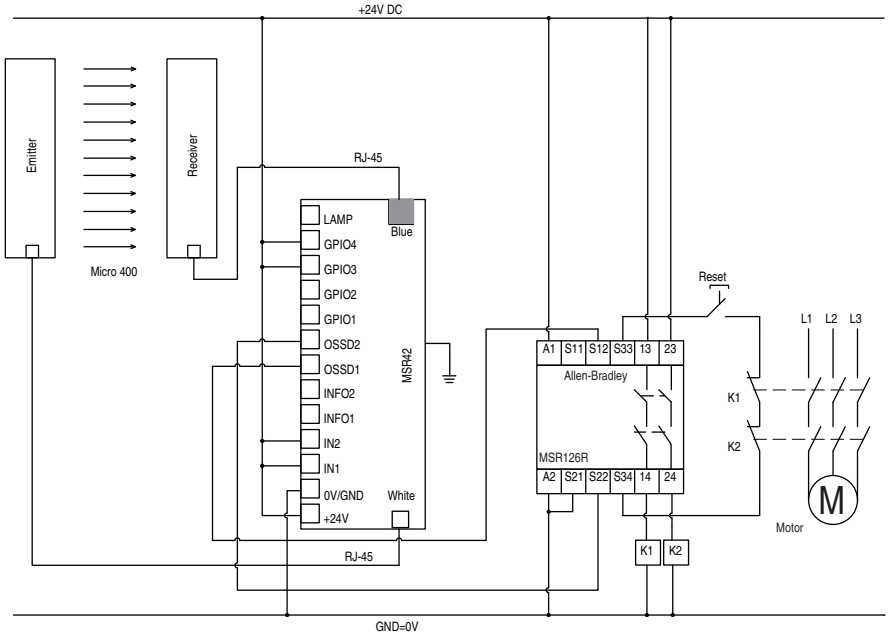
❄ P = Standard pair, C = Cascadable pair
‡ C = 14 mm, E = 30 mm

IP69K Micro 400



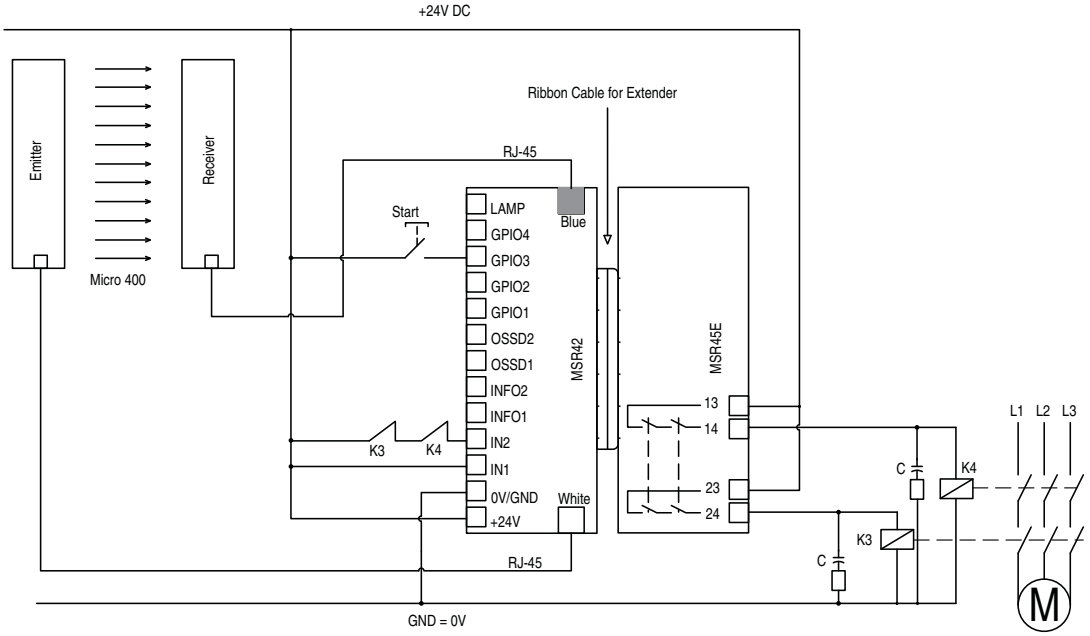
Wiring Diagram for Connection to MSR126 Relay

Wiring diagram is not intended to be used for installation purposes.



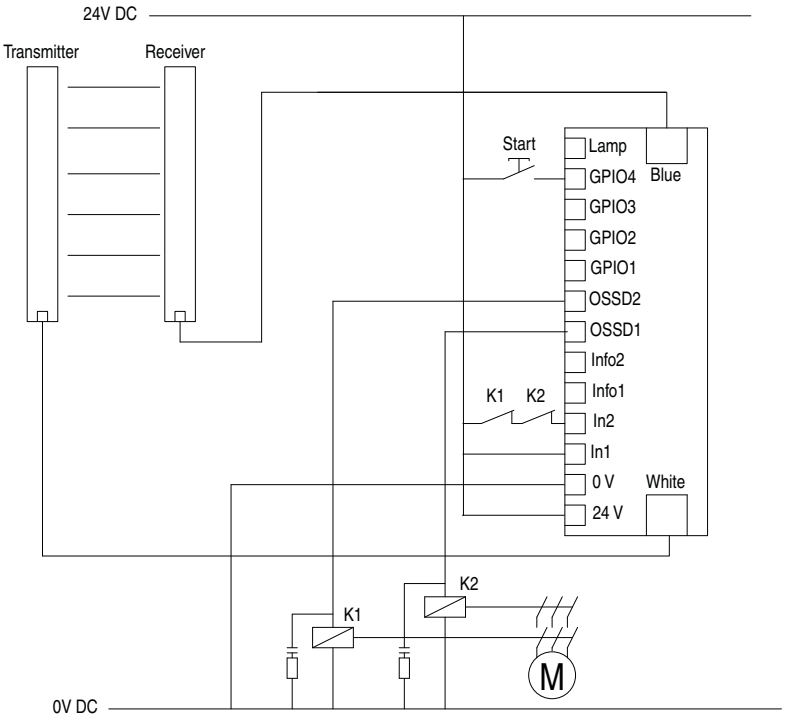
Micro 400 with MSR42 and MSR126R for Monitored Manual Reset with Monitored Output

Wiring Diagram for Connection to MSR45E Expansion Module



Micro 400 with MSR42 Add-on MSR45E for Manual Reset with Start Release

Wiring Diagram for Connection of MSR42 to Contactor if EDM Is Activated



POC Type 2 Safety Light Curtains

GuardShield Type 2

Overview

The Allen-Bradley Guardmaster GuardShield Type 2 safety light curtain is a new addition to the ABGM portfolio of Opto-Electronic safety devices. The “Type 2” designation means that this particular safety light curtain meets a lesser requirement for performance under fault conditions than the GuardShield Type 4. As a result, the GuardShield Type 2 safety light curtain can only be applied in applications where a formal risk assessment has determined that a Type 2 device is sufficient to meet the level of risk posed by the hazard.

There are a number of regulations that discuss risk assessment. The US based methods of conducting risk assessments which provide guidance for the determination of the level of risk to personnel can be found as follows:

- ANSI TR3—for machinery
- ANSI/RIA 15.05—for the Robotics industry
- ANSI/ISO 12100-1 Safety of Machinery

Typically in North America the use of Type 2 light curtains is not allowed for machinery or equipment covered by ANSI/OSHA regulations and standards whose requirement for performance under fault conditions is "control reliability." Type 2 light curtains do not meet the requirements of "control reliability."

The European Union requires the Risk Assessment be performed per EN ISO 14121 "Principles for Risk Assessment."

Safeguarding of the machine must be appropriate to the foreseeable risks and identified hazards. The level(s) of risk determined from the completion of a formal risk assessment indicate the level of the safety device required. In many instances it is necessary to use a combination of safety devices for adequate protection of personnel from hazards based on the risk assessment.

What Is "Type 2" and "Type 4"

Three types of safety ESPEs (Electro-Sensitive Protective Equipment) are defined within International and European standard IEC/EN 61496 Parts 1 and 2. This standard specifies the requirements for the design, construction, testing and performance of ESPEs—designed specifically to detect persons as part of a safety related system. The three types differ in their performance in the presence of faults and under influences from environmental conditions.

A Type 2 safety light curtain requires:

- A single fault resulting in the loss of detection capability,
- Failure of the OSSDs to go to the OFF state,
- Shall cause the light curtain to lock out as a result of the cycling of power, the next periodic test, or the interruption of the sensing function.

A Type 2 device requires the need for a periodic test of the system prior to a demand on the system, i.e., interruption of the light curtain's sensing field. This periodic test may be initiated by a simple manually operated switch (e.g., pushbutton) or by a more complex automatically controlled PLC.

Ideally the periodic test will be twice the operator interface frequency of exposure to the hazard.

The Type 4 device is required to detect a fault in its safety circuitry and immediately switch to a lock-out condition when the fault occurs. The fault detection is assured through diverse redundancy and cross monitoring of the internal circuit. A Type 4 device will fail to a safe state in the presence of an accumulation of undetected faults.

IMPORTANT	Type 2 safety light curtains do not meet OSHA regulations nor ANSI published standards, which define the requirements of “Control Reliability,” therefore it is not allowable to use a Type 2 safety light curtain device on equipment or machinery that requires “Control Reliability.”



Description

The Allen-Bradley Guardmaster GuardShield Type 2 safety light curtain is a self contained “two box,” Type 2 safety light curtain. Designed for use on or around machinery in which a formal risk assessment has determined that a Type 2 safety device is of a sufficient level of safety to meet the guarding application, the GuardShield Type 2 is the ideal solution. GuardShield Type 2 is offered in either a “Guard Only” operating mode or in a factory configured operating mode of restart interlock with external device monitoring. In either operating mode, the GuardShield Type 2 safety light curtain will provide the appropriate level of protection to personnel.

The GuardShield Type 2 is designed to protect personnel from equipment or machinery hazards where the risk of injury are low. A formal risk assessment should be performed prior to selecting the proper safeguarding device. In many instances it is necessary to use a combination of safety devices to assure complete protection of personnel from hazards.

ATTENTION 	Safety light curtains of a Type 2 level of safety typically do not meet OSHA or ANSI requirements of “Control Reliability,” therefore it is not allowable to use a safety device of a Type 2 level on or around equipment or machinery that requires “Control Reliability.”

Applications

- Conveyors
- Packaging machinery (excluding palletizers)
- Textile machinery
- Automated assembly lines
- Automatic storage and retrieval machinery

Specifications

Safety Ratings	
Standards	IEC/EN 61496 Parts 1 & 2, UL 61496 Parts 1 & 2, UL 1998
Safety Classification	Type 2 per IEC/EN61496. Category 2 device per EN 954-1, SIL 2 per IEC 61508, PLd per EN/ISO 13849
Certifications	CE Marked for all applicable directives, UL 1998 Listed, cULus Listed, and TÜV
Power Supply	
Input Power, Max.	24V DC ±20%
Maximum Residual Ripple	0.05 Vss
Power Consumption	400 mA max (no load)
Outputs	
Safety Outputs	2 OSSDs, 0.5 A, short-circuit protected
Non-Safety Outputs	1 auxiliary output, 0.5 A max.
Output Voltage, Min.	U_v - 2V
Switching Current @ Voltage, Min.	500 mA @ 24V DC
Operating Characteristics	
Response Time	20 ms
Status Indicators	On state, off state, alignment, interlock
Protected Height—mm (in)	160…1760 (6.3…69.36) in 160 (6.3) increments
Resolution [mm (in.)]	30 (1.18)
Scanning Range	16 m (52.5 ft)
Synchronization	Optical, without separate synchronization channel
Wavelength	870 nm
Environmental	
Enclosure Type Rating	IP65
Relative Humidity	15…95% (noncondensing)
Operating Temperature [C (F)]	-10…55° (14…131°)
Vibration	IEC 60068-2-6, frequency, 10…55 Hz Amplitude: 0.35 mm (0.01 in.)
Shock	IEC 60068-2-29 acceleration 10 g, pulse duration 16 ms
Physical Characteristics	
Mounting	End-cap mounting brackets
Weight	Varies by protective height
Housing Cross Section	40 x 50 mm (1.57 x 1.96 in.)
Connection Type	Transmitter: 4-pin micro QD Receiver: 8-pin micro QD
Cable Length	30 m (100 ft) max.

POC Type 2 Safety Light Curtains

GuardShield Type 2

Product Selection

Standard System

The Allen-Bradley Guardmaster GuardShield safety light curtains are ordered as pairs—transmitter and receiver—and are shipped under one part number. Each GuardShield Type 2 transmitter and receiver is packaged with two right angle mounting brackets. After selecting the appropriate light curtain pair, ensure that required interfaces and accessories are ordered.

Resolution [mm (in.)]	Number of Beams	Protective Height—mm (in)	Pair Weight [kg (lb)]	Cat. No.	
				Guard Only	Restart Interlock with EDM
30 (1.18)	8	160 (6.3)	0.9 (1.9)	440L-P2KA0160YD	440L-P2KD0160YD
30 (1.18)	16	320 (12.6)	1.1 (2.4)	440L-P2KA0320YD	440L-P2KD0320YD
30 (1.18)	24	480 (18.9)	1.6 (3.5)	**440L-P2KA0480YD**	440L-P2KD0480YD
30 (1.18)	32	640 (25.2)	2.0 (4.4)	**440L-P2KA0640YD**	440L-P2KD0640YD
30 (1.18)	40	800 (31.5)	2.5 (5.5)	440L-P2KA0800YD	440L-P2KD0800YD
30 (1.18)	48	960 (37.8)	2.9 (6.4)	440L-P2KA0960YD	440L-P2KD0960YD
30 (1.18)	56	1120 (44.1)	3.4 (7.5)	440L-P2KA1120YD	440L-P2KD1120YD
30 (1.18)	64	1280 (50.4)	3.8 (8.4)	440L-P2KA1280YD	440L-P2KD1280YD
30 (1.18)	72	1440 (56.7)	4.3 (9.5)	440L-P2KA1440YD	440L-P2KD1440YD
30 (1.18)	80	1600 (63.0)	4.7 (10.4)	440L-P2KA1600YD	440L-P2KD1600YD
30 (1.18)	88	1760 (69.1)	5.2 (11.5)	440L-P2KA1760YD	440L-P2KD1760YD

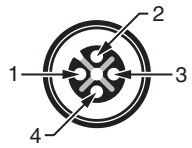
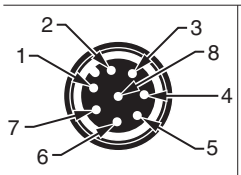
Note: The GuardShield transmitter requires a 4-pin cable and the receiver requires an 8-pin cable.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

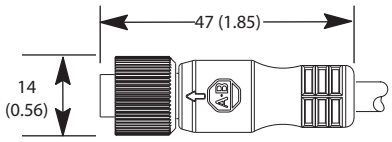
Note: The use of a category 4 safety relay module does not improve the category rating of the safety system beyond the category 2 rating of the Type 2 GuardShield light curtain.

Cordsets—Two Required (one for transmitter and one for receiver)

Female Connector (Sensor End)		Cable			
Face View of Female	Connector Style	Pin/Wire Color	Wire Rating	Length [m (ft)]	Cat. No.
Transmitter					
	Straight Female	1 Brown 2 White 3 Blue 4 Black	22 AWG 300V 4 A	2 (6.56)	889D-F4AC-2
				5 (16.4)	889D-F4AC-5
				10 (32.8)	889D-F4AC-10
				15 (49.2)	889D-F4AC-15
				20 (65.6)	889D-F4AC-20
				30 (98.4)	889D-F4AC-30
Receiver					
	Straight Female	1 White 2 Brown 3 Green 4 Yellow 5 Grey 6 Pink 7 Blue 8 Red	24 AWG 30V AC/36V DC 1.5 A	2 (6.56)	889D-F8AB-2
				5 (16.4)	889D-F8AB-5
				10 (32.8)	889D-F8AB-10
				15 (49.2)	889D-F8AB-15
				20 (65.6)	889D-F8AB-20
				30 (98.4)	889D-F8AB-30

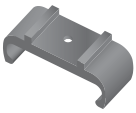
Cordsets Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Straight Female

Optional Accessories

Description		Cat. No.
	Steel L-shaped end cap mounting bracket (4 per package) **Note:** 4 brackets supplied with each GuardShield pair.	440L-AF6101 (1 package per system)
	Aluminum middle mounting bracket for vibratory applications	**440L-AF6108** (1 package per system)
	Power Supply: Output 24V DC, 3 Amps, 72 W	1606-XLP72E
	Laser alignment tool	**440L-ALAT**
	GuardShield laser alignment tool bracket	**440L-AF6109**
	Mounting stand	**440L-AMSTD**
	GuardShield weld shield (cat. no. is for a pair of light curtains)	440L-AGWS0160
		440L-AGWS0320
		440L-AGWS0480
		440L-AGWS0640
		440L-AGWS0800
		440L-AGWS0960
		440L-AGWS1120
		440L-AGWS1280
		440L-AGWS1440
		440L-AGWS1600
		440L-AGWS1760
	Vertical shock mount kit	**440L-AF6120**
	Horizontal shock mount kit	440L-AF6121
	Middle vertical mount kit	440L-AF6122
	Middle horizontal mount kit	440L-AF6123

Corner Mirror for Multi-Sided Guarding

Specially constructed glass mirrors for 2- and 3-sided safeguarding applications.

Note: Each mirror reduces maximum scan range by approximately 15% per mirror.

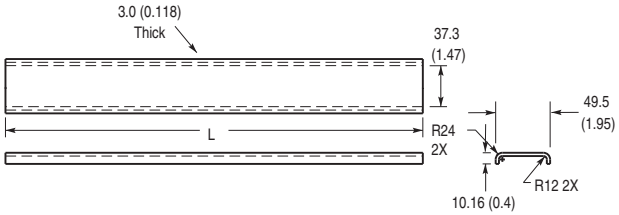
GuardShield Light Curtain Cat. No.	Narrow Mirror Short-Range 0…4 m	Cat. No.	Wide Mirror Long-Range 4…15 m	Cat. No.
440L-P2K‡0160YD		440L-AM0750300		440L-AM1250300
440L-P2K‡0320YD		440L-AM0750450		440L-AM1250450
440L-P2K‡0480YD		440L-AM0750600		440L-AM1250600
440L-P2K‡0640YD		440L-AM0750750		440L-AM1250750
440L-P2K‡0800YD		440L-AM0750900		440L-AM1250900
440L-P2K‡0960YD		440L-AM0751050		440L-AM1251050
440L-P2K‡1120YD		440L-AM0751200		**440L-AM1251200**
440L-P2K‡1280YD		440L-AM0751350		440L-AM1251350
440L-P2K‡1440YD		440L-AM0751500		440L-AM1251500
440L-P2K‡1600YD		440L-AM0751650		440L-AM1251650
440L-P2K‡1760YD		440L-AM0751800		440L-AM1251800

‡ = A or D

Weld Shields

The GuardShield weld shields are sold as pairs in the same lengths as the protective heights of the GuardShield safety light curtain.

These polycarbonate weld shields are designed as disposable devices whose purpose is to protect the front window of the GuardShield from damage.

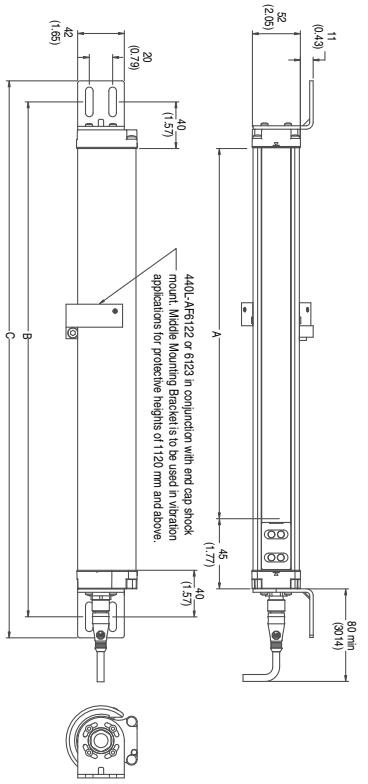


Dimensions "L"—mm (in)	Cat. No.
175.3 (6.9)	440L-AGWS0160
335.3 (13.2)	440L-AGWS0320
495.3 (19.5)	440L-AGWS0480
655.3 (25.8)	440L-AGWS0640
815.3 (32.1)	440L-AGWS0800
975.4 (38.4)	440L-AGWS0960
1135.4 (44.7)	440L-AGWS1120
1295.4 (51.0)	440L-AGWS1280
1455.4 (57.3)	440L-AGWS1440
1615.4 (63.6)	440L-AGWS1600
1778 (70.0)	440L-AGWS1760

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Safety Light Curtain

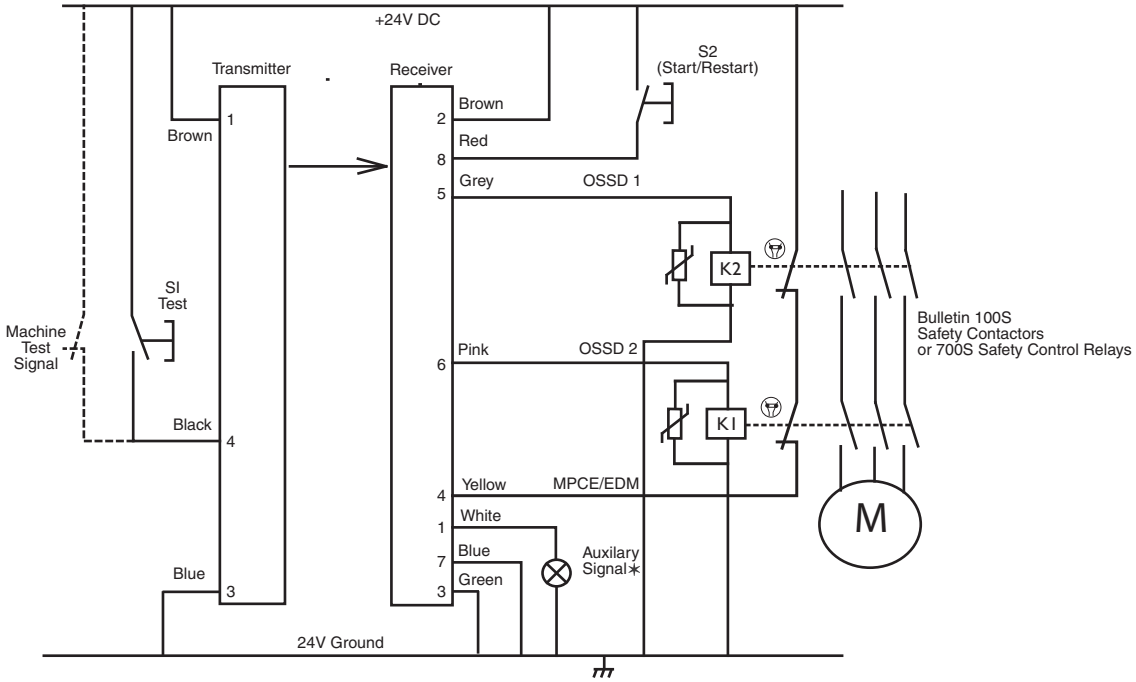


Type	A Protective Height [mm]	B Mounting Value [mm]	C Total Length [mm]
440L-P2K∗0160YD	160 ±0.5	285	321 ±1.5
440L-P2K∗0320YD	320 ±0.5	445	481 ±1.5
440L-P2K∗0480YD	480 ±0.5	605	641 ±1.5
440L-P2K∗0640YD	640 ±0.5	765	801 ±1.5
440L-P2K∗0800YD	800 ±0.5	925	961 ±1.5
440L-P2K∗0960YD	960 ±0.5	1085	1121 ±1.5
440L-P2K∗1120YD	1120 ±0.5	1245	1281 ±1.8
440L-P2K∗1280YD	1280 ±0.5	1405	1441 ±1.8
440L-P2K∗1440YD	1440 ±0.5	1565	1601 ±1.8
440L-P2K∗1600YD	1600 ±0.5	1725	1636 ±2.0
440L-P2K∗1760YD	1760 ±0.5	1885	1112 ±1.5

∗ A for Guard Only or D for Restart Interlock with EDM.

Wiring Diagram for Connection of OSSDs Directly to Contactors (FSDs) fpr GuardShield Type with EDM and Restart Interlock

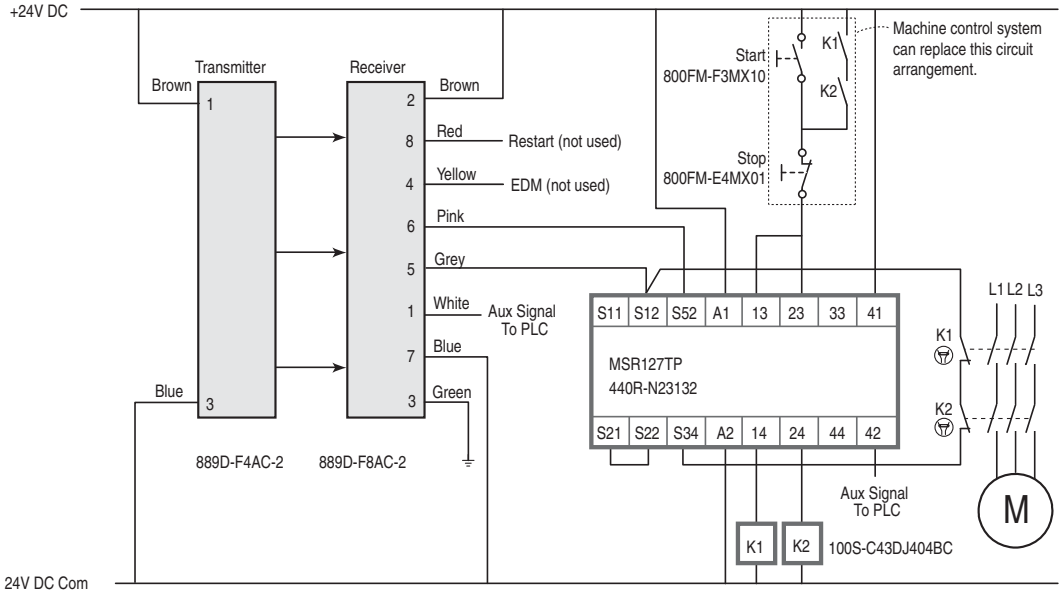
Wiring diagram is not intended to be used for installation purposes.



* Auxiliary output is nonsafety. Can be connected to a lamp, motor or status to a PLC.

K1, K2	Safety relay or safety contactor for OSSD 1 and OSSD 2 connection
S1	Switch for external system test (optional)
S2	Switch for reset of light curtain from start/restart interlock

Wiring Diagram for Connection of OSSDs Directly to a Safety Relay Module



POC Type 2 Safety Light Curtains

GuardShield Safe 2



Description

The Allen-Bradley Guardmaster GuardShield Safe 2 safety light curtain is a new addition to the Allen-Bradley Guardmaster portfolio of opto-electronic safety devices. The “Type 2” designation means that this particular safety light curtain meets a lesser requirement for performance under fault conditions than the GuardShield Type 4 safety light curtains. As a result, the GuardShield Type 2 safety light curtain can only be applied in applications where a formal risk assessment has determined that a Type 2 device is sufficient to meet the level of risk posed by the hazard.

The GuardShield Safe 2 safety light curtain is a self-contained two-box, safety light curtain in a robust housing with an integrated laser alignment system. The integrated laser alignment system generates two visible beams of light which simplifies alignment of the light curtain pair.

This economical opto-electronic Type 2 safety light curtain is offered in a guard-only mode of operation and is designed for use on or around machinery or equipment where a formal risk assessment has determined that a Type 2 safety device is of a sufficient level of safety to meet the guarding application.

ATTENTION 	Safety light curtains of a Type 2 level of safety typically do not meet OSHA or ANSI requirements of “Control Reliability,” therefore it is not allowable to use a safety device of a Type 2 level on or around equipment or machinery that requires “Control Reliability.”

Features

- M12 connectors
- Optically synchronized
- Integrated laser alignment system
- IP65 enclosure rating
- Simple Installation
- cULus Listed and CE Marked for all applicable directives

Applications

- Conveyors
- Textile machinery
- Automatic storage and retrieval machinery
- Automated assembly lines

Specifications

Safety Ratings	
Standards	IEC/EN61496 Parts 1 and 2, UL61496 Parts 1 and 2, UL1998
Safety Classification	Type 2 per IEC/EN61496. Category 2 device per EN 954-1, SIL 2 per IEC 61508, PLd per EN/ISO 13849
Certifications	cULus Listed, TÜV, and CE Marked for all applicable directives
Power Supply	
Input Power, Max.	24V DC ± 20% (U_{sp})
Maximum Residual Ripple	< 10% of U_{sp}
Power Consumption	<500 mA (no load)
Outputs	
Safety Outputs	2 PNP OSSD. 0.3 A, short-circuit protected
Output Voltage, Min.	U_{sp} -1
Switching Current @ Voltage, Min.	300 mA @ 24V DC
Operating Characteristics	
Response Time	Varies by protective height
Indicator LEDs	ON -State, OFF-State, internal error
Protected Height [mm (in.)]	120…1920 mm (4.7…75.6 in.) in 120 mm (4.7 in.) increments
Resolution [mm (in.)]	30 mm (1.18 in.)
Scanning Range	0…18 m (0…59 ft)
Synchronization	Optical, first beam adjacent to LEDs
Wavelength	950 nm
Environmental	
Enclosure Type Rating	IP65
Relative Humidity	15…95% (noncondensing)
Operating Temperature [C (F)]	0…55 ° (0…131 °)
Vibration	IEC 60068-2-6 frequency 10…55 Hz; amplitude 0.35 mm (0.01 in.)
Shock	IEC 60068-2-29; acceleration 10 g, pulse duration 16 ms 10…55 Hz; amplitude 0.35 mm (0.01 in.)
Physical Characteristics	
Mounting	Rear mounting, standard and adjustable (180°)
Weight	Varies by protective height
Housing Cross Section	30 x 40 mm (1.18 x 1.57 in.)
Connection Type	Transmitter: 5-pin M12 micro QD Receiver: 5-pin M12 micro QD
Cable Length	30 m (98.4 ft) max.
ILAS Laser Class	Class 2, IEC 60825-1

Product Selection

Standard System Safety Light Curtain

The Allen-Bradley Guardmaster GuardShield Safe 2 safety light curtains are offered in 30 mm resolution, are ordered as pairs—transmitter and receiver—and are shipped under one cat. no. Each GuardShield Safe 2 pair are shipped with 180° mounting brackets. After selecting the appropriate light curtain pair, ensure that the appropriate cables, interfaces, and accessories are ordered.

Protected Height [mm (in.)]	Resolution [mm (in.)]	Number of Beams	Pair Weight [kg (lbs)]	Cat. No.
120 (4.7)	30 (1.18)	8	1.0 (2.2)	445L-P2S0120YD
240 (9.4)	30 (1.18)	16	1.4 (3.09)	445L-P2S0240YD
360 (14.2)	30 (1.18)	24	1.8 (3.97)	445L-P2S0360YD
480 (19.9)	30 (1.18)	32	2.2 (4.85)	445L-P2S0480YD
600 (23.6)	30 (1.18)	40	2.6 (5.73)	445L-P2S0600YD
720 (28.3)	30 (1.18)	48	3.0 (6.61)	445L-P2S0720YD
840 (33.1)	30 (1.18)	56	3.5 (7.72)	445L-P2S0840YD
960 (37.8)	30 (1.18)	64	4.0 (8.82)	445L-P2S0960YD
1080 (42.5)	30 (1.18)	72	4.0 (8.82)	445L-P2S1080YD
1200 (47.2)	30 (1.18)	80	4.5 (9.92)	445L-P2S1200YD
1320 (52.0)	30 (1.18)	88	5.0 (11.02)	445L-P2S1320YD
1440 (56.7)	30 (1.18)	86	5.5 (12.13)	445L-P2S1440YD
1560 (61.4)	30 (1.18)	94	6.0 (13.23)	445L-P2S1560YD
1680 (66.1)	30 (1.18)	102	6.5 (14.33)	445L-P2S1680YD
1800 (70.9)	30 (1.18)	110	7.0 (15.43)	445L-P2S1800YD
1920 (75.6)	30 (1.18)	118	7.5 (16.53)	445L-P2S1920YD

Note: The cat. nos. listed above are pair cat. nos., to specify a transmitter or receiver only, replace the "P" in the cat. no. with a "T" for transmitter or an "R" for receiver.

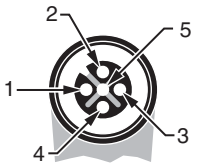
Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

Note: The use of a category 4 safety relay module does not improve the category rating of the safety system beyond the Category 2 rating of the Type 2 light curtain in use.

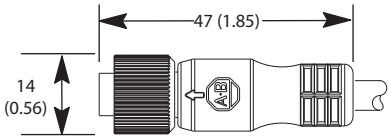
Cordsets—Transmitters and receivers both use 5-pin M12 cordsets

Note: Unshielded cordsets are most commonly used for safety light curtains, however, shielded cordsets are also offered to increase immunity to electrical interference.

Female Connector (Sensor End)		Cable			
Face View of Female	Connector Style	Pin/Wire Color	Wire Rating	Length [m (ft)]	Cat. No.
	Straight Female Nonshielded	1 Brown 2 White 3 Blue 4 Black 5 Grey	22 AWG 250V 4 A	2 (6.56)	889D-F5AC-2
				5 (16.4)	889D-F5AC-5
				10 (32.8)	889D-F5AC-10
				15 (49.2)	889D-F5AC-15
				20 (65.6)	889D-F5AC-20
				30 (98.4)	889D-F5AC-30
	Straight Female Shielded	1 Brown 2 White 3 Blue 4 Black 5 Grey	22 AWG 22 AWG 300V 4 A	2 (6.56)	889D-F5EC-2
				5 (16.4)	889D-F5EC-5
				10 (32.8)	889D-F5EC-10
				15 (49.2)	889D-F5EC-15
				20 (65.6)	889D-F5EC-20
				30 (98.4)	889D-F5EC-30

Cordsets Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Straight Female

Corner Mirror for Multi-Sided Guarding

Specially constructed glass mirrors for 2- and 3-sided safeguarding applications.

Note: Each mirror reduces maximum scan range by approximately 15% per mirror.

GuardShield Safe 2/Safe 4 Protected Height [mm (in.)]	Narrow Mirror Short-Range 0…4 m	Cat. No.	Wide Mirror Long-Range 4…15 m	Cat. No.
120/140 (4.7/9.4)		440L-AM0750300		440L-AM1250300
360 (14.2)		440L-AM0750450		440L-AM1250450
480 (19)		440L-AM0750600		440L-AM1250600
600 (24)		440L-AM0750750		440L-AM1250750
720/840 (28/33)		440L-AM0750900		440L-AM1250900
960 (38)		440L-AM0751050		440L-AM1251050
1080 (43)		440L-AM0751200		**440L-AM1251200**
1200 (47)		440L-AM0751350		440L-AM1251350
1320/1440 (52/57)		440L-AM0751500		440L-AM1251500
1560 (61)		440L-AM0751650		440L-AM1251650
1680 (66)		440L-AM0751800		440L-AM1251800
1800/1920 (70.9/75.6)		Not available		Not available

Optional Accessories

Description		Cat. No.
	Standard kit (4 pieces — supplied with each pair)	445L-AF6140
	180° Adjustable kit (two kits required per pair)	**445L-AF6141**
	Shock Mount Kit (2 kits required per pair of light curtains)	445L-AF6142
	Vertical mounting kit (two kits required per pair)	445L-AF6144
	MSR42 Multifunction Module (requires Cat. No. 440L-AF6150 to program)	**440R-P226AGS-NNR**
	MSR45E—Safety Relay for MSR41 or MSR42 (requires ribbon cable connection)	**440R-P4NANS**
	USB optical interface software configuration tool used to configure the MSR42	**445L-AF6150**
	Ribbon cable—for one MSR45E	**440R-ACABL1**
	Ribbon cable—for two MSR45Es	440R-ACABL2
	Ribbon cable—for three MSR45Es	440R-ACABL3
	Mounting stand	**440L-AMSTD**

Note: MSR42 operating software may be downloaded at *www.ab.com/safety*.

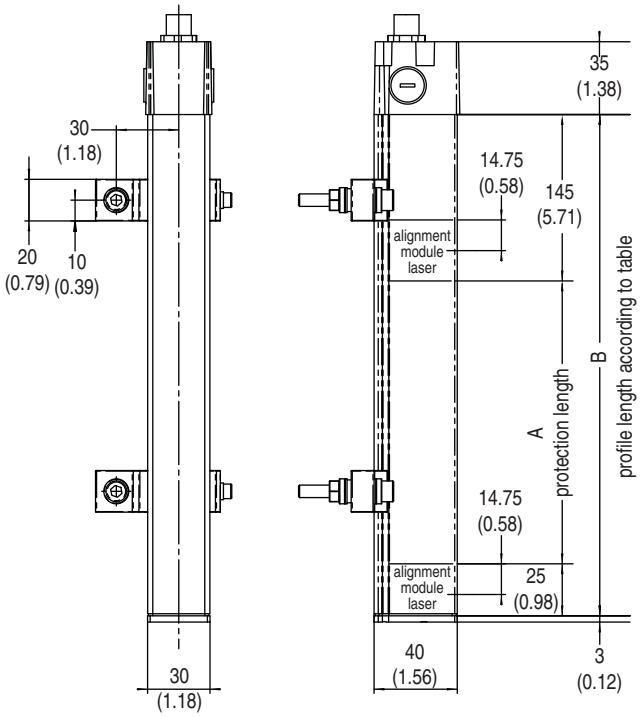
POC Type 2 Safety Light Curtains

GuardShield Safe 2

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

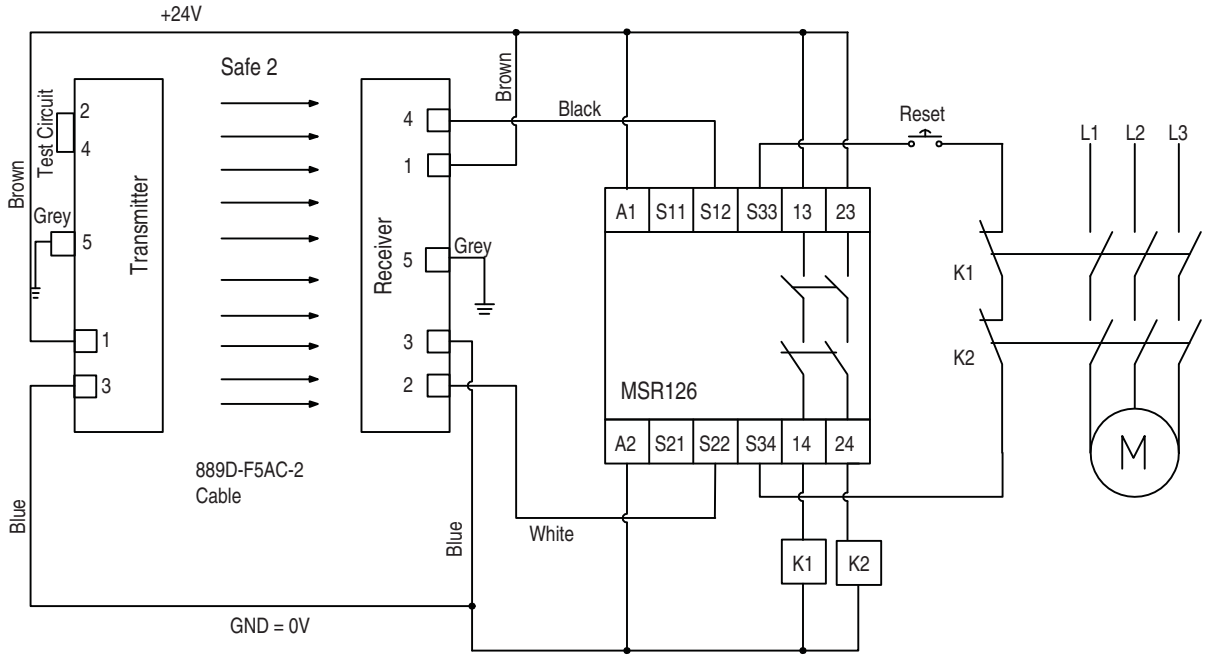
Safety Light Curtain



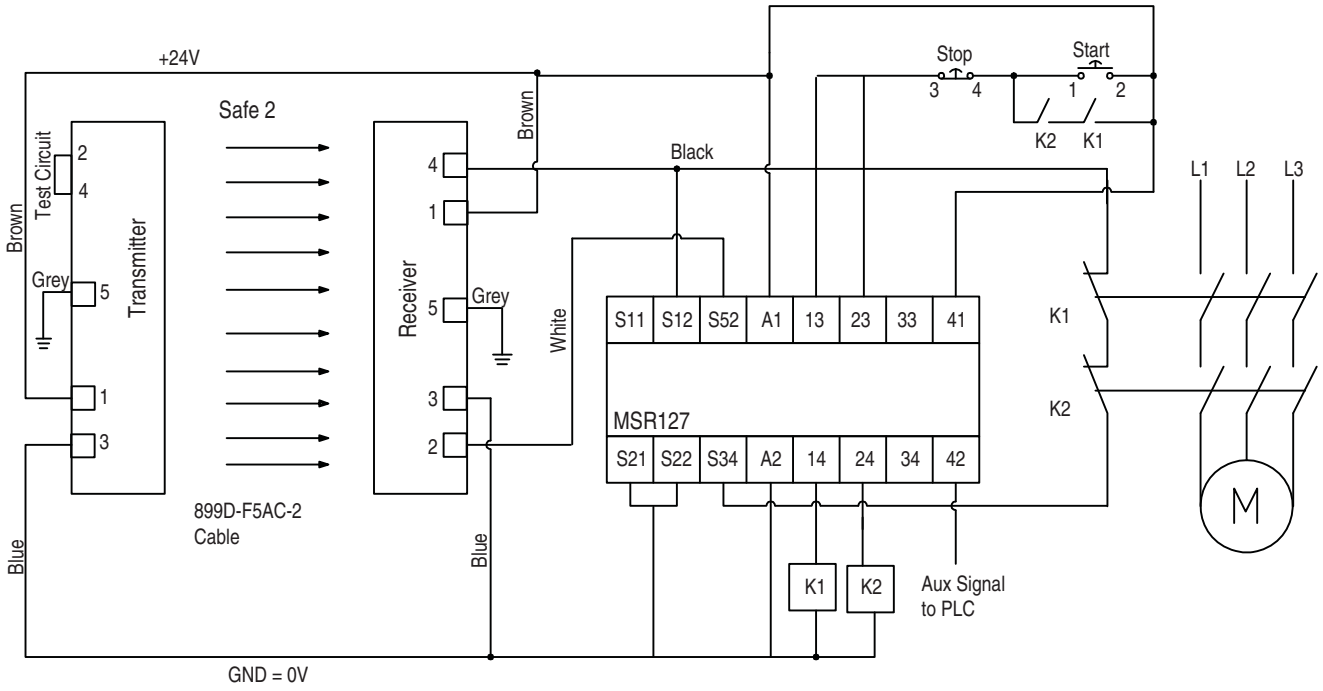
Type	A Protective Height [mm (in.)]	B Profile Length [mm (in.)]
445L-P2S0120YD	120 (4.7)	290 (11.4)
445L-P2S0240YD	240 (9.4)	410 (16.1)
445L-P2S0360YD	360 (14.2)	530 (20.9)
445L-P2S0480YD	480 (18.9)	650 (25.6)
445L-P2S0600YD	600 (23.6)	771 (30.4)
445L-P2S0720YD	720 (28.3)	891 (35.1)
445L-P2S0840YD	840 (33.1)	1011 (39.8)
445L-P2S0960YD	960 (37.8)	1131 (44.5)
445L-P2S1080YD	1080 (42.5)	1252 (49.3)
445L-P2S1200YD	1200 (47.2)	1372 (54.0)
445L-P2S1320YD	1320 (51.9)	1492 (58.7)
445L-P2S1440YD	1440 (56.7)	1612 (63.5)
445L-P2S1560YD	1560 (61.4)	1733 (68.2)
445L-P2S1680YD	1680 (66.1)	1853 (72.9)
445L-P2S1800YD	1800 (70.8)	1973 (77.7)
445L-P2S1920YD	1920 (75.6)	2093 (82.4)

Wiring Diagram for Connection to MSR126

Wiring diagram is not intended to be used for installation purposes.

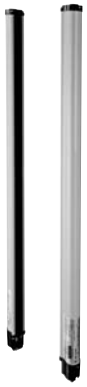


Wiring Diagram for Connection to MSR127



PAC Type 4 Safety Light Curtains

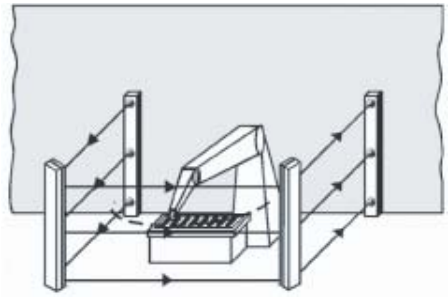
GuardShield PAC



Description

Standard GuardShield PAC

The Allen-Bradley Guardmaster GuardShield Perimeter Access Control (PAC) safety light curtain is a multiple beam, short range (0.3…16 m), Type 4 safety light curtain typically used to provide access detection at machine entry points. It is also possible to use the GuardShield PAC in perimeter guarding applications as an optoelectronic fence as long as the perimeter distance does not exceed the maximum range of 16 meters. Note that when using the GuardShield PAC with corner mirrors for multiple sided guarding, each mirror reduces the maximum scan range of 16 meters by approximately 15%.



The GuardShield PAC safety light curtain is designed for whole body detection and is currently offered in two configurations: two beams at 500 mm spacing and three beams at 400 mm spacing.

GuardShield PAC with Integrated Laser Alignment System

The GuardShield PAC light curtains are offered with an integrated laser alignment system consisting of a Class 1, eye safe, constantly powered laser located in the top of the GuardShield PAC transmitter and at the bottom of the GuardShield PAC receiver. There are targets located across from each laser which help facilitate alignment of the light curtain when the laser is emitting visible light.

Each laser emits a low level of visible light. Simply placing a finger or opaque object in front of the laser reflects the laser light back to a photo sensor. This photo sensor causes the laser to switch state from a barely visible low level of emission to a higher level of emission of visible light. Interrupting the visible light below the finger symbol will cause the laser to change state back to a low level of light emission. The visible light will also change to a low level after five minutes.

The Integrated Laser Alignment system also quickly helps with the re-alignment of pairs when units are knocked out of alignment during the course of the work process or when corner mirrors are used.

ArmorBlock Guard I/O Connectivity

The GuardShield PAC light curtains are also offered with the integrated laser alignment system and connectivity to ArmorBlock Guard I/O. The receiver of these light curtains has a five-pin M12 quick disconnect connector wired to allow connection to the 1732DS ArmorBlock I/O module. This connectivity of the GuardShield PAC receiver allows the GuardShield's OSSDs to operate over a DeviceNet Safe network.

This version of the GuardShield has limited configurability, i.e., only beam coding can be configured by setting the appropriate DIP switches and performing the teach function. EDM, Start/Restart interlock as well as the auxiliary output are not available in these GuardShield PAC models.

The ArmorBlock Guard I/O can be used with any safety controller that communicates on DeviceNet using CIP Safety for the control and monitoring of safety circuits. ArmorBlock Guard I/O detects circuit failures at each I/O point while providing detailed diagnostics directly to the controller. With CIP Safety, you can easily integrate safety and standard control systems by using safety and standard messages on the same wire.

The 1732DS ArmorBlock Guard I/O family consists of 24V DC digital I/O modules that communicate on DeviceNet networks.

Features

- Beam coding
- External device monitoring (EDM)
- Machine test signal
- Start/restart interlock

Industries

- Material handling
- Packaging equipment
- Automotive
- Robot cells

Specifications

Safety Ratings	
Standards	IEC/EN 61496 Parts 1 & 2, UL 61496 Parts 1 & 2, UL 1998
Safety Classification	Type 4 per IEC/EN61496. Category 4 device per EN 954-1, SIL 3 per IEC 61508, PLe per EN/ISO 13849
Certifications	UL 61496, UL 1998, cULus Listed, TÜV and CE marked for all applicable directives
Power Supply	
Input Power, Max.	24V DC ±20%
Maximum Residual Ripple	0.05 Vss
Power Consumption	400 mA (no load)
Outputs	
Safety Outputs	2 x PNP, 0.5 A, short circuit protected
Non-Safety Outputs	1 x PNP 0.5 A max.
Output Voltage, Min.	U_v - 2V
Switching Current @ Voltage, Min.	500 mA @ 24V DC
Operating Characteristics	
Response Time	20 ms, 30 ms with beam coding activated
Status Indicators	On-state, off-state, alignment, interlock
Protected Height—mm (in)	3 beam = 820 (32.3); 2 beam = 520 (20.4)
Scanning Range	16 m (52.5 ft)
Synchronization	Optical, without separate synchronization channel. First beam adjacent to LEDs.
Wavelength	870 nm
Environmental	
Enclosure Type Rating	IP65
Relative Humidity	15%...95% (noncondensing)
Operating Temperature [C (F)]	-10…55° (14…131°)
Vibration	IEC60068-2-6, frequency 10…55 Hz Amplitude: 0.35 mm (0.01 in)
Shock	IEC60068-2-29 acceleration 10 g, pulse duration 16 ms
Physical Characteristics	
Mounting	End-cap mounting brackets
Weight	Varies by Cat. No.
Housing Cross Section	40 mm x 50 mm (1.57 in x 1.96 in)
Connection Type	Transmitter: 4-pin micro QD (M12) Receiver: 8-pin micro QD (M12)
Cable Length	30 m (100 ft) max.

PAC Type 4 Safety Light Curtains

GuardShield PAC

Product Selection

PAC Safety Light Curtains—Standard

The Allen-Bradley Guardmaster GuardShield PAC safety light curtains are ordered as a pair—transmitter and receiver—and are shipped under one Cat. No. After selecting the appropriate Cat. No. ensure that the required interfaces and accessories are ordered as well.

Protected Height [mm (in.)]	Beam Spacing	Number of Beams	Cat. No.
520 (20.4)	500 mm (19.7 in.)	2	440L-P4A2500YD
820 (32.3)	400 mm (15.7 in.)	3	**440L-P4A3400YD**

Note: The GuardShield transmitter requires a 4-pin cable and the receiver requires an 8-pin cable.
Note: To select a transmitter or receiver substitute the "P" in the above cat. nos. with a "T" for a transmitter or an "R" for a receiver.

GuardShield PAC with Integrated Laser Alignment

Protected Height [mm (in.)]	Beam Spacing	Number of Beams	Cat. No.
520 (20.4)	500 mm (19.7 in.)	2	440L-P4AL2500YD
820 (32.3)	400 mm (15.7 in.)	3	440L-P4AL3400YD

Note: The GuardShield transmitter requires a 4-pin cable and the receiver requires an 8-pin cable.
Note: GuardShields are sold in pairs. To select a transmitter or receiver, replace the "P" in the cat. no. with a "T" for a transmitter or an "R" for a receiver.

GuardShield PAC with Integrated Laser Alignment and I/O Connectivity

Protected Height [mm (in.)]	Beam Spacing	Number of Beams	Cat. No.
520 (20.4)	500 mm (19.7 in.)	2	440L-P4AL2500YA
820 (32.3)	400 mm (15.7 in.)	3	440L-P4AL3400YA

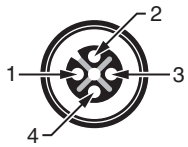
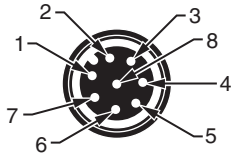
Note: GuardShields are sold in pairs. To select a transmitter or receiver, replace the "P" in the cat. no. with an "R" for a receiver. PAC with integrated laser alignment and I/O connectivity uses a standard transmitter. To order a transmitter, replace the "P" with a "T" and the last "A" with a "D" (example: 440L-T2500YD).

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

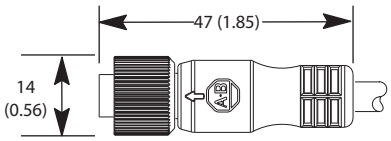
Note: The use of a category 4 safety relay module does not improve the category rating of the safety system beyond the Category 2 rating of the Type 2 light curtain in use.

Cordsets—Two Required (one for transmitter and one for receiver)

Female Connector (Sensor End)		Cable			
Face View of Female	Connector Style	Pin/Wire Color	Wire Rating	Length [m (ft)]	Cat. No.
Transmitter					
	Straight Female	1 Brown 2 White 3 Blue 4 Black	22 AWG 300V 4 A	2 (6.56)	889D-F4AC-2
				5 (16.4)	889D-F4AC-5
				10 (32.8)	889D-F4AC-10
				15 (49.2)	889D-F4AC-15
				20 (65.6)	889D-F4AC-20
				30 (98.4)	889D-F4AC-30
Receiver					
	Straight Female	1 White 2 Brown 3 Green 4 Yellow 5 Grey 6 Pink 7 Blue 8 Red	24 AWG 30V AC/36V DC 1.5 A	2 (6.56)	889D-F8AB-2
				5 (16.4)	889D-F8AB-5
				10 (32.8)	889D-F8AB-10
				15 (49.2)	889D-F8AB-15
				20 (65.6)	889D-F8AB-20
				30 (98.4)	889D-F8AB-30

Cordsets Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Straight Female

Accessories

Muting Sensors

Sensor Type	Connection Location	Type	Cat. No.
Retroreflective	Connected directly to muting module	Dark Switching	42GRU-9000-QD
Transmitted Beam	Receiver (connected directly to the muting module)		42GRR-9000-QD∗
Retroreflective	Connected directly to muting module		42GRU-9000-QD∗
Polarized Retroreflective	Three inch standard reflector		92-39
Polarized Retroreflective	Connected directly to muting module		42GRU-9200-QD∗
Polarized Retroreflective	Three inch standard reflector		92-39
Mechanical Limit Switch	Connected directly to muting module (operating lever must be selected separately)		802M-NX10∗
Muting lamp		Two cat. nos. make this assembly.	855E-24TL7
			855E-BVMC
∗Use with 4-pin, DC Micro cordset when connecting to muting module (5 m length shown). 1 m, 2 m, 3 m, and 5 m lengths available.			889D-F4AC-5

Accessories—Optional

Description		Cat. No.
	Steel L-shaped end cap mounting bracket (4 per package) **Note:** 4 brackets supplied with each GuardShield pair.	440L-AF6101 (1 package per system)
	Power Supply: Output 24V DC, 3 A, 72 W	1606-XLP72E
	Laser alignment tool	**440L-ALAT**
	GuardShield laser alignment tool bracket	**440L-AF6109**
	Mounting stand	**440L-AMSTD**
	GuardShield weld shield pair—3 beam	440L-AGWS0960
	GuardShield weld shield pair—2 beam	440L-AGWS0640
	Vertical shock mount kit	**440L-AF6120**
	GuardShield washdown enclosure kit—2 beam PAC	440L-AGST640
	GuardShield washdown enclosure kit—3 beam PAC	440L-AGST960

Note: The GuardShield washdown enclosure kits will not accommodate the GuardShield with Integrated Laser and with Inegrated Laser and ArmorBlock Guard I/O connectivity.

Corner Mirror for Multi-Sided Guarding

Specially constructed glass mirrors for 2- and 3-sided safeguarding applications.

Note: Each mirror reduces maximum scan range by 10% per mirror.

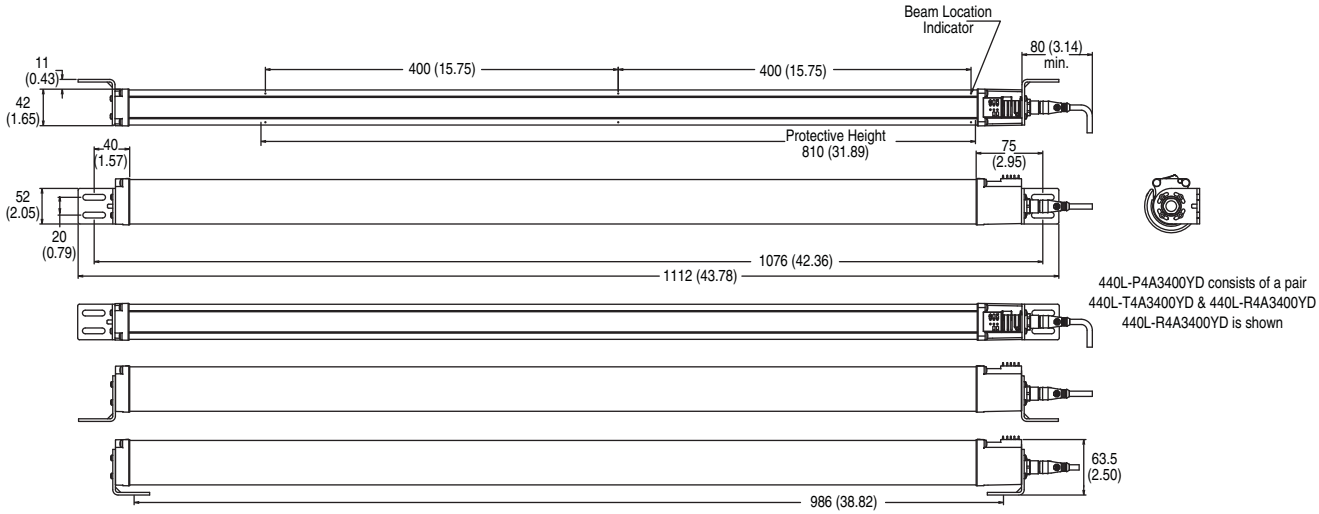
GuardShield Light Curtain Cat. No.	Narrow Mirror Short-Range 0…4 m	Cat. No.	Wide Mirror Long-Range 4…15 m	Cat. No.
440L-P4A2500YD		440L-AM0750750		440L-AM1250750
440L-P4A3400YD		440L-AM0751050		440L-AM1251050

Approximate Dimensions

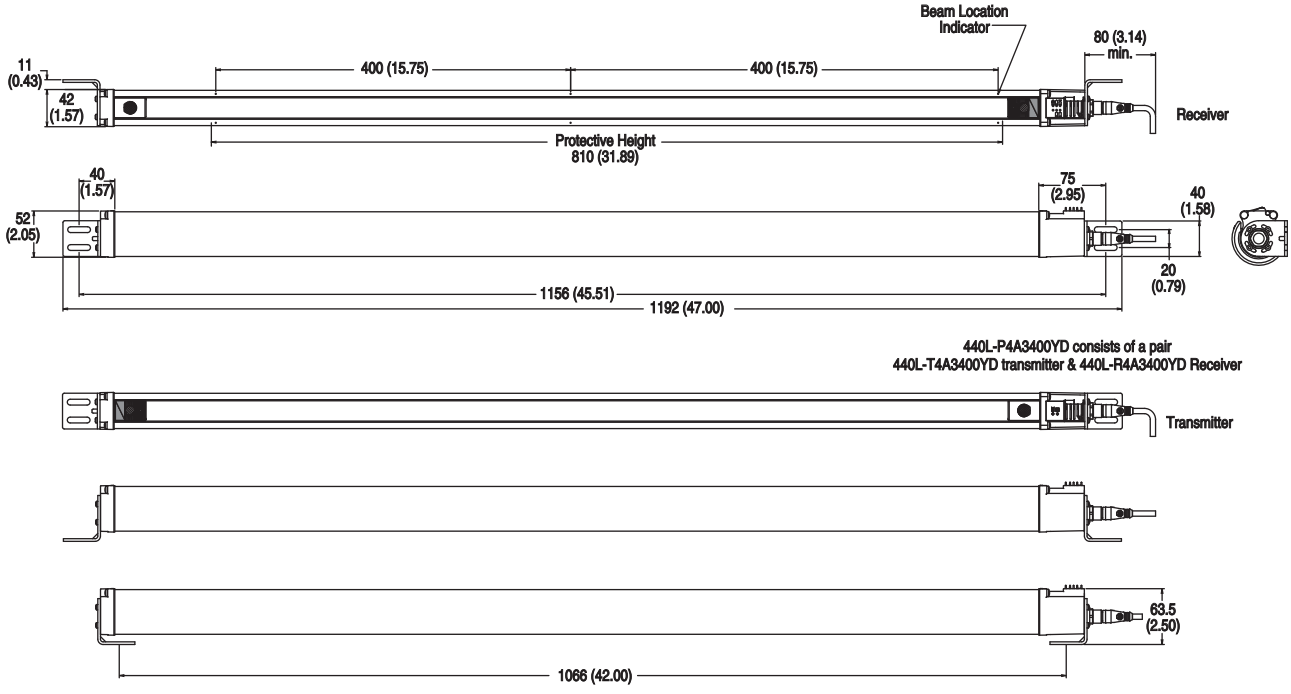
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Safety Light Curtain

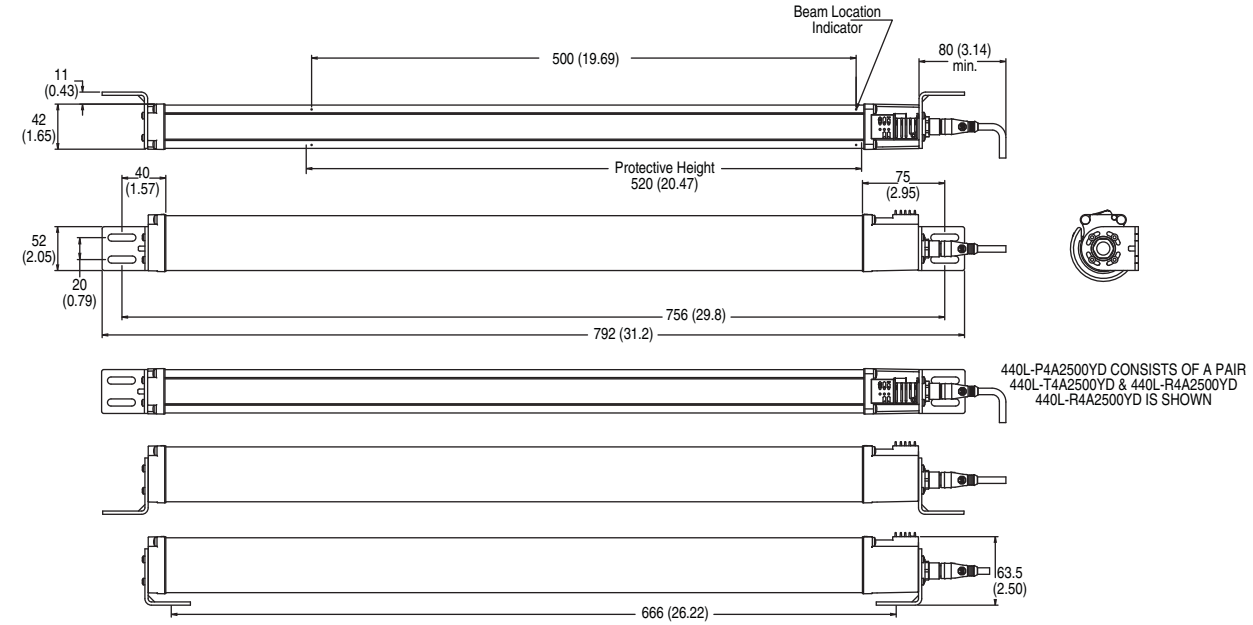
440L-P4A3400YD



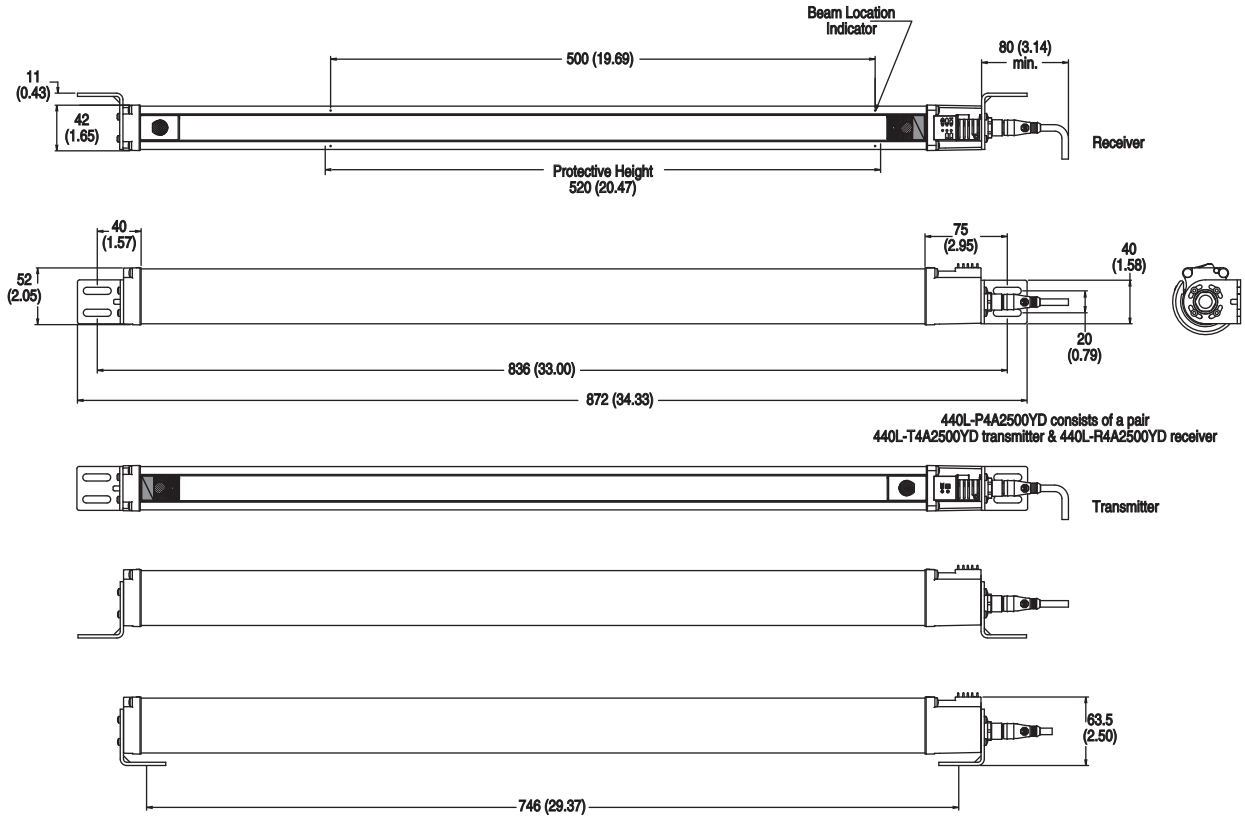
440L-P4AL3400YD



440L-P4A2500YD



440L-P4AL2500YD

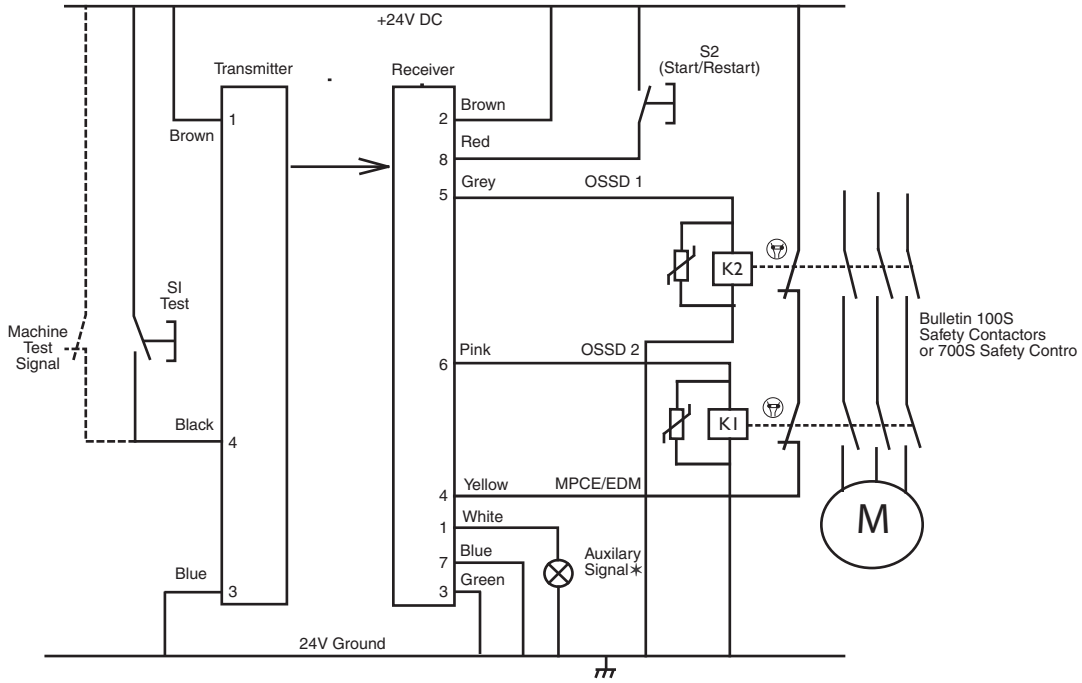


Cat. No.	A Protective Height [mm]	B Mounting Value [mm]	C Total Length [mm]
440L-P4A3400YD	820 ±0.5	1076	1112 ±1.5
440L-P4A2500YD	520 ±0.5	756	792 ±1.5
440L-P4AL3400Y∗	820 ±0.5	—	—
440L-P4AL2500Y∗	520 ±0.5	—	—

∗ Replace with "D" for standard 8-pin M12 or "A" for 5-pin M12 for ArmorBlock Guard I/O connectivity.

Wiring Diagram for Connection of OSSDs Directly to Contactors (FSDs)

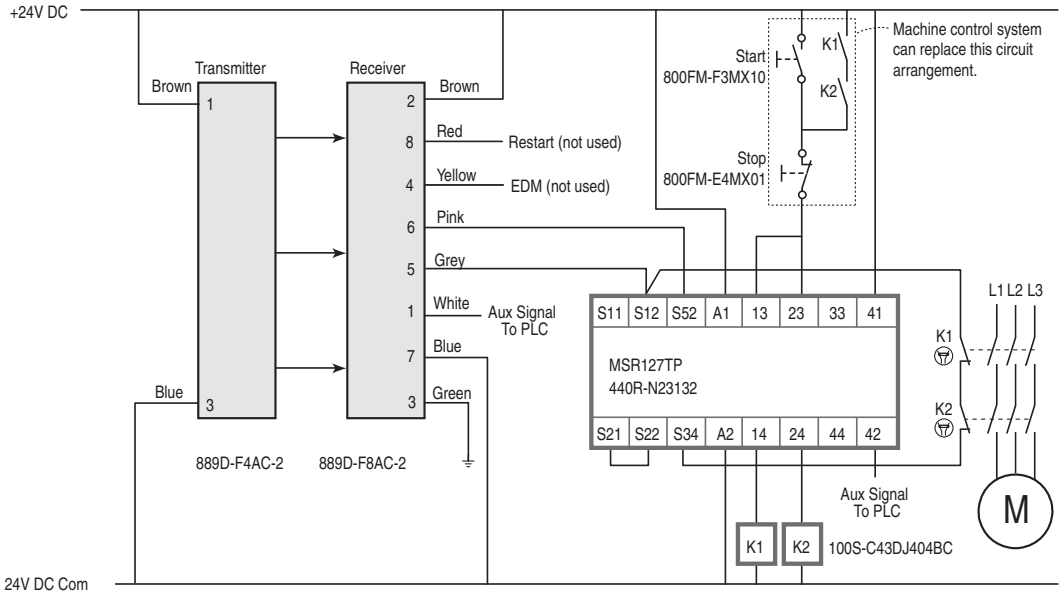
Wiring diagram is not intended to be used for installation purposes.



* Auxiliary output is nonsafety. Can be connected to a lamp, motor or status to a PLC.

K1, K2	Safety relay or safety contactor for OSSD 1 and OSSD 2 connection
S1	Switch for external system test (optional)
S2	Switch for reset of light curtain from start/restart interlock

Wiring Diagram for Connection of OSSDs Directly to a Safety Relay Module



PAC Type 4 Safety Light Curtains

GuardShield Safe 4 PAC



Description

The Allen Bradley Guardmaster GuardShield Safe 4 PAC is an economical two box, Type 4 safety light curtain with ON/OFF functionality. This basic, guard-only operating mode, perimeter access safety light curtain has an integrated laser alignment system that simplifies the alignment of each pair of light curtains. Visible laser beams are activated by touching the finger symbol on front face of the light curtains. Positioning of the transmitter and receiver laser beams to their respective targets facilitates optimal alignment of each Safe 4 PAC pair. The integrated laser alignment system also helps with the re-alignment of pairs if units are knocked out of alignment during the course of the work process or when corner mirrors are used.

The GuardShield Safe 4 PAC is offered with two 120 mm long, 30 mm resolution optic modules spaced at 500 mm and three 120 mm long, 30 mm resolution optic modules spaced at 400 mm providing whole body detection. Designed for perimeter guarding applications, both configurations of the Safe 4 PAC have operating ranges from 5 to 30 meters which allows them to be used as opto-electronic fences. The use of corner mirrors with the Safe 4 PAC allows multiple-sided guarding in large perimeter applications. The GuardShield Safe 4 PAC is also a low cost solution for entry or exit guarding of a machine process when paired with the MSR42 muting module. The MSR42 can be configured for two-sensor muting with the Safe 4 PAC. The muting function allows material to pass through the sensing field of the Safe 4 PAC when the muting sensors are properly activated by the flow of material.

The GuardShield Safe 4 PAC, with an environmental rating of IP65, is designed to be used in a variety of applications across a broad range of industries in medium to heavy industrial environments. Offered with shock isolator kits for shock and vibration applications, the Safe 4 PAC is suited to medium- and heavy-duty applications.

Features

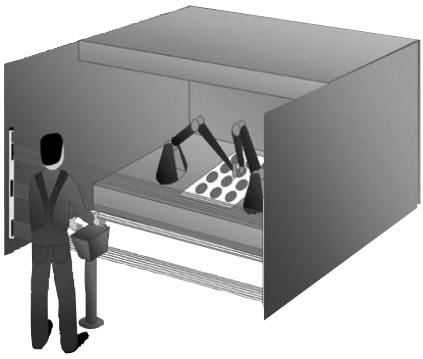
- M12 connectors
- Optically synchronized
- Integrated laser alignment system
- IP65 enclosure rating
- Simple installation
- cULus Listed and CE Marked for all applicable directives

Applications

- Palletizers
- Material handling systems
- Packaging equipment
- Robot cells
- Automated processes

Specifications

Safety Ratings	
Standards	EN/IEC 61496 Parts 1 and 2, UL 61496 Parts 1 and 2, UL1998
Safety Classification	Type 4 per IEC/EN61496. Category 4 device per EN 954-1, SIL 3 per IEC 61508, PLe per EN/ISO 13849
Certifications	cULus Listed and CE Marked for all applicable directives
Power Supply	
Input Power, Max.	24V DC ± 20%
Maximum Residual Ripple	< 10% of U_{sp}
Power Consumption	<500 mA (no load)
Outputs	
Safety Outputs	2 PNP OSSD. 0.3 A, short-circuit protected
Output Voltage, Min.	U_{sp} -1
Switching Current @ Voltage, Min.	300 mA @ 24V DC
Operating Characteristics	
Indicator LEDs	ON -State, OFF-State, internal error
Protected Height [mm (in.)]	3 beam = 840 mm (33.0 in.) 2 beam = 600 mm (23.6 in,)
Scanning Range	5…30 m (16.4…98.4 ft)
Synchronization	Optical, first beam adjacent to LEDs
Wavelength	950 nm
Environmental	
Enclosure Type Rating	IP65
Relative Humidity	15…95% (noncondensing)
Operating Temperature [C (F)]	0…55° (0…131°)
Vibration	IEC 60068-2-6 frequency 10…55 Hz; amplitude 0.35 mm (0.01 in.)
Shock	IEC 60068-2-29; acceleration 10 g, pulse duration 16 ms 10…55 Hz; amplitude 0.35 mm (0.01 in.)
Physical Characteristics	
Mounting	Rear mounting, standard and adjustable (180°)
Weight	Varies by by cat. no., see Installation Manual
Housing Cross Section	30 x 40 mm (1.18 x 1.57 in.)
Connection Type	Transmitter: 5-pin M12 micro QD Receiver: 5-pin M12 micro QD
Cable Length	30 m (98.4 ft) max.
ILAS Laser Class	Class 2, IEC 60825-1



Product Selection

Safety Light Curtain—Standard PAC System

The Allen-Bradley Guardmaster GuardShield Safe 4 PAC safety light curtains are offered with two or three modules with various spacing for whole body detection. These are ordered as pairs (transmitter and receiver) and are shipped under one catalog number. Each GuardShield Safe 4 PAC pair is shipped with mounting brackets. After selecting the appropriate Safe 4 PAC, ensure that the appropriate cordsets, interfaces and accessories are ordered.

Protected Height [mm (in.)]	Number of Beams	Beam Spacing	Pair Weight [kg (lbs)]	Cat. No.
600 (23.6)	2	500 mm	4.0 (8.8)	445L-P4S2500YD
840 (33.0)	3	400 mm	4.5 (9.9)	445L-P4S3400YD

Note: The cat. nos. listed above are pair cat. nos. designated by the "P" in the cat. no. To specify a transmitter or receiver, replace the "P" with a "T" for transmitter and "R" for a receiver. The GuardShield Safe 4 PAC requires a 5-pin M12 cordset for the transmitter and the receiver.

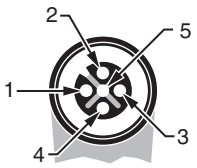
Required Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

Note: The use of a category 4 safety relay module does not improve the category rating of the safety system beyond the Category 2 rating of the Type 2 light curtain in use.

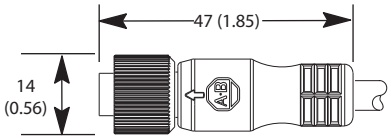
Cordsets—Transmitters and receivers both use 5-pin M12 cordsets

Note: Unshielded cordsets are most commonly used for safety light curtains, however, shielded cordsets are also offered to increase immunity to electrical interference.

Female Connector (Sensor End)		Cable			
Face View of Female	Connector Style	Pin/Wire Color	Wire Rating	Length [m (ft)]	Cat. No.
	Straight Female	1 Brown 2 White 3 Blue 4 Black 5 Grey	22 AWG 250V 4 A	2 (6.56)	889D-F5AC-2
				5 (16.4)	889D-F5AC-5
				10 (32.8)	889D-F5AC-10
				15 (49.2)	889D-F5AC-15
				20 (65.6)	889D-F5AC-20
				30 (98.4)	889D-F5AC-30
	Shielded Straight Female	1 Brown 2 White 3 Blue 4 Black 5 Grey	22 AWG 22 AWG 300V 4 A	2 (6.56)	889D-F5EC-2
				5 (16.4)	889D-F5EC-5
				10 (32.8)	889D-F5EC-10
				15 (49.2)	889D-F5EC-15
				20 (65.6)	889D-F5EC-20
				30 (98.4)	889D-F5EC-30

Cordsets Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Straight Female

Accessories

Muting Sensors

Sensor Type	Connection Location	Type	Cat. No.
Retroreflective	Connected directly to muting module	Dark Switching	42GRU-9000-QD
Transmitted Beam	Receiver (connected directly to the muting module)		42GRR-9000-QD*
Retroreflective	Connected directly to muting module		42GRU-9000-QD*
Polarized Retroreflective	Three inch standard reflector		92-39
Polarized Retroreflective	Connected directly to muting module		42GRU-9200-QD*
Polarized Retroreflective	Three inch standard reflector		92-39
Mechanical Limit Switch	Connected directly to muting module (operating lever must be selected separately)		802M-NX10*
Muting lamp		Two cat. nos. make this assembly.	855E-24TL7 **855E-BVMC**
*Use with 4-pin, DC Micro patchcord when connecting to muting module (5 m length shown). 1 m, 2 m, 3 m, and 5 m lengths available.			889D-F4AC-5

Optional Accessories

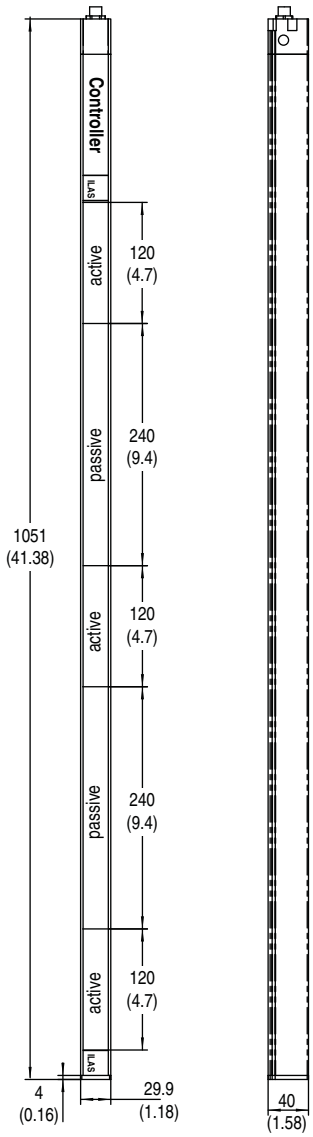
Description		Cat. No.
	Standard kit (4 pieces — supplied with each pair)	445L-AF6140
	180° Adjustable kit (two kits required per pair)	**445L-AF6141**
	Shock Mount Kit (2 kits required per pair of light curtains)	445L-AF6142
	Vertical mounting kit (two kits required per pair)	445L-AF6144
	MSR42 Multifunction Module (requires 440L-AF6150 to program)	**440R-P226AGS-NNR**
	MSR45E — Safety relay expansion module for MSR42	**440R-P4NANS**
	USB optical interface software configuration tool used to configure the MSR42 (Used to configure the MSR42 module or get diagnostic information from the Safe 4.)	**445L-AF6150**
	Ribbon cable — to connect one MSR45E to an MSR42	**440R-ACABL1**
	Ribbon cable — to connect two MSR45Es to an MSR42	440R-ACABL2
	Ribbon cable — to connect three MSR45Es to an MSR42	440R-ACABL3
	Mounting stand (Comes with hardware to level base and two GuardShield mounting brackets.)	**440L-AMSTD**

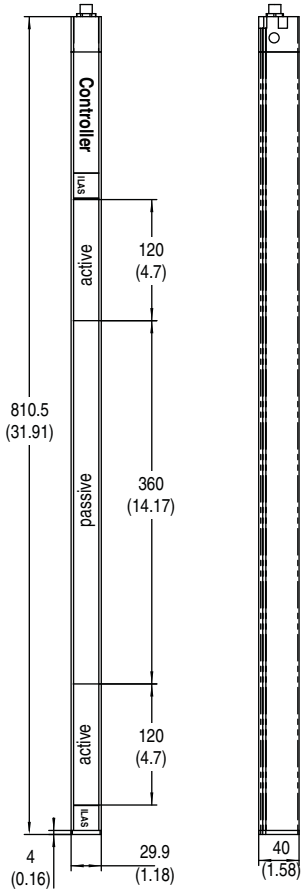
Corner Mirror for Multi-Sided Guarding

GuardShield Safe 4	Narrow Mirror Short-Range 0…4 m	Cat. No.	Wide Mirror Long-Range 4…15 m	Cat. No.
445L-P4S2500YD		440L-AM0750900		440L-AM1250900
445L-P4S3400YD		440L-AM0751200		**440L-AM1251200**

Approximate Dimensions

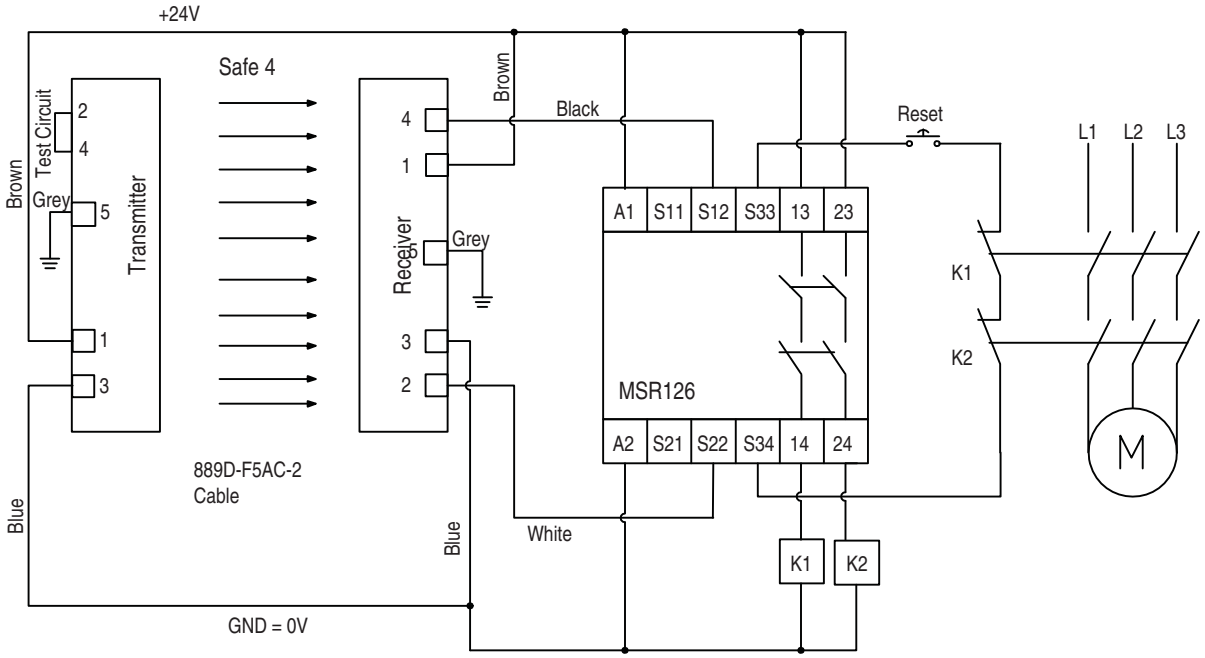
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



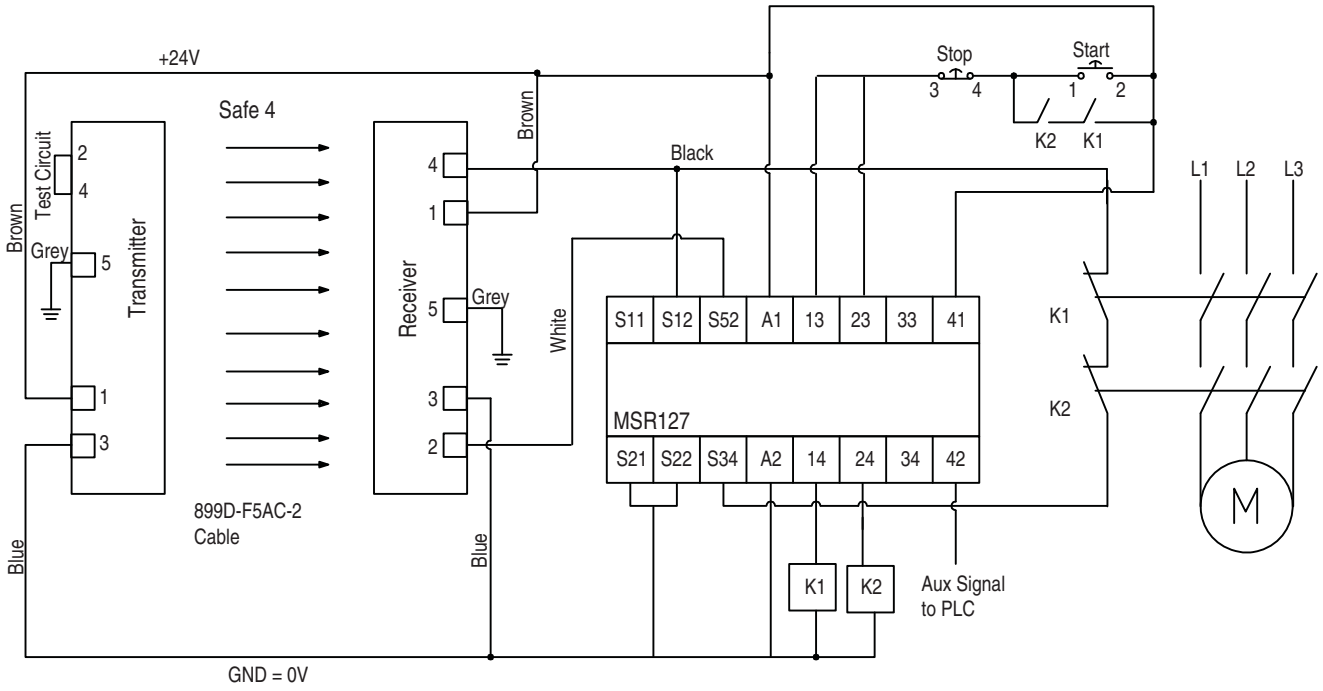


Wiring Diagram for Connection to MSR126

Wiring diagram is not intended to be used for installation purposes.



Wiring Diagram for Connection to MSR127



Safety Single Beam

Area Access Control



Description

The Area Access Control (AAC) safety single-beam is a 24V DC through-beam opto-electronic safety switch offered with two operating ranges (a short range (0.5…20 m (1.64…65.5 ft) or a long range (15…70 m (49.2…300 ft)) system. The AAC system uses the same transmitter for both ranges and one of two receivers for a short-range or long-range system. This unique system configuration minimizes the number of cat. nos. necessary for specifying the AAC single-beam system.

The AAC safety single-beam is used as a whole-body detection device. The light beam produced between the AAC transmitter and receiver provides whole-body access detection for hazardous areas such as:

- Robotic work cells
- Processing machines
- Machining centers
- Palletizers
- Transfer lines
- High bay warehouses

Features

- Long scan range (up to 70 m (300 ft))
- Easy installation
- Die cast aluminium housing
- Heated front lens, allowing use even in outdoor applications
- Relay outputs

Specifications

Safety Ratings	
Standards	IEC 61496, Parts 1 & 2
Safety Classification	Type 4, IEC 61496; SIL 3 (IEC 61508); SIL CL3 (IEC 62061); Category 4 (EN ISO 13849); PLe (EN ISO 13849); B_{10d} parameter: 1 x 10^6 switching cycles (@ DC-13, 24V, 0.6 A); 2 x 10^5 switching cycles (@ DC-13, 24V, 1.5 A) PFH_d: 4.0 x 10^{-9}; Mission time: 20 years
Certifications	CE Marked for all applicable directives and BG
Power Supply	
Input Power, Max.	24V DC ±20%
Maximum Residual Ripple	5% of U_v, max.
Power Consumption	24V DC 8 W max.
Outputs	
Safety Outputs	2 N.O. Relays
Switching Current @ Voltage, Min.	0.02 A to 2 A
Operating Characteristics	
Response Time	< 22 ms
Status Indicators	On state, Off state, alignment
Beam Diameter	23 mm (0.91 in.)
Scanning Range	0.5…20 m (1.64…65.5) or 15…70 m (49.2…300 ft)
Synchronization	Optical
Wavelength	950 nm
Environmental	
Enclosure Type Rating	IP67 (EN 60529)
Relative Humidity	15…95%, noncondensing
Operating Temperature [C (F)]	-25…55° (-13…131°)
Vibration	5 g, 10…55 Hz per IEC 60068-2.6
Shock	10 g, 16 ms per IEC 60068-2.29
Physical Characteristics	
Front Window	Heated
Weight	Transmitter unit: approx. 0.9…1.3 kg Receiver unit: approx. 1…1.4
Housing Cross Section	50 x 156 x 116 mm (1.96 x 6.14 x 4.56 in.)
Connection Type	Terminal chamber with cable gland (PG13.5 thread)
Cable Length	50 m (164 ft) max.

Note: The external power supply must be capable of buffering brief power failures of 20 ms as specified in IEC 60204-1.

Product Selection

Selection Guide for Receiver

Operating Range	Connection Type	Cat. No.
0.5…20 m (1.64…65.5)	Terminal chamber with cable gland (PG13.5 thread)	**440L-R4F0020Q**
15…70 m (49.2…300 ft)		**440L-R4F1570Q**

Selection Guide for Transmitter

Operating Range	Connection Type	Cat. No.
0…70 m (0…300 ft)	Terminal chamber with cable gland (PG13.5 thread)	**440L-T4F2070Q**

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

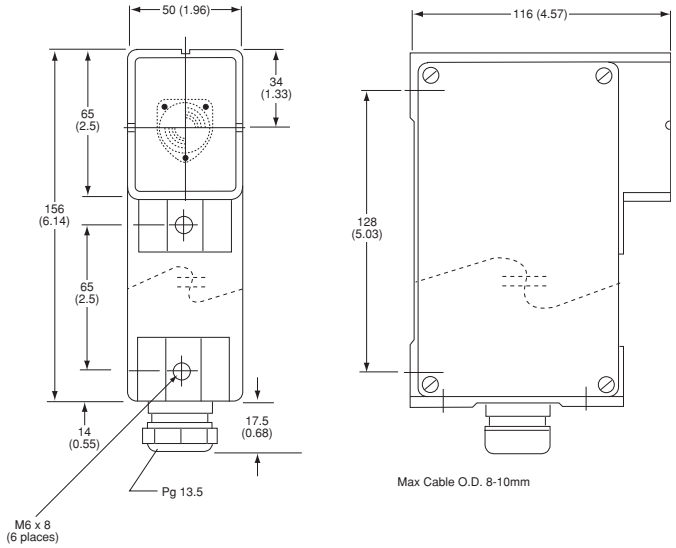
Note: The use of a category 4 safety relay module does not improve the category rating of the safety system beyond the Category 2 rating of the Type 2 light curtain in use.

Accessories

	Description	Cat. No.
	Laser alignment tool	**440L-ALAT**
	Adaptor for alignment aid on AAC	440L-ALBRK1
	Mounting bracket for AAC	**440L-AMBRK4**
	Corner mirror for scanning range 0…30 m	440L-AMIRR1
	Mounting kit for 440L-AMIRR1	440L-AMKIT
	Mounting bracket for mirror 440L-AMIRR1	440L-AMBRK1
	Glass corner mirror, 45° angle 0…30 m	**440L-AMIRR2**

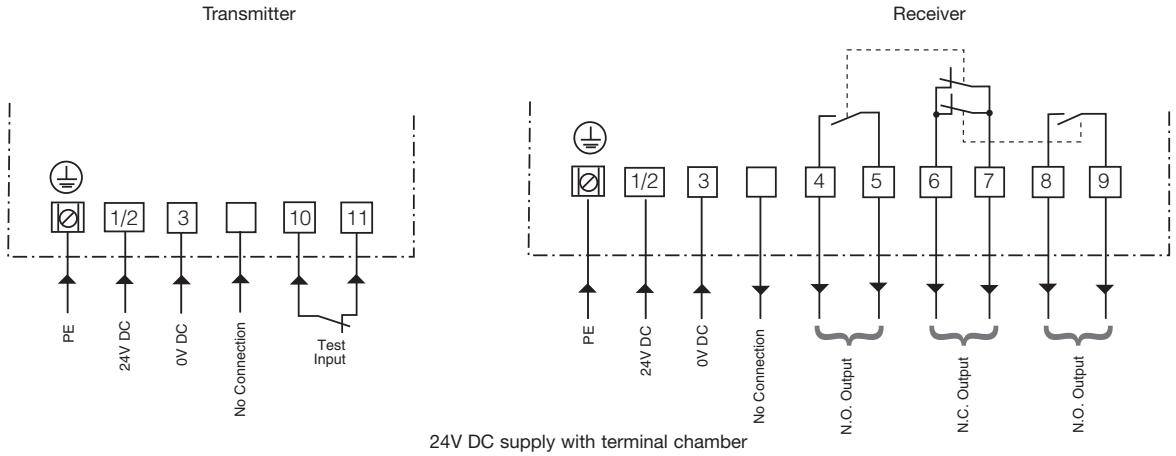
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



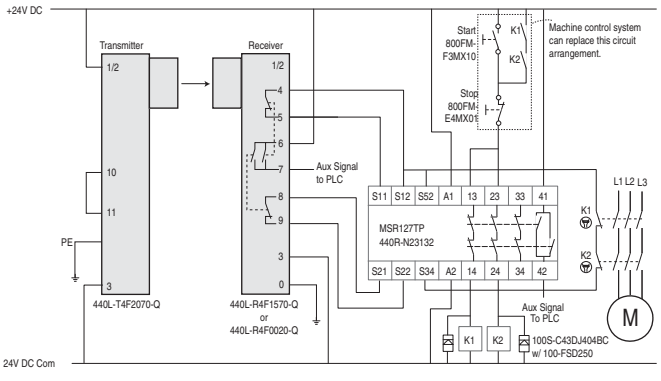
Typical Wiring Diagrams

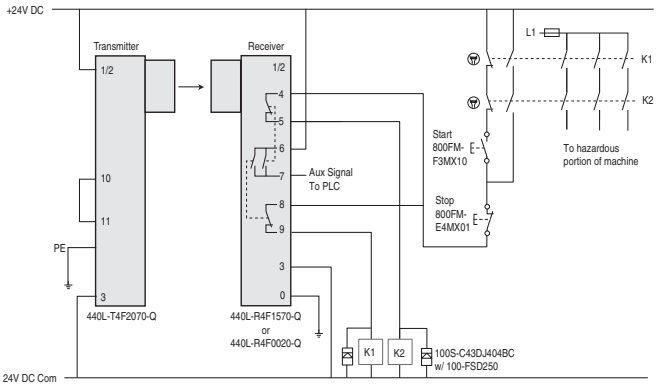
Wiring diagram is not intended to be used for installation purposes.



24V DC supply with terminal chamber

Transmitter

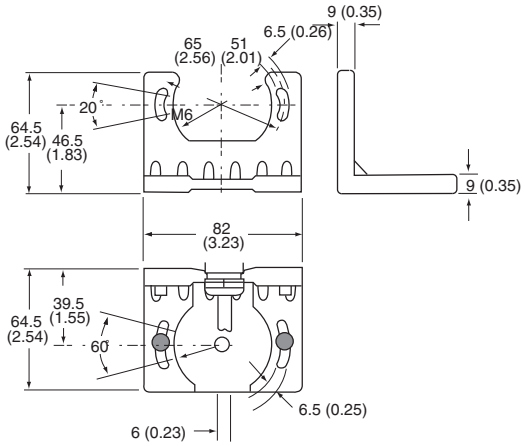




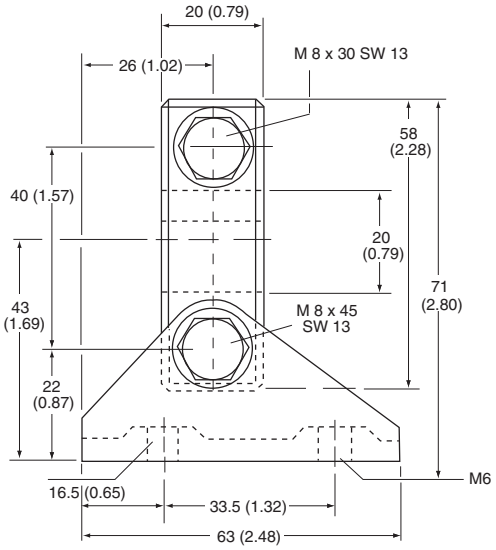
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

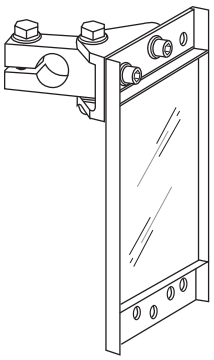
AAC Mounting Bracket 440L-AMBRK4



Mounting Bracket 440L-AMBRK1

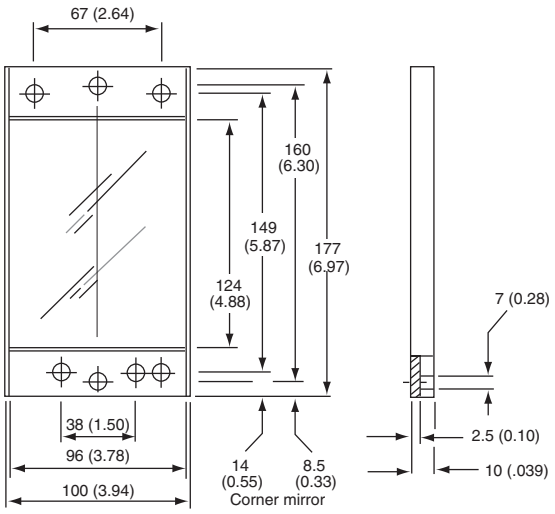


Mounting Bracket 440L-AMBRK1 Mounted to Mirror 440L-AMIRR1



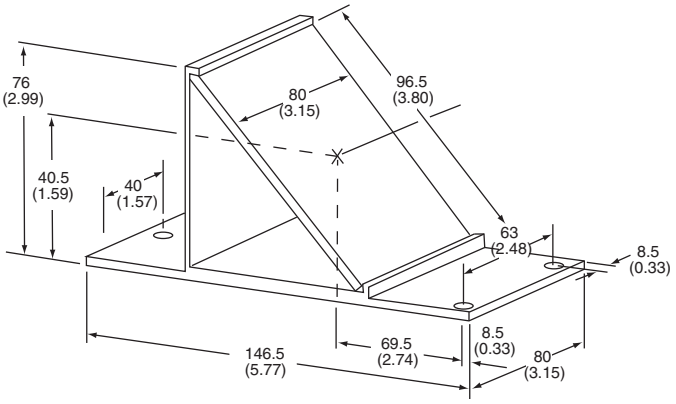
Shown with bracket 440L-AMBRK1
Mounted to mirror 440L-AMIRR1

Mirror 440L-AMIRR1

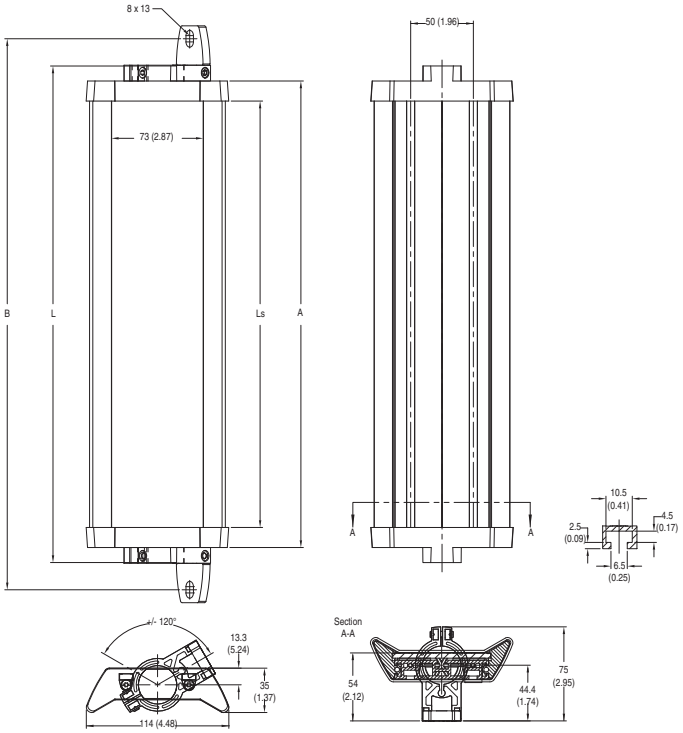


Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Mirror 440L-AMIRR2



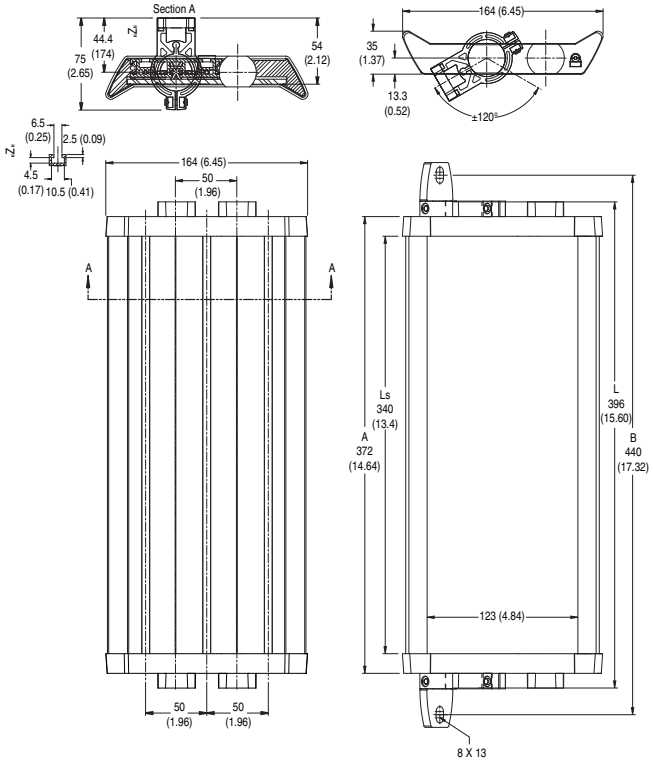
Mirror 440L-AM075



MODEL NO.	SERIES	DESCRIPTION	L	L_S	A	B
440L-AM0750300	A	Mirror, 300 mm, 4 m	396	340	372	440
440L-AM0750450	A	Mirror, 450 mm, 4 m	546	490	522	590
440L-AM0750600	A	Mirror, 600 mm, 4 m	696	640	672	740
440L-AM0750750	A	Mirror, 750 mm, 4 m	846	790	822	890
440L-AM0750900	A	Mirror, 900 mm, 4 m	996	940	972	1040
440L-AM0751050	A	Mirror, 1050 mm, 4 m	1146	1090	1122	1190
440L-AM0751200	A	Mirror, 1200 mm, 4 m	1296	1240	1272	1340
440L-AM0751350	A	Mirror, 1350 mm, 4 m	1446	1390	1422	1490
440L-AM0751500	A	Mirror, 1500 mm, 4 m	1596	1540	1572	1640
440L-AM0751650	A	Mirror, 1650 mm, 4 m	1746	1690	1722	1790
440L-AM0751800	A	Mirror, 1800 mm, 4 m	1896	1840	1872	1940

Note: The 1800 mm corner mirror can not be mounted to the floor stand (440L-AMSTD) with end cap brackets. This requires the t-nut kit (440L-AF6115) for rear mounting.

Mirror 440L-AM125

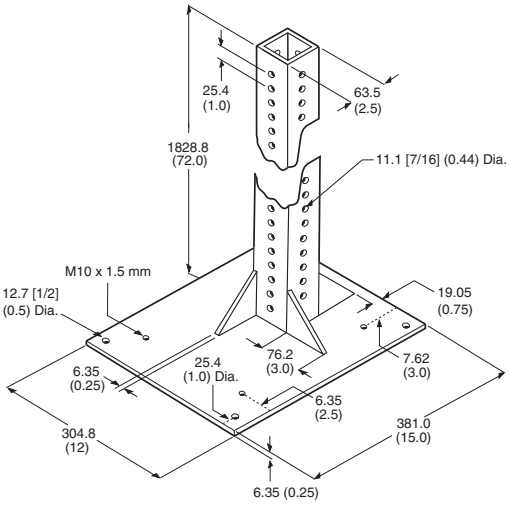


MODEL NO.	SERIES	DESCRIPTION	L	L_S	A	B
440L-AM1250300	A	Mirror, 300 mm, 15 m	396	340	372	440
440L-AM1250450	A	Mirror, 450 mm, 15 m	546	490	522	590
440L-AM1250600	A	Mirror, 600 mm, 15 m	696	640	672	740
440L-AM1250750	A	Mirror, 750 mm, 15 m	846	790	822	890
440L-AM1250900	A	Mirror, 900 mm, 15 m	996	940	972	1040
440L-AM1251050	A	Mirror, 1050 mm, 15 m	1146	1090	1122	1190
440L-AM1251200	A	Mirror, 1200 mm, 15 m	1296	1240	1272	1340
440L-AM1251350	A	Mirror, 1350 mm, 15 m	1446	1390	1422	1490
440L-AM1251500	A	Mirror, 1500 mm, 15 m	1596	1540	1572	1640
440L-AM1251650	A	Mirror, 1650 mm, 15 m	1746	1690	1722	1790
440L-AM1251800	A	Mirror, 1800 mm, 15 m	1896	1840	1872	1940

Note: The 1800 mm corner mirror can not be mounted to the floor stand (440L-AMSTD) with end cap brackets. This requires the t-nut kit (440L-AF6115) for rear mounting.

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

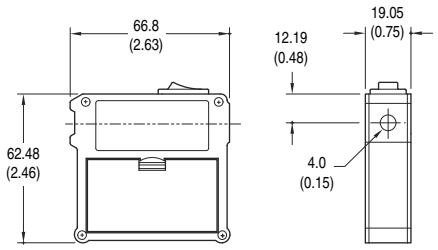
Mounting Stand—440L-AMSTD



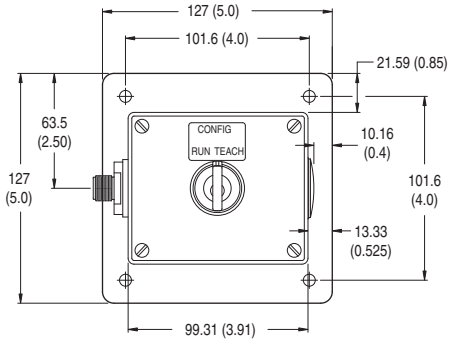
Two of each bracket included with **440L-AMSTD** to mount GuardShield light curtains to mounting stand.



Laser Alignment Tool—440L-ALAT

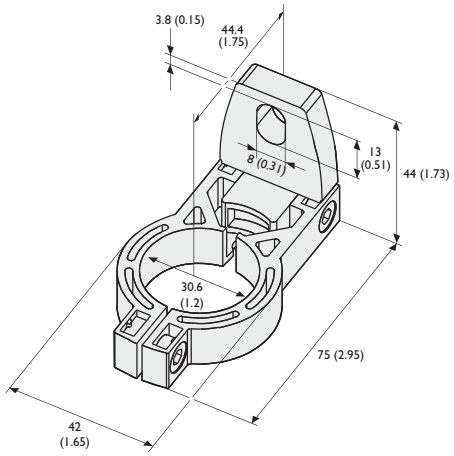


440L-M8600—GuardShield Remote Teach Box

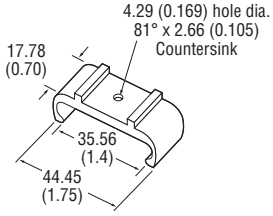


Swivel Mounting Bracket 442L-AF6106

Used for end mounting of corner mirrors. Two supplied with each corner mirror.



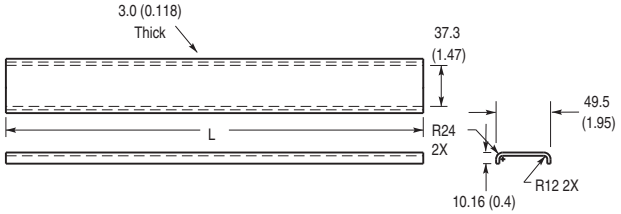
440L-AF6109—used to mount the 440L-ALAT laser alignment tool to Guard Shield light curtains



Weld Shields

The GuardShield weld shields are sold as pairs in the same lengths as the protective heights of the GuardShield safety light curtain.

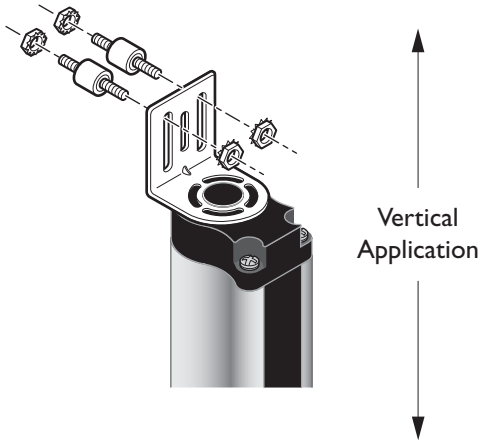
These polycarbonate weld shields are designed as disposable devices whose purpose is to protect the front window of the GuardShield safety light curtain from damage.



Dimension "L" [mm (in.)]	Cat. No.	Dimension "L" [mm (in.)]	Cat. No.
175.3 (6.9)	440L-AGWS0160	1135.4 (44.70)	440L-AGWS1120
335.3 (13.20)	440L-AGWS0320	1295.4 (51.00)	440L-AGWS1280
495.3 (19.50)	440L-AGWS0480	1455.4 (57.30)	440L-AGWS1440
655.3 (25.80)	440L-AGWS0640	1615.4 (63.60)	440L-AGWS1600
815.3 (32.10)	440L-AGWS0800	1778 (70.00)	440L-AGWS1760
975.4 (38.40)	440L-AGWS0960		

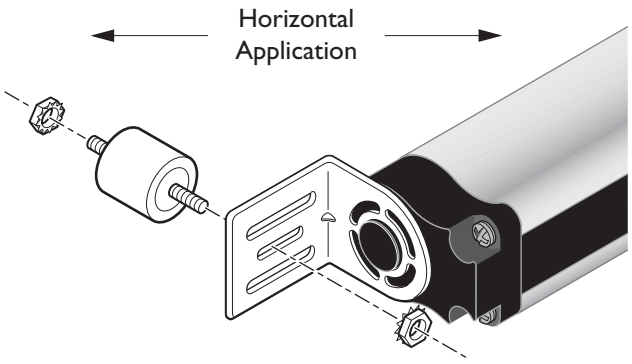
Torque Requirements by Mounting Kit

Cat. No.	Description	Max. Load per Isolator (shear)	Tightening Torque	Spring Rate (shear)
440L-AF6120	Vertical shock mount kit	5 lbs	40 inch lbs	55 lbs/inch
440L-AF6121	Horizontal shock mount kit	22 lbs	40 inch lbs	200 lbs/inch
440L-AF6122	Middle vertical mount kit	5 lbs	40 inch lbs	55 lbs/inch
440L-AF6123	Middle horizontal mount kit	22 lbs	40 inch lbs	200 lbs/inch



Shock Mounts

Shock mount kits are used for attenuating excessive shock and vibration for both vertical and horizontal applications of the GuardShield family of safety light curtains. These kits are designed to protect the internal optical and electronic components of the GuardShield light curtains and are used mostly in press applications.

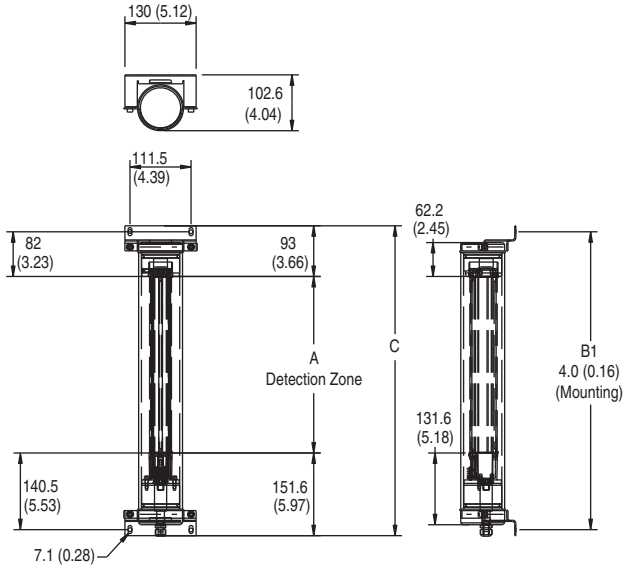


GuardShield Washdown Enclosures

The GuardShield washdown enclosure is designed to provide an environmentally protective enclosure for the GuardShield Type 4 and GuardShield PAC safety light curtains when they are applied in washdown applications. There is a range loss of approximately 10% when GuardShield light curtains are mounted inside of the IP67 washdown enclosures.

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



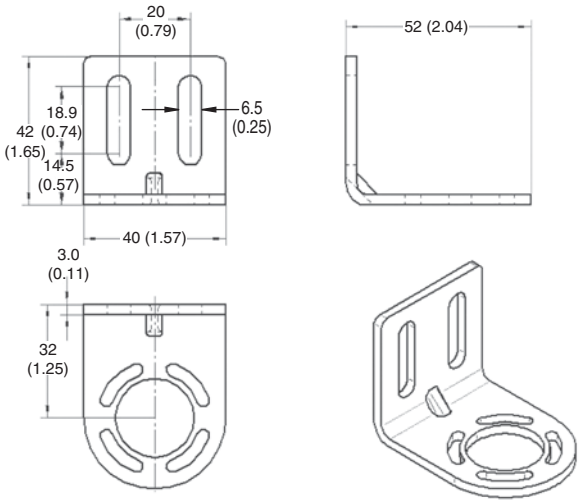
Cat. No.	Use with Light Curtain Cat. No.	A Protective Height [mm (in.)]	B1 Mounting Value [mm (in.)]	C Total Length [mm (in.)]
440L-AGST320	440L-P4➢0320YD	320 ±0.5 (12.6 ±0.02)	542.58 (21.36)	564.58 (22.23)
440L-AGST480	440L-P4➢0480YD	480 ±0.5 (18.9 ±0.02)	702.58 (27.66)	724.58 (27.66)
440L-AGST640	440L-P4➢0640YD	640 ±0.5 (25.2 ±0.02)	862.58 (33.96)	884.58 (34.83)
440L-AGST800	440L-P4➢0800YD	800 ±0.5 (31.5 ±0.02)	1022.58 (40.26)	1044.58 (41.13)
440L-AGST960	440L-P4➢0960YD	960 ±0.5 (37.8 ±0.02)	1182.58 (46.56)	1204.58 (47.42)

➢ Replace with J for 14 mm or K for 30 mm.

GuardShield PAC

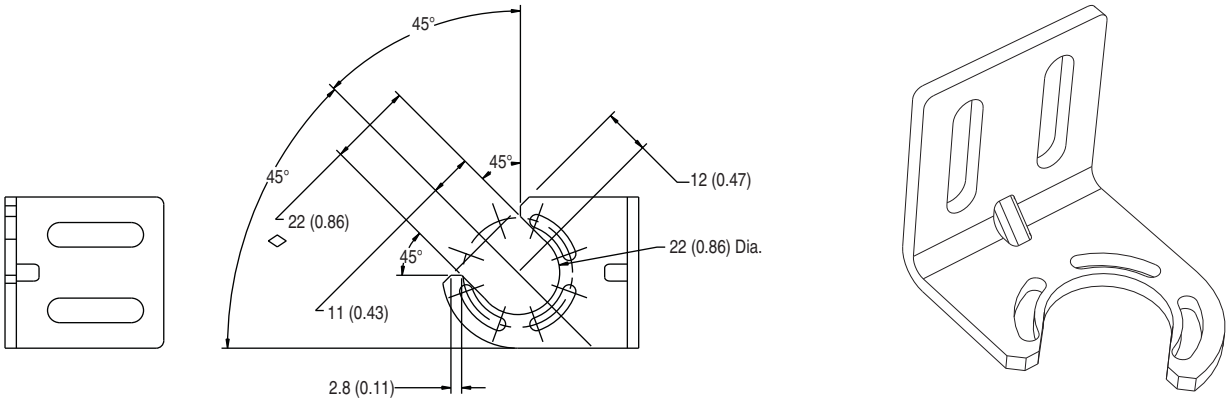
Cat. No.	Use with Light Curtain Cat. No.	A Protective Height [mm (in.)]	B1 Mounting Value [mm (in.)]	C Total Length [mm (in).]
440L-AGST960	**440L-P4A3400YD**	810 ±0.5 (31.8 ±0.02)	1182.58 (46.56)	1204.58 (47.42)
440L-AGST640	440L-P4A2500YD	810 ±0.5 (31.8 ±0.02)	1182.58 (46.56)	884.58 (34.83)

GuardShield Mounting Brackets:



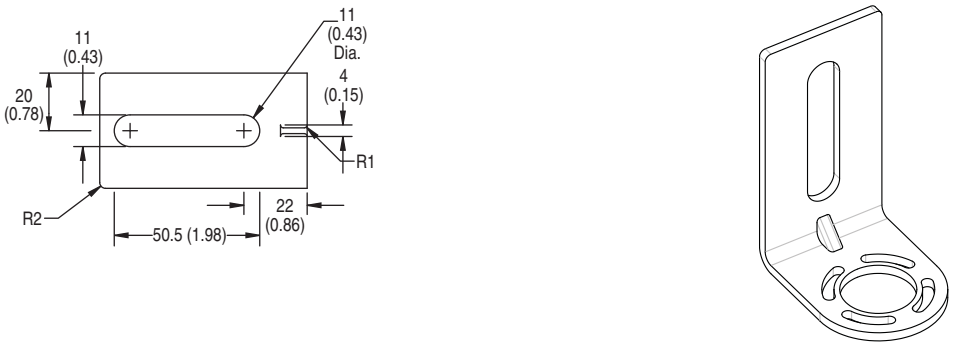
Supplied with each GuardShield safety light curtains.

GuardShield Remote Teach Receiver Bracket



One supplied with each Remote Teach receiver.

GuardShield 440L-AMSTD mounting column brackets



Two supplied with each stand.

Safety Light Curtain Interfaces

120V AC Power Supply and Safety Relay



Description

The Allen-Bradley Guardmaster 120V AC interface box consists of a NEMA 4 rated lockable metal enclosure, a DIN mount 3 A, 24V DC power supply and either a single or dual 22.5 mm safety relay(s).

The single safety relay module provides three N.O. safety and one N.C. auxiliary (nonsafety) “potential free” relay outputs. The dual safety relay configuration allows two pairs of safety light curtains to independently control one or two machines.

The safety relay(s) can be configured for manual reset or automatic reset. The resetting function can be through the key switch mounted on the front cover of the interface box.

Pre-punched holes located on the bottom of the enclosure allow for easy wiring of the system.

Product Selection

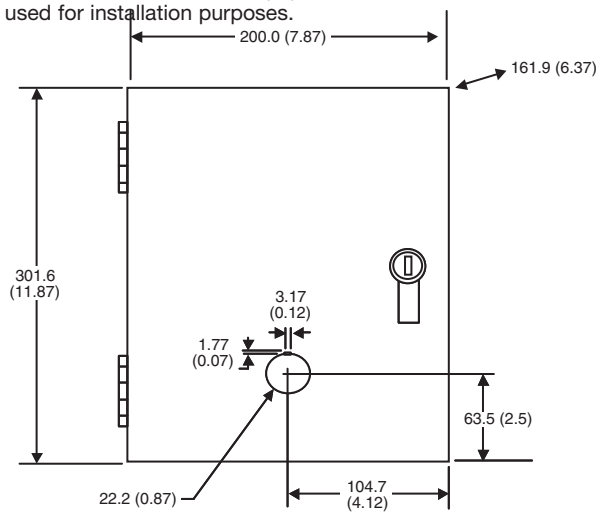
Safety Outputs	Auxiliary Outputs	Power Supply Output	Cat. No.
2 N.O.	1 N.C. nonsafety	120V AC/230V DC	440L-M8400
4 N.O.	2 N.C. nonsafety	120V AC/230V DC	440L-M8500

Specifications

Safety Ratings	
Safety Classification	Nonsafety Rated
Power Supply	
Input Power, Max.	120/230V AC
Power Consumption	2 W/4 W
Outputs	
Safety Outputs	2 N.O. or 4 N.O.
Auxiliary Outputs	1 N.C. or 2 N.C. Nonsafety
Switching Current @ Voltage, Min.	10 mA @ 10V
Operating Characteristics	
Response Time	15 ms
Status Indicators	Power = Green K1 = Green if Closed. K2 = Green if Closed.
Recovery Time	100 ms
Electrical Life	222V AC/4 A/880V A cosϕ = 0.35 - 100,000 operations
Mechanical Life	2,000,000 operations
Operating Frequency	1200 cycles/hour, max.
Environmental	
Enclosure Type Rating	IP65 (NEMA 4)
Relative Humidity	90%
Operating Temperature [C (F)]	-5…55° (23…131°)
Vibration	0.35 mm, 10…55 Hz
Shock	10 g, 16 ms, 100 shocks
Physical Characteristics	
Weight [kg (lb)]	440L-M8400: 4.87 (10.75) 440L-M8500: /5.1 (11.25)

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



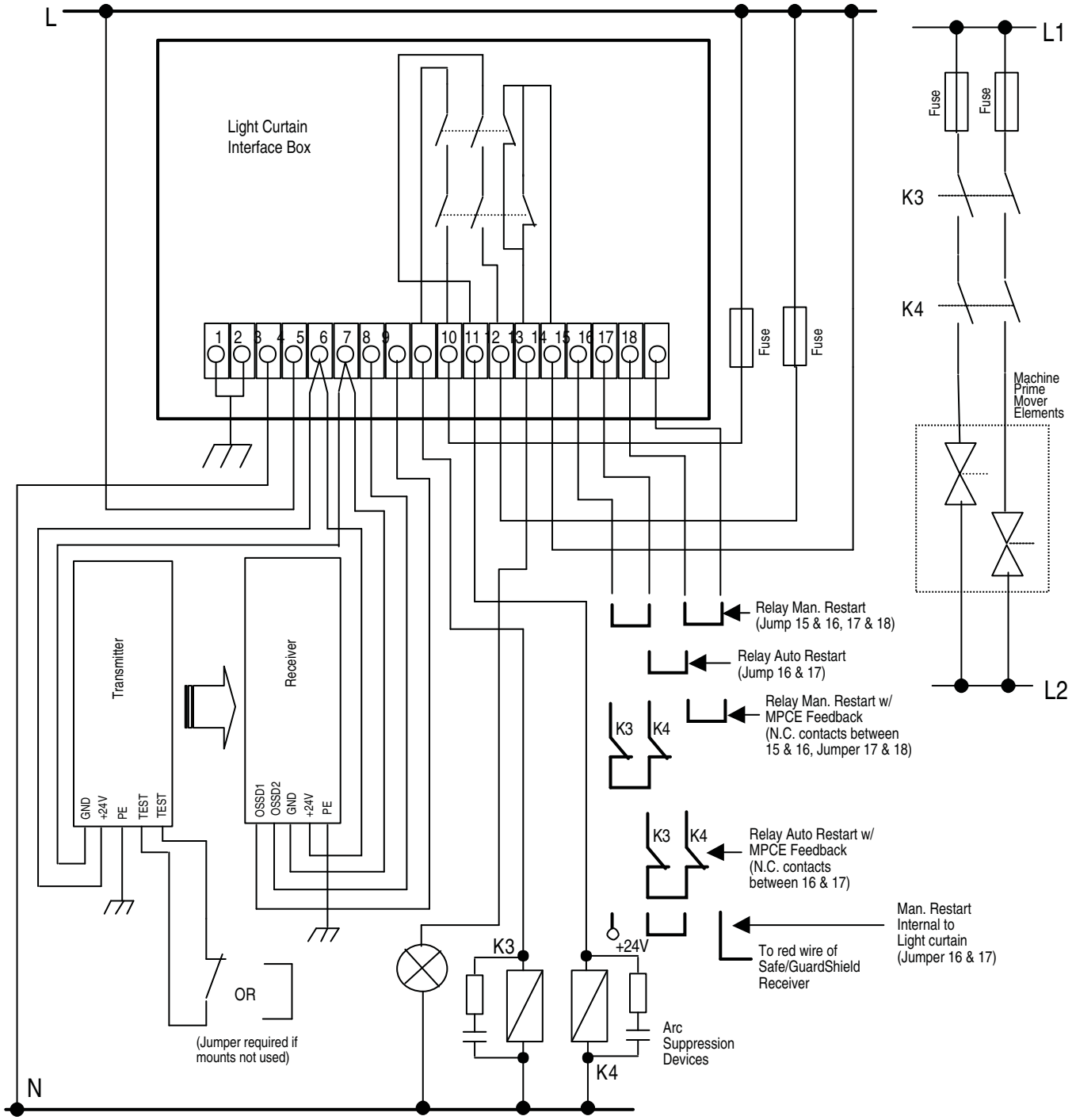
Safety Light Curtain Interfaces

120V AC Power Supply and Safety Relay

Typical Wiring Diagram

M8400 Single Relay

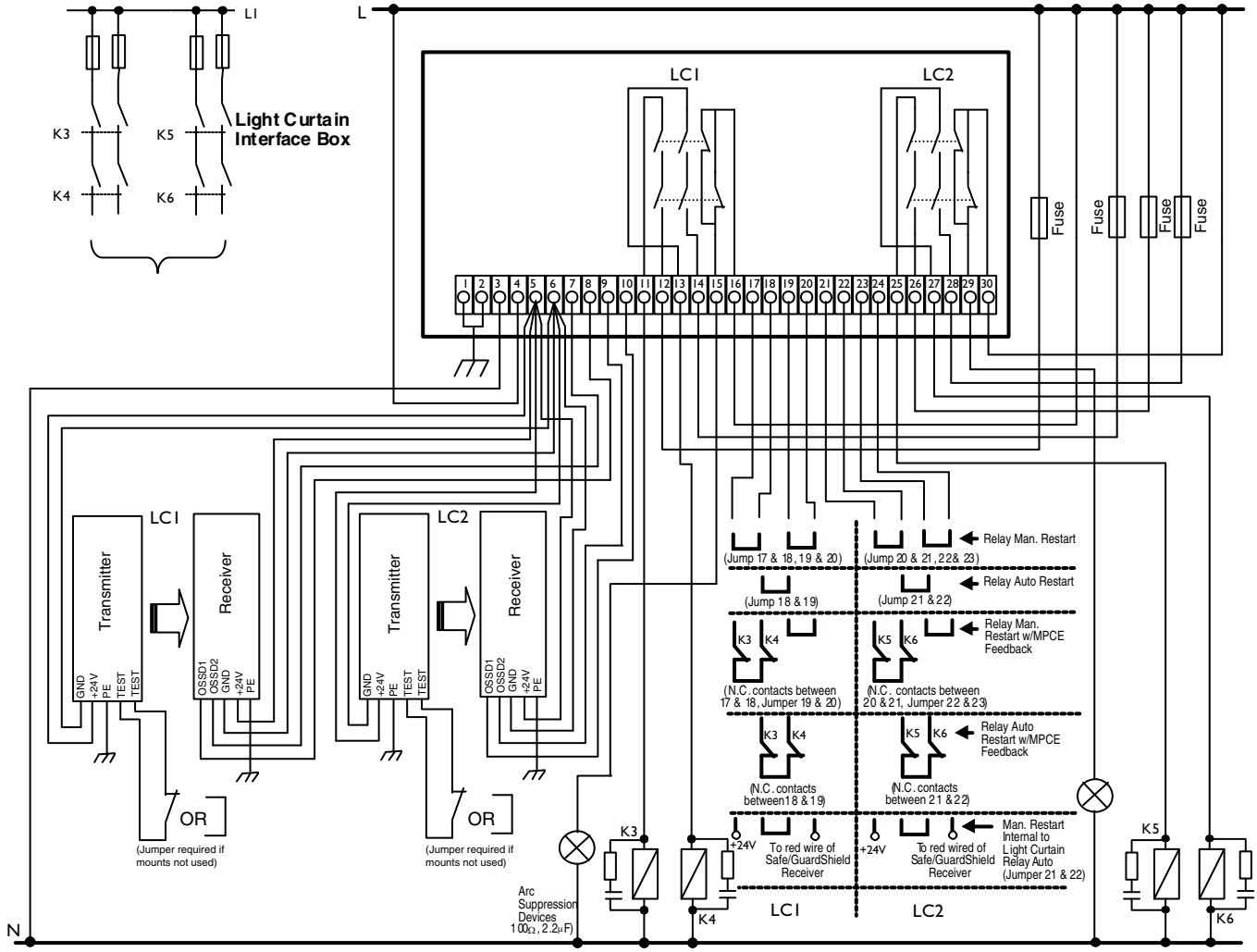
Wiring diagram is not intended to be used for installation purposes.



Typical Wiring Diagram

M8500 Dual Relay

Wiring diagram is not intended to be used for installation purposes.

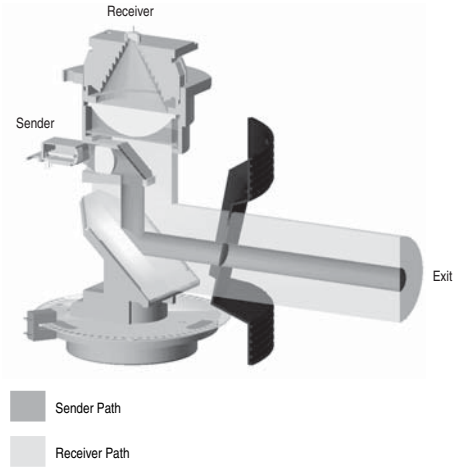


Safety Laser Scanner

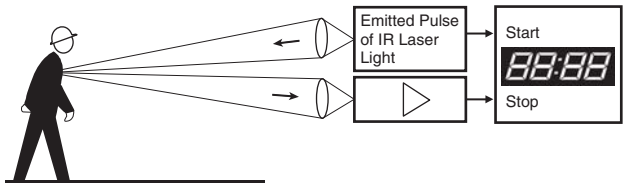
Overview

Principles of Operation

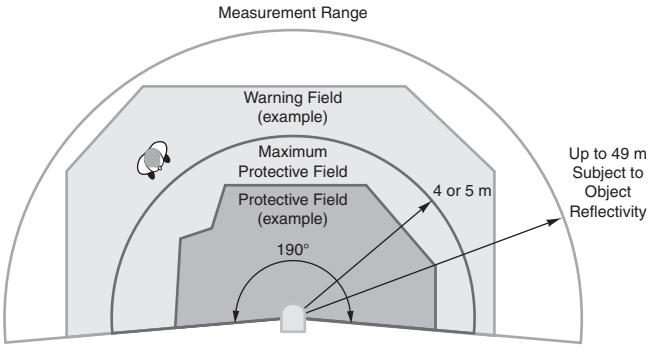
The SafeZone™ safety laser scanner operates on the principle of diffuse reflection and the time flight of light. Pulses of Infrared light are reflected off of a rotating mirror and are emitted over a 190° arc. The diffuse reflection of light is received from an intrusion in the preconfigured sensing field and processed to determine the location and distance of the object from the SafeZone scanner.



At the time of the emission of Infrared light, an electronic stop watch begins. The reflected light is then seen by the SafeZone scanner and processed to determine the distance of the object from the scanner.



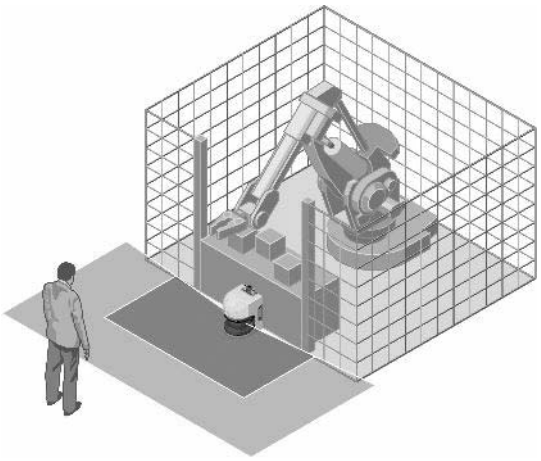
Configuration of the SafeZone's warning and safety fields are accomplished using the Safety Configuration and Diagnostic (SCD) software supplied with each scanner. This Windows®-based software allows easy configuration of irregularly shaped fields by simply clicking and dragging points along the perimeter of the particular zone to shape the contour of the perimeter of the warning or safety field.



The SafeZone safety laser scanner is well suited to industrial applications and can be used in either vertical or horizontal applications to detect the intrusion of personnel or objects into the configured sensing field(s). This detection can result in an audible alarm or warning light being activated to warn of the intrusion or if the intrusion is in the safety field, the hazardous motion of machinery can be stopped.

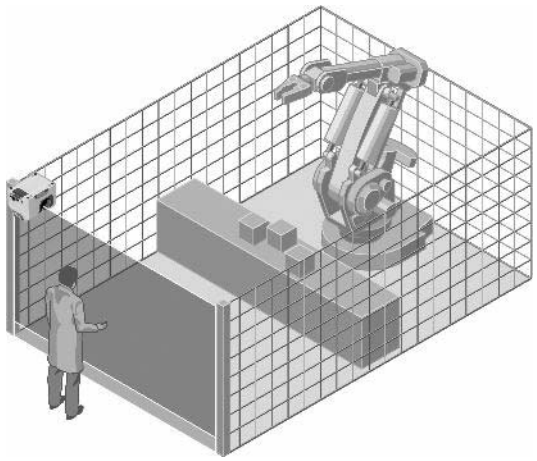
Stationary Horizontal Guarding—Single Field Set

It is possible to configure a warning field and a safety field in front of machinery or equipment to protect personnel from accessing the area where hazardous motion takes place. The SafeZone safety laser scanner is required to be mounted at a particular height from the floor. Irregular shapes are easily configured using the Windows-based SCD software.



Stationary Vertical Guarding

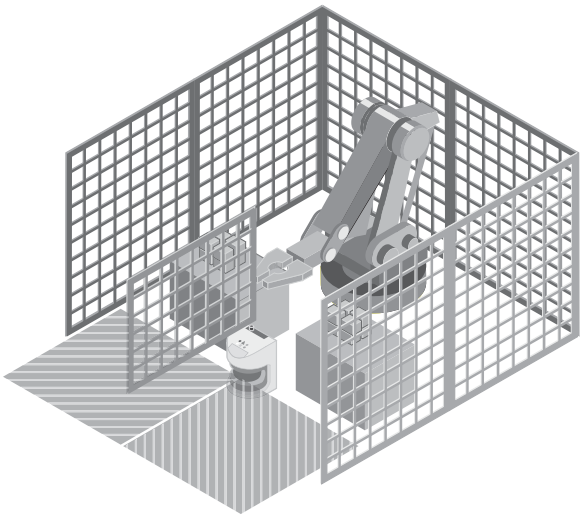
It is possible to mount the SafeZone safety laser scanner to create a vertical safety field that provides access detection to a hazardous area. It is necessary to configure "contour as a reference," which monitors specific areas at the perimeter of the safety field. Contour as a reference must be configured for vertical applications as this configured feature prevents the manipulation of the scanner.



Note: Both the SafeZone singlezone and multizone can be used in stationary horizontal or vertical guarding applications. The SafeZone multizone has a safety field range of 5 m (16.4 ft) and up to four configurable and switchable field sets. The SafeZone singlezone has a safety field range of 4 m (13 ft) and a single configurable field set.

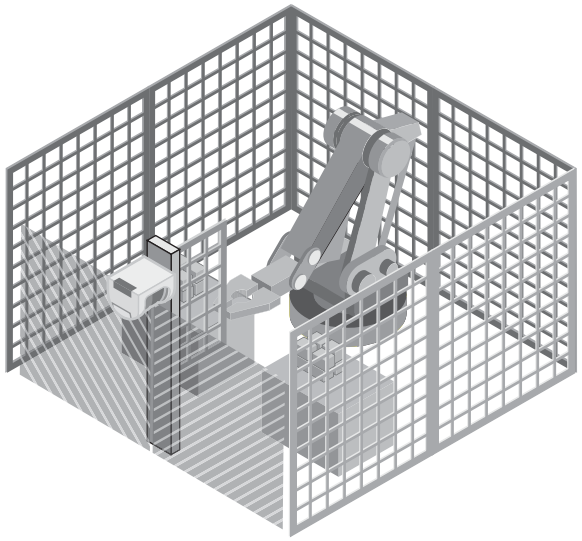
Stationary Horizontal Guarding—Up to Four Safety Zones

The SafeZone multizone safety laser scanner can be configured with up to four field sets; each set may consist of a warning zone and a safety zone. If the application warrants, it may only be necessary to configure the safety zone(s).



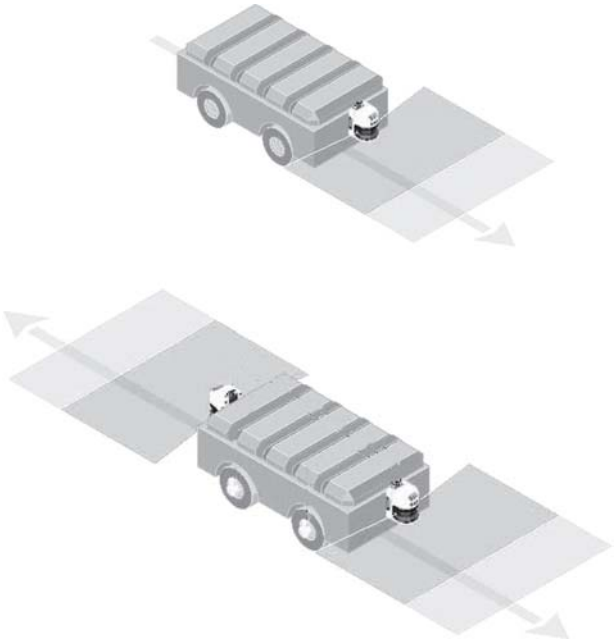
Stationary Vertical Guarding—Two or More Safety Zones

The SafeZone multizone safety laser scanner can be mounted to create up to four vertical detection areas in the same plane. Contour as a reference should be configured to prevent manipulation of the scanner. A static control input switches between the configured fields.



Automatic Guided Vehicles (AGVs)

The SafeZone safety laser scanner is designed to detect fixed objects (walls, columns), as well as moving objects (people, AGVs). The SafeZone safety laser scanner is typically mounted on the front of a mobile vehicle or for AGVs capable of bi-directional travel, in each direction of travel. Any object in the path of the moving vehicle, of sufficient resolution, is detected. When an object or person is detected in the configured warning field, a signal can be used to decrease the speed of the AGV. Intrusion into the safety field will send a signal to the AGV to stop. It is also possible to configure a predetermined time delay where the SafeZone safety laser scanner will monitor the safety field. If the safety field becomes clear, the SafeZone's Output Signal Switching Device (OSSD) will change to a green state and allow the AGV to continue traveling.



Note: Both the SafeZone singlezone and multizone can be used in mobile applications, depending upon safety field range requirements and the required number of switchable pre-configured field sets.

Safety Laser Scanner

SafeZone™ Singlezone/Multizone



Description

The Allen-Bradley Guardmaster SafeZone safety laser scanners are Type 3 opto-electronic devices, which use the diffuse reflection of emitted infrared laser light to determine the intrusion of a person or object within a defined area. A rotating deflection mirror periodically emits Class 1 (eye safe) infrared laser pulses over a 190° angular area to create a two dimensional detection field.

The reflected light is processed by the SafeZone, which sends a stop signal by switching the state of its OSSD, if it is determined that an object is within the preconfigured sensing field(s).

The SafeZone laser scanners are versatile, rugged, opto-electronic devices in an IP65 housing and are ideally suited for a wide range of industrial applications.

Singlezone

The single field set (warning and safety) can be configured within the maximum scanning range of the device. The Safety Configuration and Diagnostic (SCD) Windows-based software, supplied with each scanner, makes programming the SafeZone singlezone simple. A configuration wizard is available to guide the programmer through simple or complex system configurations.

Multizone

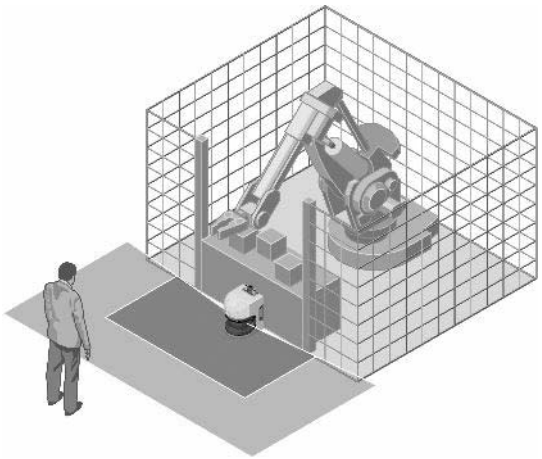
Four switchable zone sets (warning and safety) can be configured within the maximum scanning range of the device. The SCD Windows-based software, supplied with each scanner, simplifies the programming of the SafeZone multizone scanners. A configuration wizard is available to guide the programmer through simple or complex system configurations.

Features

- 190° scanning angle
- Seven-segment diagnostic display
- Configurable resolutions 30, 40, 50, 70, and 150 mm
- Integrated EDM
- Horizontal or vertical mounting
- Four or five meter safety field range

Specifications

Safety Ratings	
Standards	IEC 61496-3, UL 61496, IEC 61508
Safety Classification	Type 3, IEC 61496; SIL CL 2, IEC 61508, IEC 62061; Category 3, PLd EN ISO 13849:2009
Certifications	CE Marked for all applicable directives, TÜV, cULus, Type 3 AOPDDR per IEC 61496, SIL 2 per IEC 61508
Power Supply	
Input Power, Max.	24V DC +20%/-30%
Maximum Residual Ripple	5%
Power Consumption	55 W with max. output load, 19 W without output load
Outputs	
Safety Outputs	2 PNP OSSDs 500 mA short-circuit protection
Auxiliary Outputs	1 PNP OSSD, 500 mA nonsafety
Switching Current @ Voltage, Min.	2 A
Operating Characteristics	
Response Time	60 ms or 120 ms
Status Indicators	OSSDs on, reset required, warning field interruption, front screen contaminated, OSSDs off
Scanning Angle	190° max.
Safety Field Range	4 m (13 ft) for Singlezone 5 m (16.4 ft) for Multizone
Resolution [mm (in.)]	30 (1.18), 40 (1.57), 50 (1.96), 70 (2.75), 150 (5.90)
Angular Resolution	0.25…0.50°
Wavelength	905 nm
Power-Up Delay	9…20 s
Environmental	
Enclosure Type Rating	IP65
Operating Temperature [C (F)]	-5…55° (23…131°)
Storage Temperature [C (F)]	-25…70° (-13…+158°)
Vibration	10…150 Hz, 0.35 mm or 5 g per IEC 61496
Shock	Single: 15 g, 11 ms per EN 60068-2-27 Continuous: 10 g, 16 ms per IEC 61496
Physical Characteristics	
Weight [kg (lb)]	3.3 (7.28)
Material	Die-cast aluminum
Display Window	Polycarbonate
Cable Length	10 m or 20 m (32.8 ft or 65.6 ft)



Product Selection

Singlezone Safety Laser Scanner System Components

Item	Description		Cat. No.
1		Scan head and I/O module assembly	**442L-SFZNSZ**
2		Prewired 13 conductor cable with memory module (10 or 20 m (32.8 or 65.6 ft) required)	**442L-CSFZNMZ-10** 442L-CSFZNMZ-20
3	2 m (6.56 ft) RS232 program cable (required) or		**442L-ACRS232**
	10 m (32.8 ft) RS232 program cable		442L-ACRS232-8

Multizone Safety Laser Scanner System Components

Item	Description		Cat. No.
1		Scan head and I/O Module (required)	**442L-SFZNMZ**
2		Prewired 13 conductor cable with memory module (10 or 20 m (32.8 or 65.6 ft) required)	**442L-CSFZNMZ-10** 442L-CSFZNMZ-20
3	2 m (6.56 ft) RS232 program cable (required)		**442L-ACRS232**
	10 m (32.8 ft) RS232 program cable		442L-ACRS232-8

Note: A SafeZone safety laser scanner system requires the scan head and I/O module assembly (1) with either a 10 or 20 meter prewired memory module (2) and a programming cable (3).

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
Modular Safety Relays							
MSR211P Base 2 N.C. only	2 N.O.	1 N.C.	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-84	440R-H23177
MSR221P Input Module	—	—	Removable	—	24V DC from the base unit	5-88	440R-H23179
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218
Muting Modules							
MSR22LM	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	5-48	**440R-P23071**
MSR42 (requires optical interface to configure 445L-AF6150	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	5-52	**440R-P226AGS-NNR**

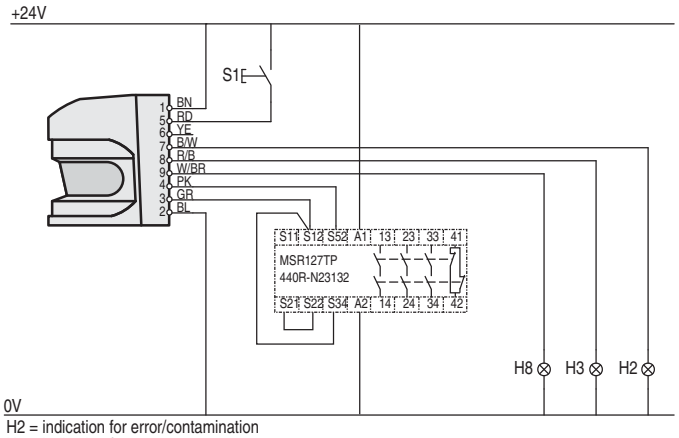
Accessories—Optional

Description		Cat. No.
	Mounting Kit 1: Mounting bracket for direct mounting at the rear on wall or machine. No adjustment facility.	**442L-AMBSFZNMZ1**
	Mounting Kit 2: Bracket only in conjunction with mounting kit 1. Mounting at the rear on wall or machine. Longitudinal and cross-wise adjustment possible.	442L-AMBSFZNMZ2
	Mounting Kit 3: Bracket only in conjunction with mounting kit 1 and 2. Mounting at the rear or below on wall, floor or machine. Longitudinal and cross-wise adjustment possible.	442L-AMBSFZNMZ3
	3.0 A power supply	1606-XLP72E
	USB to serial port adaptor cable	9300USBS
	100 m cable spool 13 conductor	442L-C13GD-S100
	Replacement window kit	442L-SFZNMZW
	Replacement part—Singlezone scan head, 4 m	442L-SFZNSZ-SM
	Replacement part—Multizone scan head, 5 m	442L-SFZNMZ-SM
	Replacement part—Singlezone I/O module, 1 field set	442L-SFZNSZ-FM
	Replacement part—Multizone I/O module, 4 field sets	442L-SFZNMZ-FM
	Replacement part—unwired memory module	442L-SFZNMZ-MEM

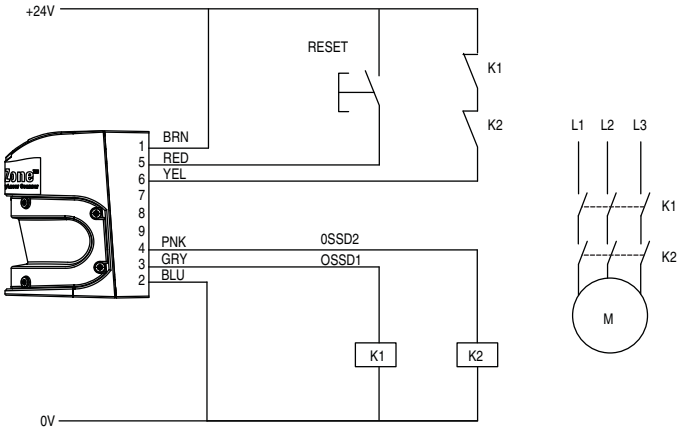
Note: All SafeZone accessories work with either the multizone or singlezone.

Typical Wiring Diagram

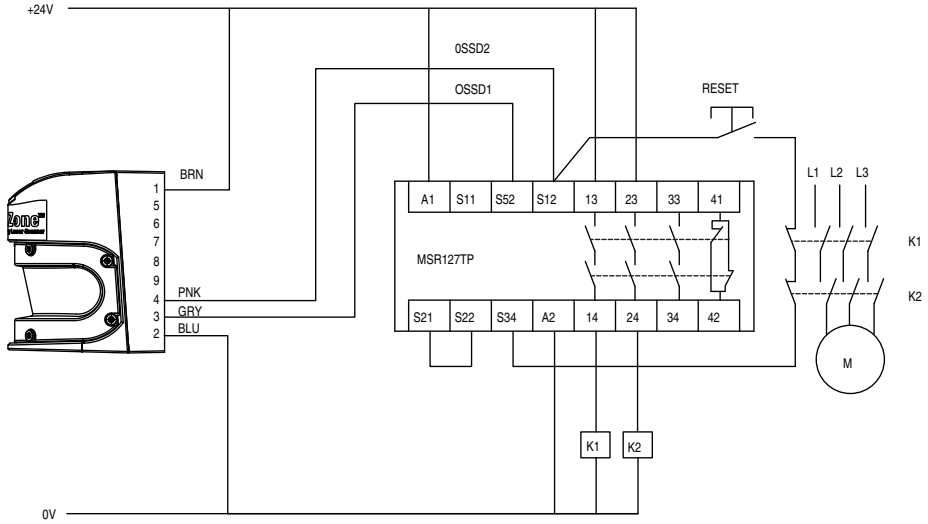
Wiring diagram is not intended to be used for installation purposes.



SafeZone with Restart Interlock to MSR127

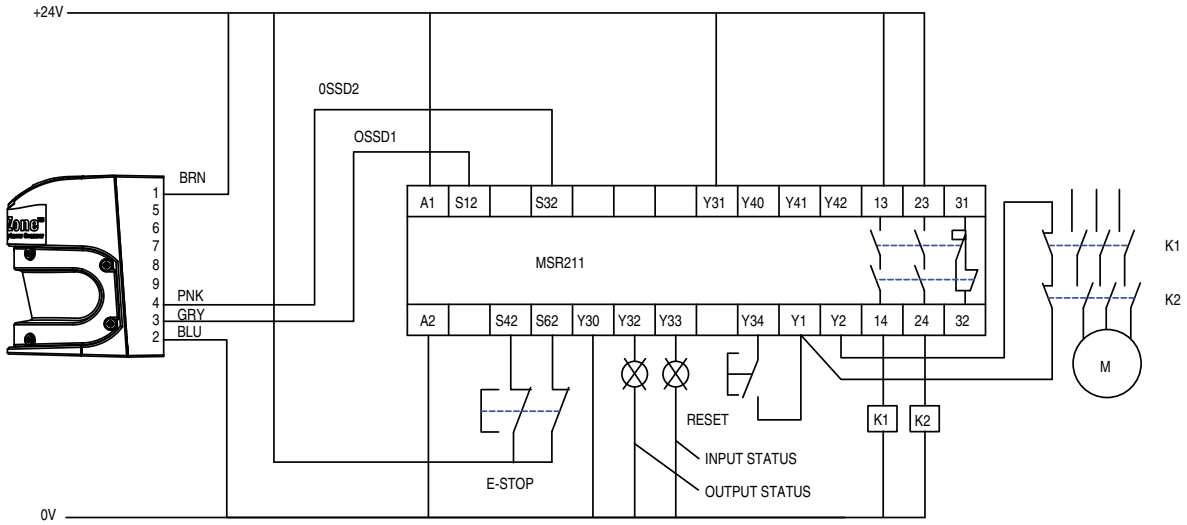


SafeZone with EDM and Restart Interlock

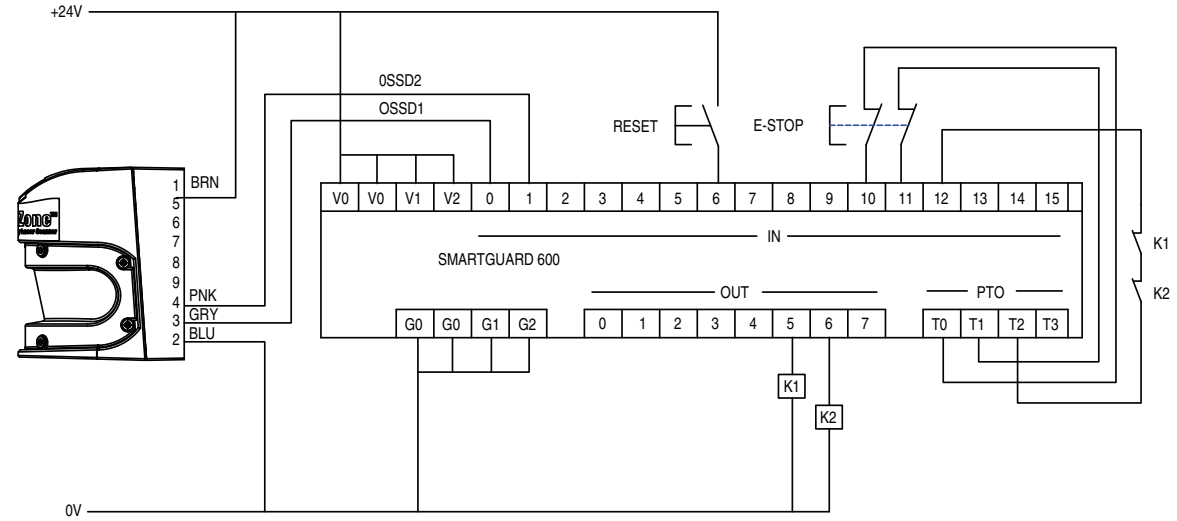


SafeZone to MSR127

Wiring diagram is not intended to be used for installation purposes.



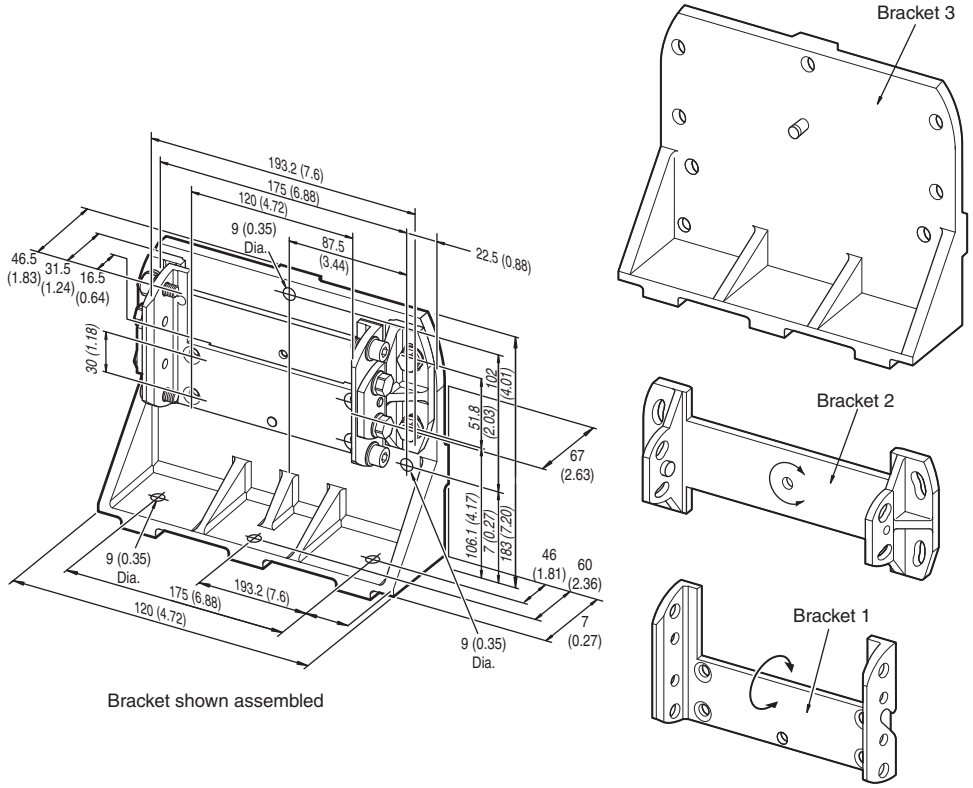
SafeZone to MSR211



SafeZone to SmartGuard 600

Bracket Assembly

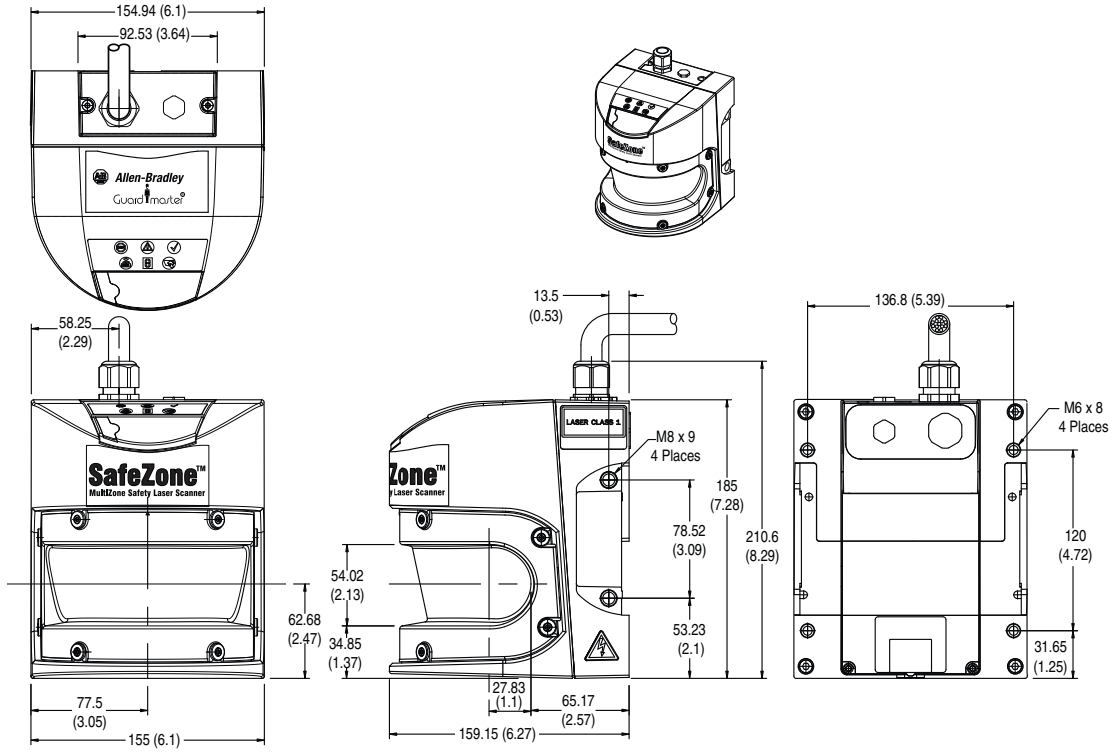
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Bracket shown assembled

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



MatGuard™ Mats

Overview



Description

MatGuard consists of a number of interconnecting pressure-sensitive safety mats and a monitoring control unit that provide a system for area detection. The mat has been designed from the "ground up" to meet the arduous conditions found on the factory floor, and uses well-tried components and techniques to be consistent with Category B and Category 1 requirements.

The mats are available in a wide range of standard sizes to meet most requirements. Special sizes and shapes are available. Each mat has two conductive plates that are held apart by non-conductive compressible separators. Each four-wire mat, operating on only 24V DC, is pre-wired and connected in series with other mats, forming a complete floor-level guarding system for hazardous areas. The circuit through the mat must be monitored by a safety-rated control unit, which may be a Minotaur™ Safety Relay, MatGuard control unit, or MatGuard Mat Manager. When the mat is clear, the control unit provides a signal to the machine control circuit.

When a mat is stepped on, the conductive plates touch and the resistance in the circuit falls to zero. This is monitored by the control unit, which sends a stop command to the machine control system.

The unique molding process allows for the long life and reliability of the mat. Being completely sealed (IP67), water, liquids and coolants present no problem. In addition the tough vinyl will resist bleaches, acids, salts, and all but the most aggressive of industrial chemicals.

A range of control units is available including the Mat Manager, which monitors the status of each mat or area of mats individually. This enables quick fault detection/repair and identification of actuated area.

Features

- EC type certification
- Third party certification to EN 1760-1
- Also meets EN954-1 (ISO 13849-1) category 3 system and IEC/EN 60204-1, AS 4024.5, ANSI B11.19, ANSI RIA R15.06
- Overall sensitivity including uniting strip
- Mat manager monitors the status of each mat individually
- Rugged construction will take the pressure of 4500 psi (does not include the active uniting trim)
- Vinyl construction resistant to most oils
- Sealed to IP67
- 5-year warranty on mats

Chemical Resistance of Sensor Mat Vinyl Covering

Substance	Resistance of Mat Covering
Water	Excellent
Ethyl Alcohol	Excellent
Sodium Chloride	Excellent
Bleach	Excellent
Hydrochloric Acid	Fair to Excellent
Sulphuric Acid	Fair to Excellent
Nitric Acid	Fair to Excellent
Acetic Acid	Fair
Petrol (Gasoline)	Fair
Trichlorethylene	Poor to Fair
Benzene	Poor
Acetone	Poor
Water (Sea)	Excellent
Lubricating Oil	Fair to Excellent
Cutting Fluids	Fair to Excellent
Oil (Auto)	Fair to Excellent
Brake Fluids	Poor to Fair

In general, the covering has excellent resistance to acids, alkalis and salts. Hot acids and alkalis, as well as concentrated and organic acids, have a deleterious effect on prolonged exposure. The covering has fair resistance to aliphatic solvents, fair to poor resistance to aromatic and chlorinated solvents, and poor resistance to ketones and most esters.

Note: Combinations of chemicals can have unpredictable effects. Testing is recommended in such cases. Small pieces of the vinyl material are available if testing is required.

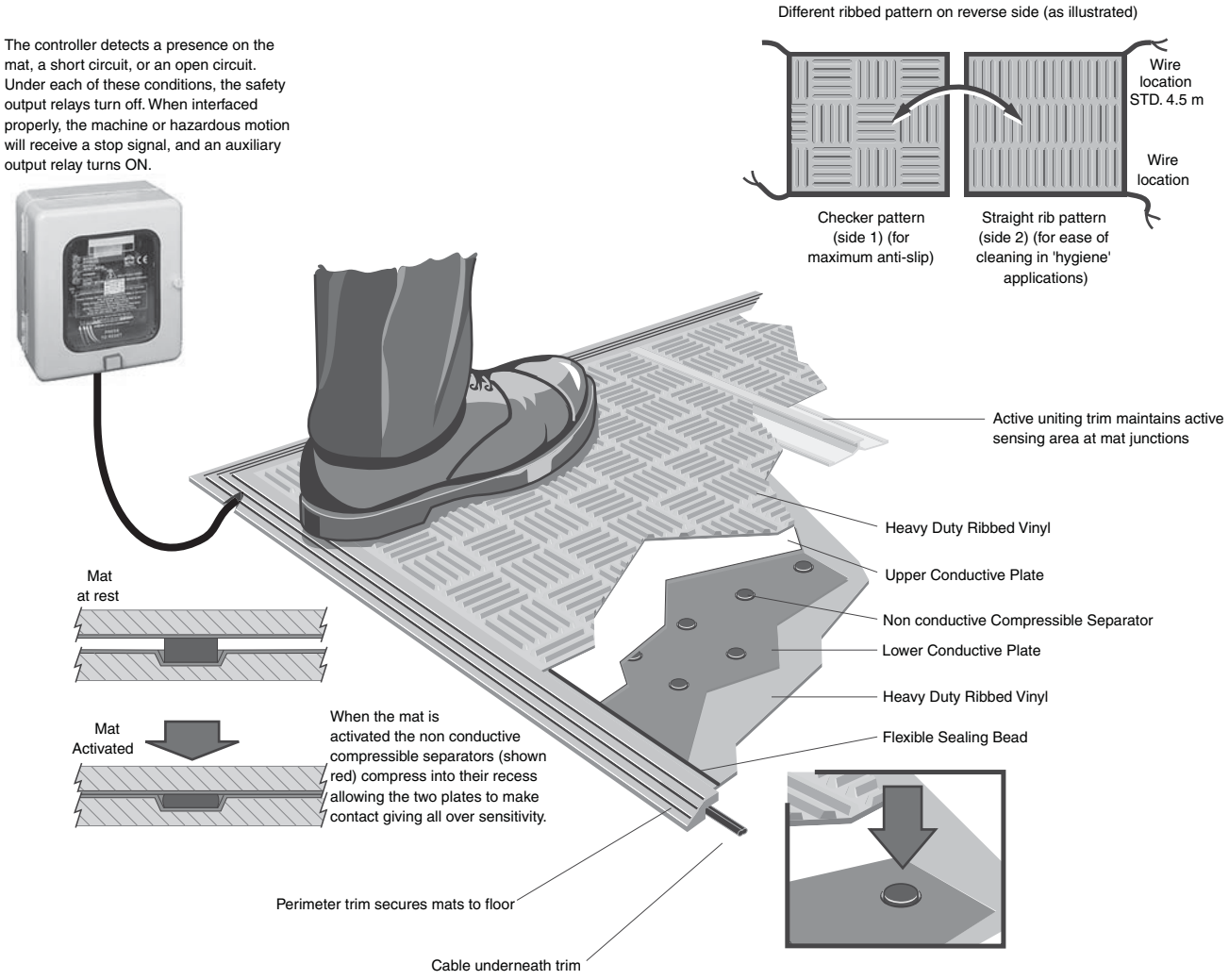
Application Types







Anatomy of a Mat System



Standards

The MatGuard mat system has been designed to conform with the latest European Standard EN 1760-1 “Safety of machinery—Pressure sensitive devices; mats and floors.”

This standard contains requirements for all aspects of design. Some of the most important points are as follows: **(From 4.2.2)** Where an effective sensing area is built up from more than one sensor (mat) it shall have no dead zone.

The standard gives details of the size, force and positioning of test pieces for testing the mat sensitivity.

(From 4.5.1) A single sensor (mat) shall still perform its function after one million actuations by a mass of 75 kg.

(From 4.7) When the actuating force is applied the output signal switching device(s) shall change from an ON state to an OFF state. It shall remain in the OFF state for at least as long as the actuating force is applied.

(From 4.7.1) Device with reset – b) After the actuating force has been removed, the output signal switching device(s) shall only change to the ON state after the application of a reset signal.

(From 4.7.2) Device without reset—For a pressure sensitive mat without reset the output signal switching device(s) shall change to an ON state at power ON and after the actuating force has been removed.

(From 4.15) The pressure sensitive mats shall meet the requirements of the category for which they are specified...

Note: The MatGuard mat system features an “active” mat and a dual channel monitoring control unit. This means that a single electrical fault in the mat, wiring or control unit will be detected and the control unit will go to a safe (OFF) condition.

(From informative annex B.1.1) The top (mat) surface should be of a material which will withstand the operating duty.....The top surface should not present a risk through becoming slippery due to wear or the effects of liquids....

(From informative annex B.1.7) In some situations, heavy loads (such as fork lift trucks) can be applied to the sensor (mat)..... If this is required the user should identify the need to the mat manufacturer.

Note: The standard MatGuard mat can be successfully used with fork lift trucks. The MatGuard Mat System should be installed in accordance with the requirements of EN 999, "The positioning of protective equipment in respect of approach speeds of parts of the human body."

The MatGuard Safety Mat system is also designed to meet the U.S. standards ANSI/RIA R15.06-1999 Safety Requirements for Industrial Robots and Robot Systems and ANSI B11.19 Performance Criteria for Safeguarding.

These two U.S. standards have many similar requirements and provide performance criteria for design, installation and use. Excerpts from these standards include:

From RIA R15.06

(From 11.7) Safety mat systems shall be designed, constructed, and applied such that any single component failure shall not prevent the stopping action of the robot.

(From 5.3.4) Safety mats shall have a minimum object sensitivity which detects 30 kg (66 lb,) weight of an 80 mm (3.125 in.) diameter circular disk anywhere on the mat sensing surface; provide a means to retain minimum object sensitivity at the area where mats joined together.

From ANSI B11.19

(From 11.1.1.4) The safety mat device shall have a maximum response time that is not affected by object sensitivity adjustments or environmental changes.

(From 11.1.1.5) When a component, module, device or system failure occurs, the safety related function shall prevent initiation of the hazardous machine motion, initiate an immediate stop command and prevent re-initiation of the hazardous machine motion.

From AS 4024.5

The MatGuard Safety Mat system is designed to meet the Australian Standard AS 4024.5, which has many similarities to the European Standard EN1760-1. Excerpts from this standard include:

(From 3.2.2) Where an effective sensing area is built up of more than one sensor, it shall have no dead zone.

(From 3.7) When the actuating force is applied the output signal switching device (s) shall change from an 'on' state to an 'off' state. It shall remain in the 'off' state for at least as long as the actuating force is applied.

(From 3.8) The sensor shall be provided with a means for fixed permanent location.

(From 3.10) Provisions shall be made on the top surface of the sensor to minimize slipping under the expected operating conditions.

Application Details

Safety Distance Calculations ANSI/RIA R15.06

The minimum distance calculated is the minimum horizontal distance from the outer edge of the MatGuard sensor mat detection zone to the nearest part of the hazard. The formula for floor mounted safety mats is:

Ds = [K x (Ts + Tc + Tr)] + Dpf

- **Ds** is the minimum safety distance.
- **K** is a minimum speed constant based on the movement of the hand/arm only and the body being stationary.
  K=1600 mm/s (63 in./s)
- **Ts** is the worst stopping time of the machine/equipment.
- **Tc** is the worst stopping time of the control system.
- **Tr** is the response time of the safeguarding device.
- **Dpf** is the depth penetration factor which is the maximum travel towards the hazard within the safety mat area that may occur before a stop is signalled.
  Dpf=1200 mm (48 in.)

The response time of the machine and control system used in the calculation must be the worst case. Some machines have inconsistent response times that are dependent upon mode of operation, nature of the work piece and point in the operating cycle at which stopping is initiated. An allowance should be made for wear in brakes, temperature, aging of components, etc., if this can affect the response time. An allowance for further delays in the machine control system may be required in some circumstances.

Calculation Example

In this example, the MatGuard system is being used with a machine and control system with a worst-case response time measured at 0.485 seconds. The system is on a flat surface, it is not on a raised platform. Using the formula above.

$$T = Ts + Tc + Tr$$
$$0.035 + 0.485$$
$$0.520 \text{ s}$$

$$S = (63 \times 0.520) + 48$$
$$80.76 \text{ in.}$$

Sensor mats will be required from 2032 mm right up to the edge of the machine base plate.

Safety Distance Calculations EN999

The minimum distance calculated is the minimum horizontal distance from the outer edge of the MatGuard sensor mat detection zone to the nearest part of the hazard. The formula for floor mounted safety mats is:

S = [1600 x (t1 + t2)] + (1200 – 0,4H)

- **S** is the minimum safety distance in mm in a horizontal plane from the danger zone to the detecting edge of the device furthest from the danger zone.
- **1600** is a minimum speed constant based on the movement of the hand/arm only and the body being stationary.
  1600 mm/s = 63 in./s
- $\mathbf{t_1}$ is the maximum time between the actuation of the sensing function and the output signal switching devices being in the off state.
- $\mathbf{t_2}$ is the maximum response time of the machine, i.e., the time required to stop the machine or remove the risks after receiving the output signal from the protective equipment.
- **1200** is the depth penetration factor which is the maximum travel towards the hazard within the safety mat area that may occur before a stop is signalled.
  1200 mm = 48 in.
- **H** is the distance above the reference plane, e.g., floor, in millimeters.

The response time of the machine and control system used in the calculation must be the worst case time. Some machines have inconsistent response times that are dependent upon mode of operation, nature of the work piece and point in the operating cycle at which stopping is initiated. An allowance should be made for wear in brakes, temperature, aging of components, etc., if this can affect the response time. An allowance for further delays in the machine control system may be required in some circumstances.

Calculation Example

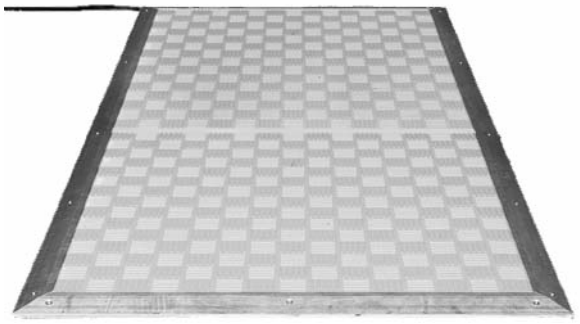
In this example, the MatGuard system is being used with a machine and control system whose worst case response time has been measured as 0.485 seconds. The system is on a flat surface, it is not on a raised platform. Using the formula above,

$$T = t_1 + t_2$$
$$0.035 + 0.485$$
$$0.520 \text{ s}$$

$$S = (1600 \times 0.520) + 1200$$
$$832 + 1200$$
$$2032 \text{ mm}$$

Sensor mats will be required from 2032 mm right up to the edge of the machine base plate.

MatGuard™ Mats



Description

The MatGuard safety mat is a pressure-sensitive safeguarding product that is designed to detect the presence of people on its sensing surface.

The MatGuard safety mat has two conductive hardened steel plates that are held apart by non-conductive compressible separators. Each four-wire mat, operating on only 24V DC, is pre-wired and connected in series with other mats to form a floor level guarding system for hazardous areas. The circuit through the mat must be monitored by a safety-rated control unit, which may be a Minotaur Safety Relay, MatGuard control unit, or MatGuard Mat Manager. When the mat is clear, the control unit provides a signal to the machine control circuit.

When a mat is stepped on, the conductive plates touch and the resistance in the circuit falls to zero. This is monitored by the control unit, which sends a shutdown signal to the machine.

Since the MatGuard safety mat is completely sealed (IP67), water, liquids and coolants present no problem. In addition, the tough vinyl will resist bleaches, acids, salts and many industrial chemicals.

The unique molding process allows the long life and reliability of the mat.

Features

- Hardened steel plate construction
- No dead spots
- 4-wire system to detect opens and shorts
- Can withstand a static pressure of 4500 psi
- IP67 rated

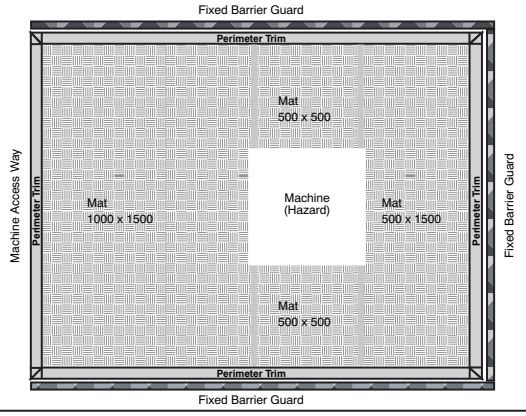
Specifications

Standards	EN1760-1, EN954-1, ISO 13849-1, IEC/EN60204-1, ANSI RIA R15.06, ANSI/B11.19, AS4024.5
Category	Cat. 1 device per EN954-1, suitable for Cat. 3 systems
Certifications	CE Marked for all applicable directives, cULus Listed, CSA Z432-04, and TÜV
Power Supply	24V DC, -20% +10%, provided by the control unit
Connection Wire Length, Max.	200 m (656 ft)
Cable Length	4.5 m (15 ft) standard (see Product Selection)
Detection Weight	30 kg (66 lbs) minimum on an 80 mm (3.125 in.) diameter circular disk
Maximum Pressure Applied to Mat	31,034 kPa (4500 psi)
Zone Size	100 m^2 (1076 ft^2), maximum
Mechanical Life	10,000,000 operations
Operating Temperature [C (F)]	-25…55° (-14…131°)
Relative Humidity	100%
Enclosure Type Rating	IP67 (NEMA 6P)
Vibration	5 g, 10…200 Hz
Shock	11 ms 10 g/16 ms 10 g
Terminal Protection	IP 20 DIN 0470
Wire Size	0.75 mm^2 (18 AWG), 2 wire; 3.8 mm x 7.4 mm (0.15 in. x 0.29 in.) jacket OD
Weight	10.9 kg/m^2 (2.2lbs/ft^2)
Material	Plastisol Vinyl
Color	Yellow or Black
Trim Material	6063 Aluminum
Mounting	Flat surface
Thickness	16 mm (0.63 in.)

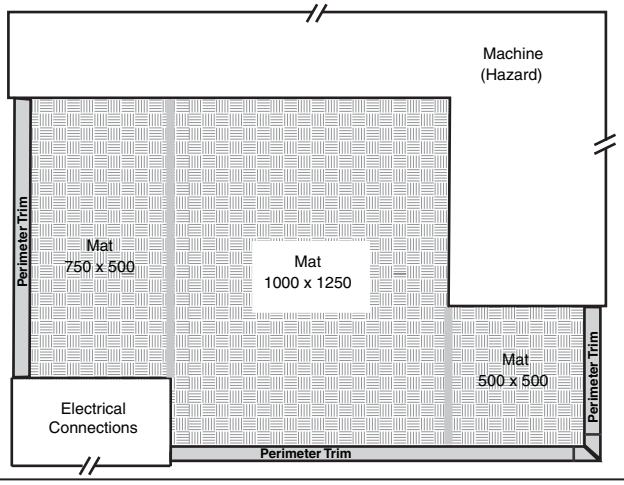
Product Selection—Standard Mats

Mat Size [mm (in.)]	Cat. No.	
	Standard Perimeter Trim Kit	Safety Mat
500 x 500 (19.7 x 19.7)	440F-T1010	**440F-M1010BYNN**
500 x 1500 (19.7 x 59.1)	440F-T1030	**440F-M1030BYNN**
500 x 750 (19.7 x 29.5)	440F-T1015	440F-M1015BYNN
750 x 750 (29.5 x 29.5)	440F-T1515	440F-M1515BYNN
750 x 1500 (29.5 x 59.1)	440F-T1530	**440F-M1530BYNN**
500 X 1000 (19.7 X 39.4)	440F-T1020	**440F-M1020BYNN**
750 X 1000 (29.5 X 39.4)	440F-T1520	440F-M1520BYNN
1000 x 1000 (39.4 x 39.4)	440F-T2020	**440F-M2020BYNN**
1000 x 1250 (39.4 x 49.2)	440F-T2025	**440F-M2025BYNN**
1000 x 1500 (39.4 x 59.1)	440F-T2030	**440F-M2030BYNN**
1000 x 1800 (39.4 x 70.9)	440F-T2036	440F-M2036BYNN
Recommended control unit. For other control units, see page 5-69.		**440R-C23139**

Examples of Standard System Configurations



Bill of Materials		
Description	Quantity	Cat. No.
Mat	1	**440F-M2030BYNN**
	2	**440F-M1010BYNN**
Mat	1	**440F-M1030BYNN**
Perimeter Trim*	2	440F-T3210
Perimeter Trim*	1	440F-T3310
Active Uniting Trim Used to join two mats to ensure no dead spots	1	440F-T3220
MatGuard Controllers	1	440F-C4000S
Corner Trim	4	440F-T3012

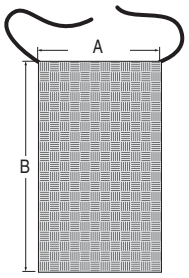


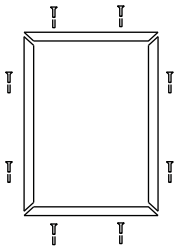
Bill of Materials		
Description	Quantity	Cat. No.
MatGuard Safety Mats	1	**440F-M2025BYNN**
	1	**440F-M1010BYNN**
	1	440F-M1015BYNN
Perimeter Trim*	1	440F-T3310
Corner Trim	1	440F-T3012
Uniting Trim	2	440F-T3020
MatGuard Controllers	1	440F-C4000P

* Customer must cut trim to proper length.

Product Selection—Configurable Mats

MatGuard safety mat and trim kit cat. nos. can be configured by selecting the appropriate codes from the tables below.





Mats:	440F	M	13	23	A	Y	NN
			a	*b*	*c*	*d*	
Trim Kit:	440F	T	13	23			
		e	*a*	*b*			

a

"A" Dimension [mm (in.)]	
Code	Description
2 digit number	Length of the mat in millimetres/50 Must be in 50 (1.97) increments Min. allowed 150 (03); Max. allowed 1000 (20) The length of A must be equal to or shorter than B.

b

"B" Dimensions [mm (in.)]	
Code	Description
2 digit number	Length of the mat in millimetres/50 Must be in 50 (1.97) increments Min. allowed 200 (04); Max. allowed 1800 (36) The length of A must be equal to or shorter than B.

c

Cable Exit	
Code	Description
A	Two 4.5 m (15 ft) 2-wire cables—exit out the A corners
B	Two 4.5 m (15 ft) 2-wire cables—exit out the B corners
C	One 9.1 m (30 ft) 4-wire cable with M12 male connector exits out of upper left corner
D	One 9.1 m (30 ft) 4-wire cable without connector exits out of upper left corner
F	One 0.76 m (2.5 ft) 4-wire cable with M12 male connector exits out of upper right corner
G	One 9.1 m (30 ft) 4-wire cable with M12 male connector exits out of upper left corner for use with 898D Distribution Box
H	One 9.1 m (30 ft) 5-wire cable with M12 male connector exits out of upper left corner for use with ArmorBlock Guard I/O

d

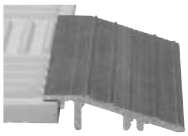
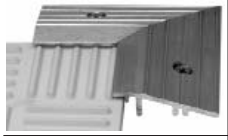
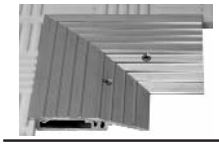
Color	
Code	Description
B	Black
Y	Yellow

e

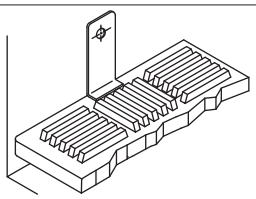
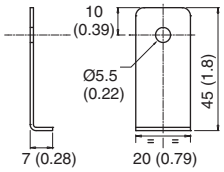
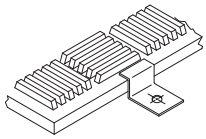
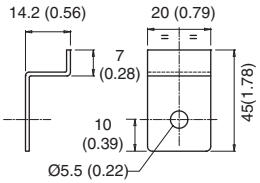
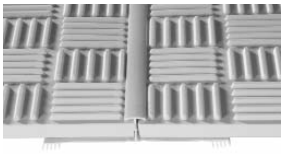
Trim Options	
Code	Description
K	Cable Channel Trim
T	Standard Trim

Note: Order controller separately, see page 5-68 for selection details.

Product Selection, Trim Options

Type	Description	Length	Cat. No.
	Standard perimeter trim (aluminum) for use with up to 3 cables running through channel.	2 m, square ends	440F-T3210
	Aluminum standard perimeter trim. For use with up to 3 cables running through channel.	3 m, square ends	440F-T3310
	Aluminum external corner standard perimeter trim	See page 2-99	440F-T3012
	Aluminum internal corner standard perimeter trim		440F-T3013
	Aluminum perimeter trim with cable channel. Used when up to 8 cables need to be fed through channel.	2 m, square ends	440F-T3211
		3 m, square ends	440F-T3311
		4 m, square ends	440F-T3411
	Aluminium external corner perimeter trim with cable channel	See page 2-99	440F-T3014
	Internal corner perimeter trim with cable channel		440F-T3015

Accessories

Type	Description	Dimensions—mm (in)	Cat. No.
	Aluminum right angle perimeter trim	13 x 25 mm, 2 m length (½ x 1 in., 6.6 ft length)	440F-T3216
		13 x 25 mm, 3 m length (½ x 1 in., 9.8 ft length)	440F-T3316
	Stainless steel angle clip perimeter trim (5 per package)		440F-T102933
	Stainless steel z-clip perimeter trim (5 per package)		440F-T102935
	Active uniting trim (used to join two mats to ensure no dead spots)	1 m (3.28 ft) length, square ends	440F-T3120
		1.5 m (4.9 ft) length, square ends	440F-T3020
		2 m (6.5 ft) length, square ends	440F-T3220
		3 m (9.8 ft) length, square ends	440F-T3320
	Vinyl wire guide	63.5 mm (2.5 in.) width, 2 m (6.6 ft) length	440F-T3230
	Accessories kit for 440F-C4000S and 440F-C4000P. 4 butt splices, 2 500 mA fuses, 4 wire terminations	N/A	440F-A108433
	12 Philips flat head, stainless steel screws for 440FA-3211 and 440FT3411 channel trim. Secures top to the bottom.	#6 x 9.5 (3/8)	440F-A17143
	12 Philips flat head, stainless steel screws with anchors for 440F-T3210, 440F-T3310, and 440F-T3510 trim	#10 x 38 (1.5)	440F-A17141
	12 flat head, stainless steel screws with anchors for 440F-T3211 and 440F-T3411 channel trim	#10 x 32 (1.25)	440F-A17142
	DC Micro QD Cordset, 4-pin 1 Brown 2 White 3 Blue 4 Black	2 m (6.5 ft)	889D-F4AC-2
		5 m (16.4 ft)	889D-F4AC-5
		10 m (32.8 ft)	889D-F4AC-10
		15 m (49.2 ft)	889D-F4AC-15
		20 m (65.6 ft)	889D-F4AC-20
		30 m (98.4 ft)	889D-F4AC-30
Reset push button for Mat Manager controllers			800FP-FOPN3YX11

Approximate Dimensions

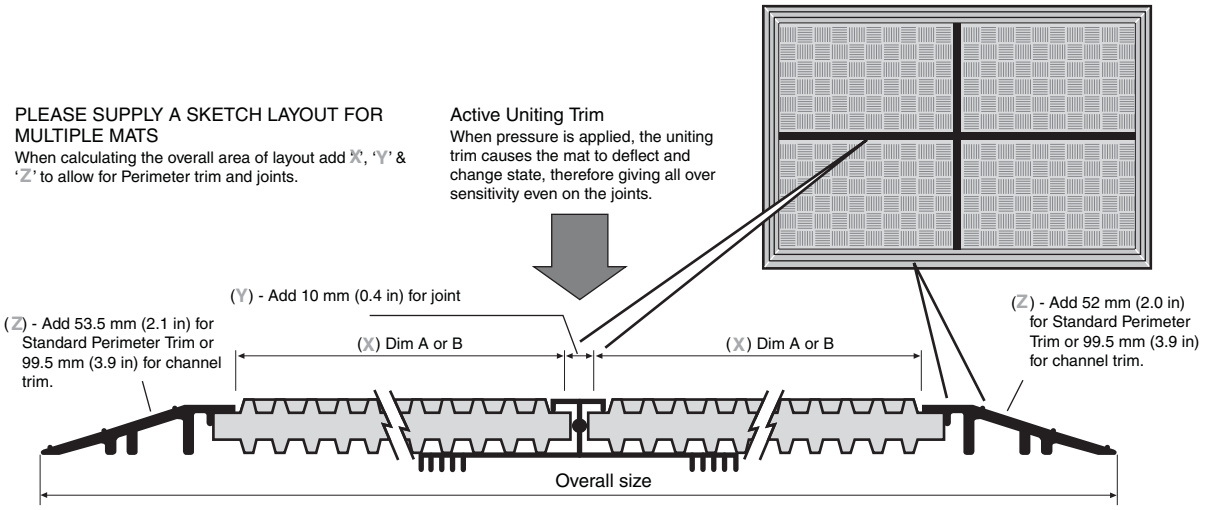
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Mat System

When more than one mat is needed to protect an area, use the dimensions below to determine how large of an area is covered.

PLEASE SUPPLY A SKETCH LAYOUT FOR MULTIPLE MATS
When calculating the overall area of layout add 'X', 'Y' & 'Z' to allow for Perimeter trim and joints.

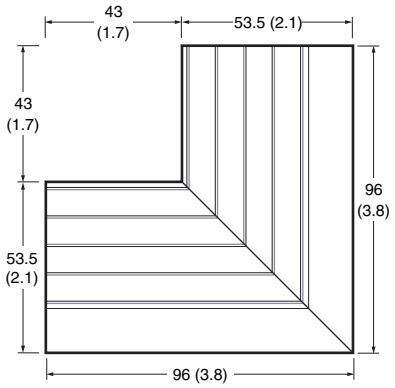
Active Uniting Trim
When pressure is applied, the uniting trim causes the mat to deflect and change state, therefore giving all over sensitivity even on the joints.



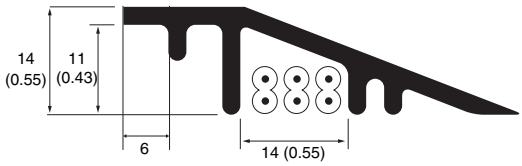
IMPORTANT Use the Distance Calculation on page 2-92 to ensure adequate coverage around the hazard.

Standard Perimeter Trim

Internal and External Corners



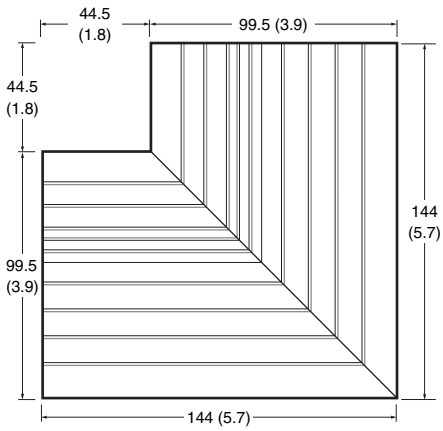
Channel Dimensions



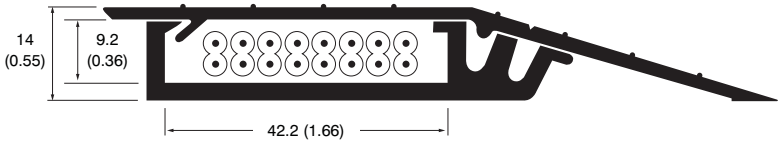
Standard perimeter trim holds three standard 2-wire mat cables or 2 4-wire cables. The equivalent of two cables are needed when connecting two mats in series.

Perimeter Trim with Cable Channel

Internal and External Corners



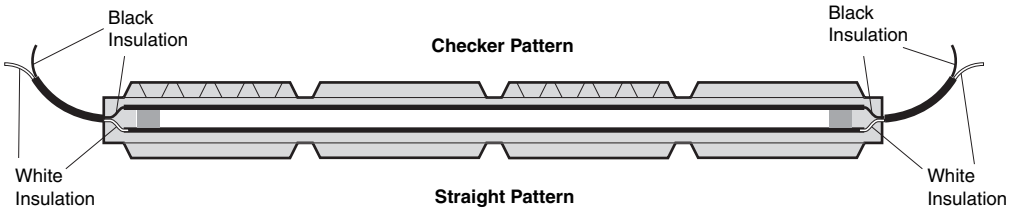
Channel Dimensions



Cable channel trim holds up to 8 standard 2-wire mats cables or 7 4-wire cables even when going around corners.

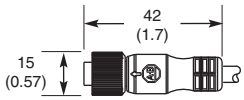
Connectivity

Two-Wire Cable Option



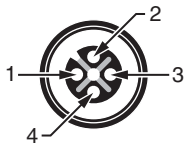
Note: Flat cable O.D. 6.5 mm x 3.5 mm

4-Pin Micro M12 Connector Option [mm (in.)]



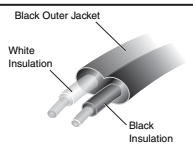
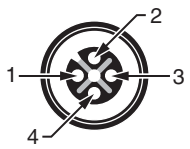
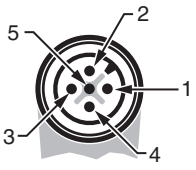
Straight Male

Checkered Rib Side of Mat



Straight Rib Side of Mat

Connection Cables

Cable Exit Configuration Code	Description	Compatibility	Connector	Wire Color	Circuit
A	Two 4.5 m (15 ft) 2-wire cables—exit out the A corners	Safety Relays		Black Black	N.C.
B	Two 4.5 m (15 ft) 2-wire cables—exit out the B corners	Safety Relays		White White	N.C.
C	One 9.1 m (30 ft) 4-wire cable with M12 male connector exits out of upper left corner	Mat Managers		1 Brown 2 White	N.C.
				3 Blue 4 Black	N.C.
D	One 9.1 m (30 ft) 4-wire cable without connector exits out of upper left corner	Safety Relays		1 Brown 2 White	N.C.
				3 Blue 4 Black	N.C.
F	One 0.76 m (2.5 ft) 4-wire cable with M12 male connector exits out of upper left corner	Mat Managers		1 Brown 2 White	N.C.
				3 Blue 4 Black	N.C.
G	One 9.1 m (30 ft) 4-wire cable with M12 male connector exits out of upper left corner	Distribution Block (2 N.C.) 898D-4*LT-DM4		1 Brown 3 Blue	N.C.
				2 White 4 Black	N.C.
H	One 9.1 m (30 ft) 5-wire cable with M12 male connector exits out of upper left corner	ArmorBlock Guard I/O		1 Brown 2 White	N.C.
				4 Black 5 Grey	N.C.

Connection to Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR131RTP	3 N.O.	2 N.C., 2 PNP Solid State	Removable (Screw)	Auto./Manual or Monitored Manual	24V AC/DC	5-28	440R-C23139
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Specialty Safety Relays							
MSR23M	2 N.O.	1 N.C.	Fixed	Automatic/Manual Monitored Manual	24V AC/DC	5-66	**440R-P23073**
Mat Controller	2 N.O.	1 N.C.	Fixed	Automatic/Manual Monitored Manual	24V AC/DC or 115/230V AC	5-68	**440F-C4000S**
Mat Manager	2 N.O.	1 N.C.	Fixed	Auto./Manual Monitored Manual	24V DC	5-70	**440F-C28011**
Modular Safety Relays							
MSR210P Base (2 N.C.)	2 N.O.	1 N.C. and 2 PNP Solid State and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module (all)	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR320P Input Module (all)	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

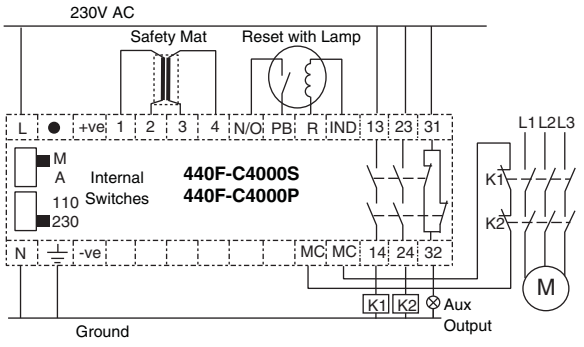
Note: For additional Safety Relays connectivity, see the Logic section of this catalog.
For additional Safety I/O connectivity, see the Safety I/O section of this catalog.
For Application and wiring diagrams, see the Applications section of this catalog.

Connection Systems

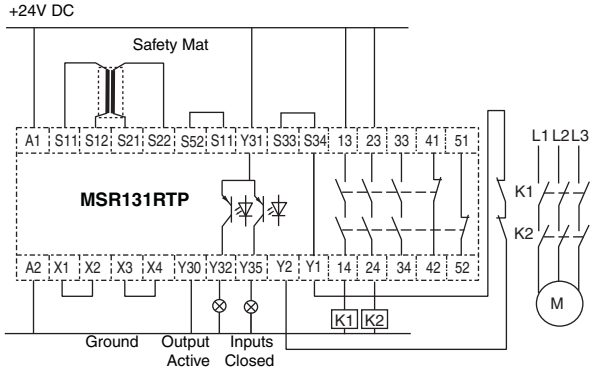
Connection	4-Pin	5-Pin
Cordset	889D-F4AC-✶	889D-F5AC-✶
Patchcord	889D-F4ACDM-❄	889D-F5ACDM-❄
Distribution Box	898D-4‡LT-DM4	NA
Shorting Plug	898D-41LU-DM	NA
T-Port	898D-43LY-D4	NA

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.

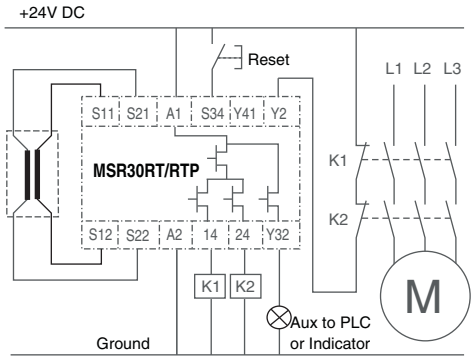
Typical Wiring Diagrams



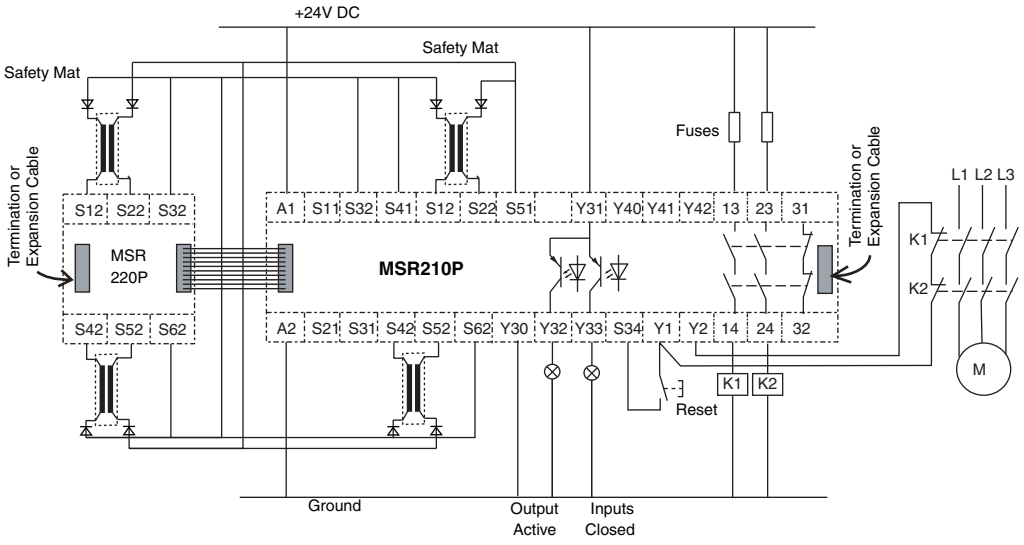
Safety Mat, Monitored Manual Reset, Dual Channel Output, Monitored Output



Safety Mat, Automatic Reset, No Output Monitoring

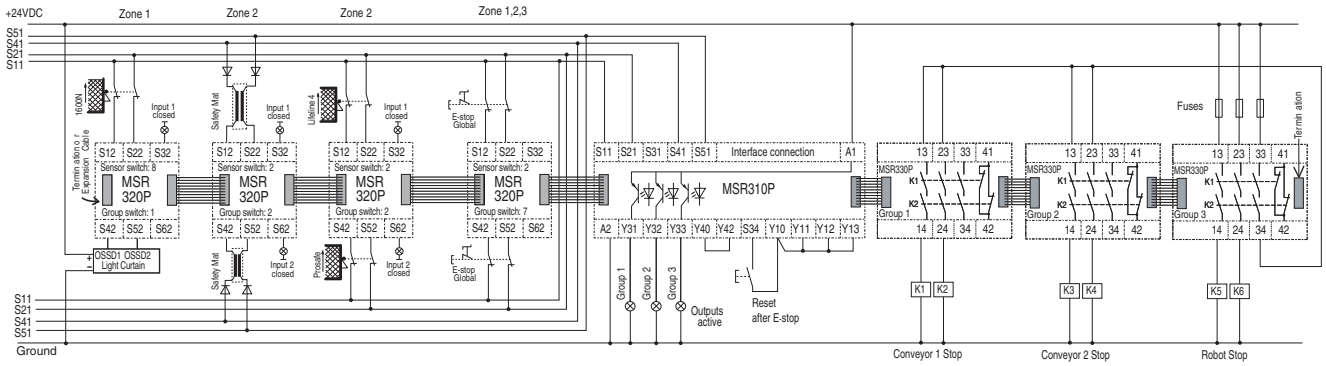


Safety Mat, Dual Channel Output Monitored, Manual Reset, Output Monitoring

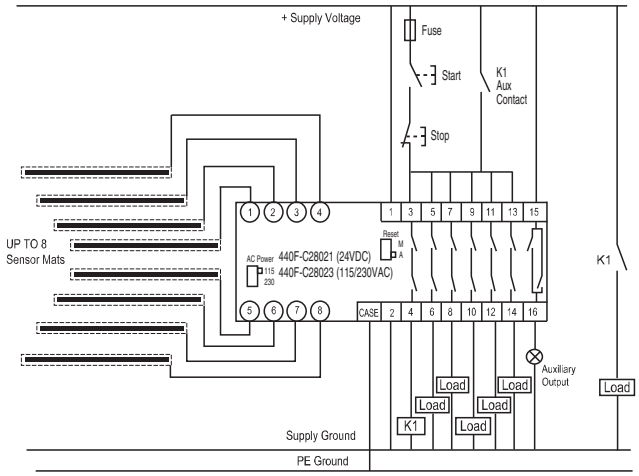


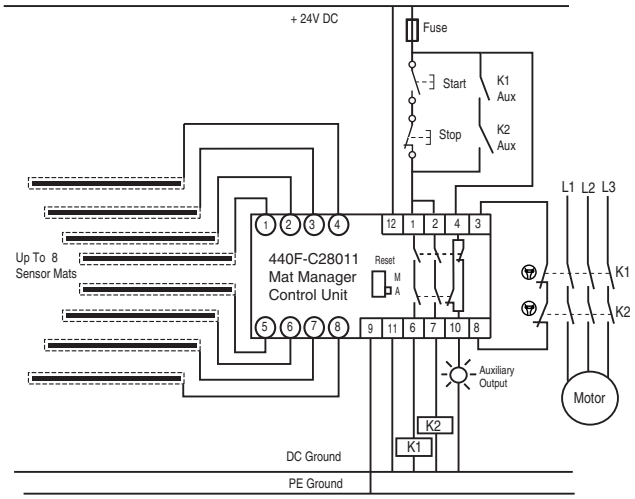
Four Individually Monitored Safety Mats, Monitored Manual Reset, Dual Output, Output Monitoring

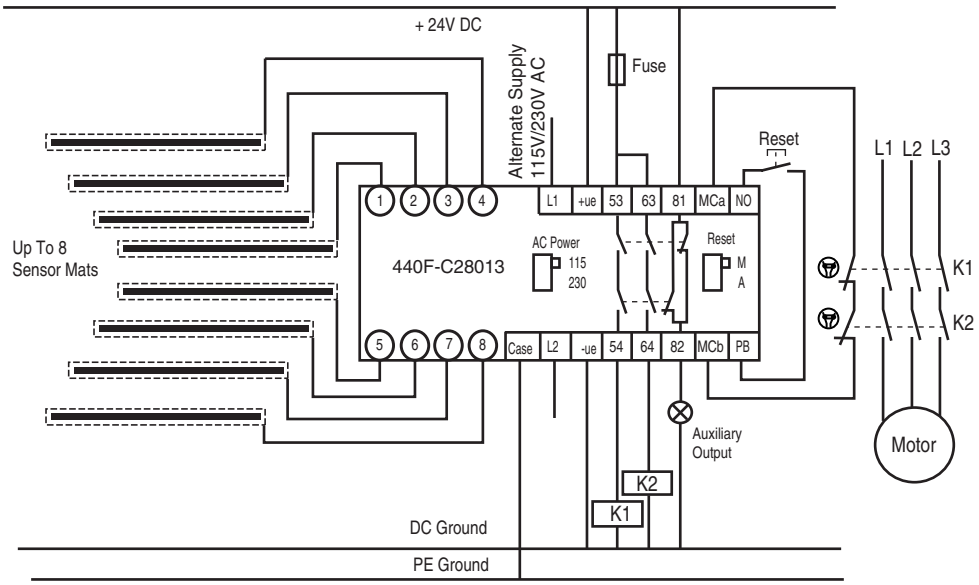
Note: The diodes shown can be terminal blocks with built-in diodes (1492-JD3DF or 1492-JD3DR).



Note: The diodes shown can be terminal blocks with built-in diodes (1492-JD3DF or 1492-JD3DR).





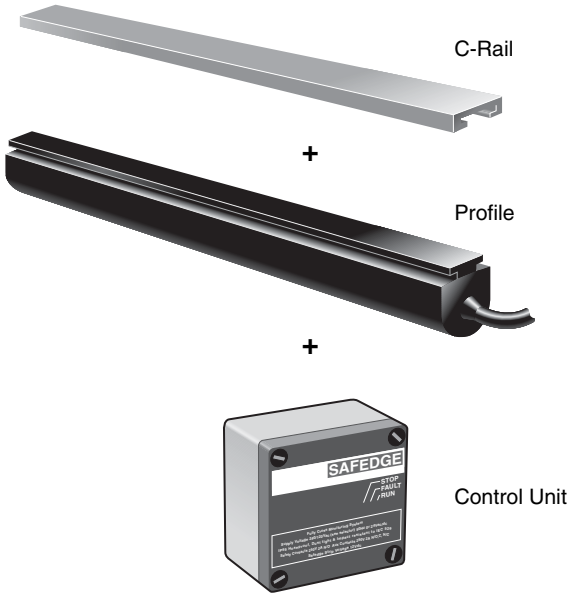


Safedge™ Profiles

Overview

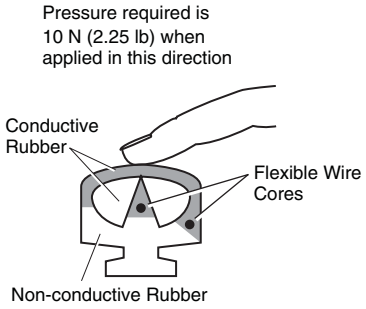
System Components

The Safedge sensitive edge systems are used in a variety of applications where the edge of an object must be detected by contact. The Safedge system consists of three parts: 1) a C-rail, which is used to mount the profile; 2) a profile, which contains the sensing surface; and 3) a control unit, which checks the operation of the profile and interfaces with the control system. A typical system is shown below.



Operating Principle

The profile works on the principle of a two-wire design with conductive rubber. Two wires run the length of the profile. The wires are terminated with a known resistor. When the profile is deformed, the conductive rubber comes in contact with each other and causes the overall resistance to drop.

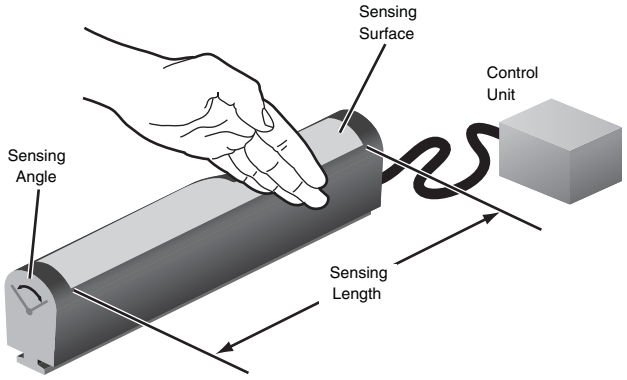


The control unit provides a voltage source to the wires in the profile. It continuously checks the continuity of the wires for shorts, opens and changes in resistance. If the circuit opens, becomes shorted, or the resistance changes, the output of the control unit turns off.

The control unit can also be used to monitor the performance of the output switching devices.

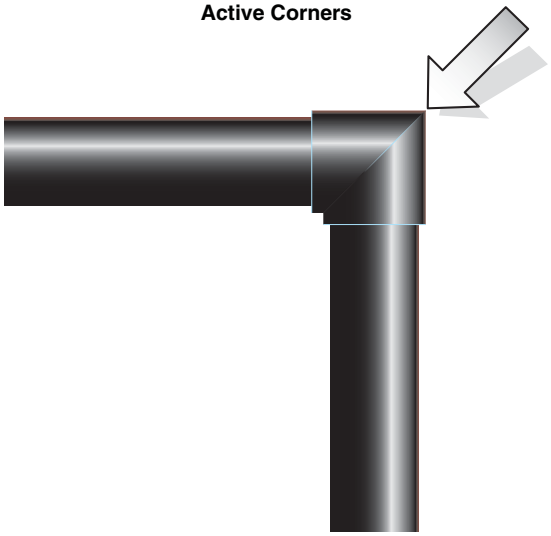
Sensing Surface

The profile is best actuated along its sensing surface. The sensing surface of the Safedge system is active along almost the full length of the edge. The 10 mm at the beginning and end are not active.



One distinct advantage of the Safedge system is the active corners. Pressure applied to the corners is detected by the control unit.

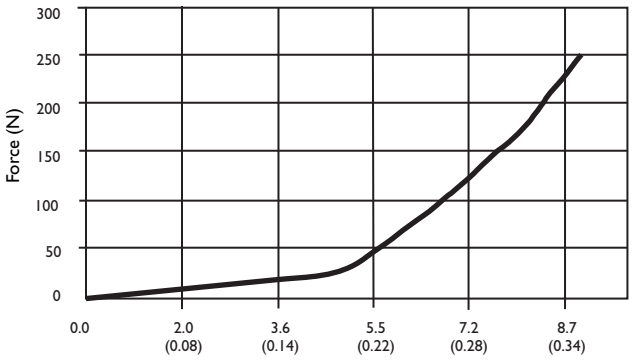
Active Corners



Force Travel Relationship

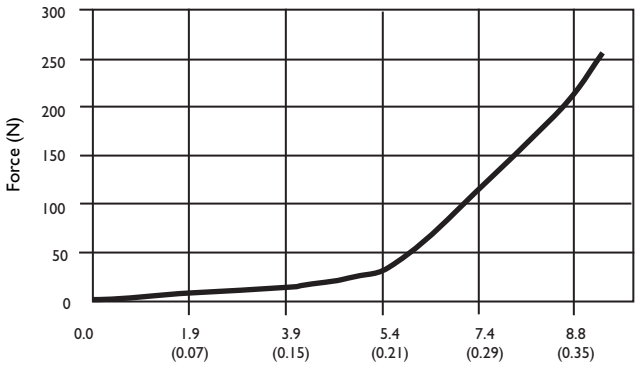
Since the Safedge system is a contact device, a force is required to operate the device. This force is dependent on the shape of the object applying the force, the speed of the object and deformation distance on the profile. To help understand the force requirements, the European standard EN1760-2 2001 provides three test objects travelling at two speeds. Shown in the graph below is the force that is applied over the deformation distance on the surface of the profile. Note that the force required to operate the corners is greater than the force required along the straight section of the profile. This force must be used as a guideline, as the inanimate object can not be harmed.

Force vs. Distance



Vp = 10 mm/s

Force vs. Distance



Vp = 100 mm/s

Risk Assessment

A risk assessment must be performed to determine the proper use of the edge system. Additional protective measures must be used when an individual can reach around or over the edge system and gain access to a hazard. The edge system is designed to be a contact type of system. Therefore “cushion factor” is an important consideration.

Selecting the Cushion Factor

One of the important characteristics of edge systems is called cushion factor. The cushion factor is the distance the profile can be depressed after the signal is generated. This is important when the profile is mounted on automated doors.

Automated doors will continue to close for some finite time after the profile sends the initial stop signal. This is known as the system response time. The system response time is the sum of the Safedge control unit response time, the control system response time, and the mechanical stopping time. Systems with longer response time should utilize larger cushion factors. Users must validate that injury does not occur if parts of the body get jammed, for example between the sensing edge and the fixed part of a machine.

Users might also consider a reversing option. When the profile is depressed, the Safedge control unit sends a signal to a reversing relay. Since the reversing relay is not a safety rated device, the user must still confirm that injury does not occur if parts of the body get jammed.

Typical Applications

Typical applications for sensitive edge systems are:

- Sliding doors
- Sliding gates
- Automated guided vehicles
- X-Y tables
- Fence tops
- Scissor jacks
- Loading platforms

The profile is mounted on the leading edge of the moving object. As the profile comes in contact with an object, the sensing surface of the profile deforms. The deformation causes the conductive rubber parts to make contact and reduce the circuit resistance. The control makes contact.

Typically, the edge of the object is leading edge and is moving, like a sliding door or gate. Edge systems have also been used on the leading edges of X-Y tables and automated guided vehicles.

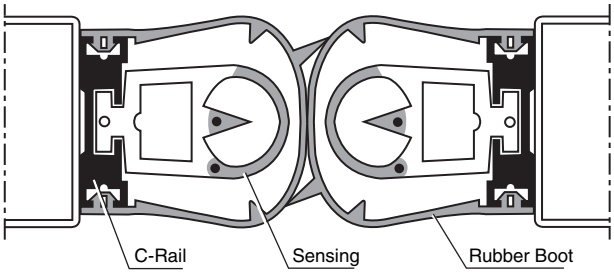
In some applications, a drip edge or seal is needed to reduce wind and rain leaking into a door. The Safedge system accommodates both types of applications. Safedge has three profiles that include a sealing lip.



Safedge™ Profiles

Overview

Safedge can also be ordered with a rubber cover as shown below. This allows compression of the rubber boot without deforming the profile.



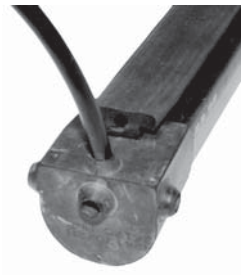
Cable Termination

The cable can be terminated in one of four ways providing flexibility in design and installation of cable routing. Specify the LHT or RHT from the point of view of looking directly at the end of the profiles as shown below.

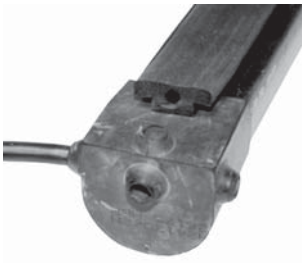
SET—Straight



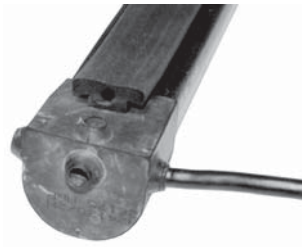
UNDER—Under



LHT—Left-hand



RHT—Right-hand

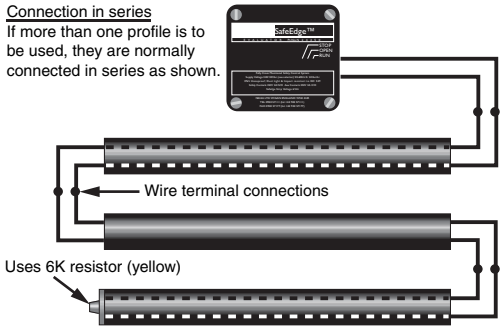


Connection Methods

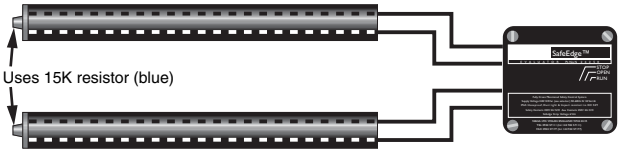
The profiles can be connected in one of two ways: series or parallel. Either method provides the same performance. Selection of the method is determined by ease of installation. The more popular method is series.

Series Connection

Connection in series
If more than one profile is to be used, they are normally connected in series as shown.



Parallel Connection



A maximum of two profiles can be connected in parallel.

Safedge™ Profiles



Description

The ability of the Safedge profile to out perform competition lies in its innovative design. It uses a combination of non-conductive rubber and flexible wire-cored conductive rubber bonded together so it keeps bouncing back into shape even after repeated compressions.

The Safedge profiles come in three different cushions factors: 5 mm (0.2 in.), 19 mm (0.75 in.), and 41 mm (1.6 in.). Cushion factor is the distance the profile can be depressed after a signal has been generated. The profiles are also offered with a sealing lip which is designed to reduce drafts between the profile and opposing surface.

The profiles come in two different materials. Use the EPDM material in the presence of conductive fluids. The NBR/CR material performs better in the presence of oils. Review the chemical resistance chart to help make the best choice of material. If in doubt, a small sample of the profile should be tested for chemical resistance before a final selection is made.

The Safedge profile has no rigid internal parts which can “break through” or cause fatigue failures after prolonged use. The multi-stranded copper wire core throughout the length of the strip reduces the risk of resistance build up on long lengths.

Features

- Various profiles
- Conductive rubber technology
- Up to 50 m lengths
- Aluminum, plastic or zinc-coated steel mounting rails
- Rubber boot optional
- Active corners
- Sealing lip available

Specifications

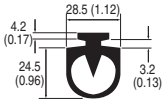
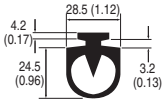
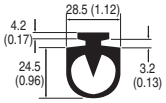
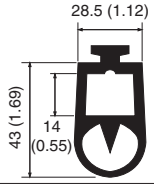
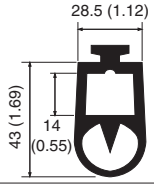
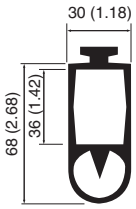
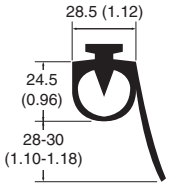
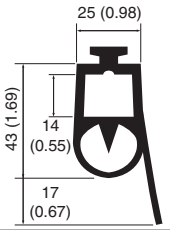
Standards	EN1760-2, EN 954-1, ISO13849-1, IEC/EN60204-1, ANSI B11.19, AS 4024.5
Certifications	CE Marked for all applicable directives and TÜV. C-Tick not required.
Power Supply	Operates on 4V DC supplied from control unit.
Operating Temperature [C (F)]	EPDM material: -5…55° (23…131°) NBR/CR material: 0…55° (32…131°)
Relative Humidity	90%
Enclosure Type Rating	IP65 (NEMA 6P)
Wire Size	18 AWG
Material	EPDM: Ethylene Propylene Diene Modified Rubber NBR/CR: Acrylonitrile (34% nitrile) Butadiene Rubber/Chloropriene Rubber
Bend Radius, Min.	500 mm (19.6 in.)

Chemical Resistance of Safedge Profile

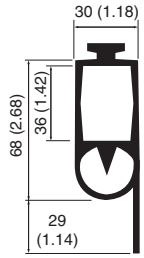
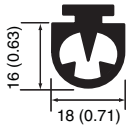
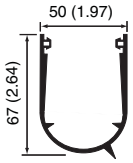
Substance	Resistance—"S" Profile EPDM	Resistance—"N" Profile NBR/CR
Acetic Acid (10%)	Good	Good
Acetone	Good	Fair
Ammonium Hydroxide (35%)	Good	Good
Benzene	Poor	Poor
Diesel Oil	Poor	Good
Ethyl Alcohol (Ethanol)	Good	Good
Hydrochloric Acid (10%)	Good	Good
Lubricating Oil	Poor	Good
Nitric Acid (10%)	Good	Fair
Petrol (Gasoline)	Poor	Fair
Silicone Fluids	Good	Good
Sodium Chloride (25%)	Good	Good
Trichlorethylene	Good	Poor
Vegetable Oils (general)	Good	Good
Water (distilled)	Good	Good
Water (sea)	Good	Good
Latex Paint	Good	Good
Oil Base Paint	Good (easy to clean)	

Safedge™ Profiles

Product Selection—Profiles

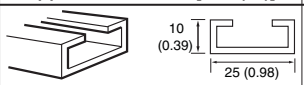
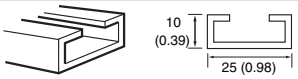
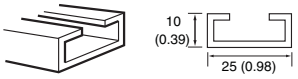
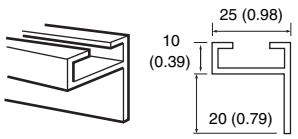
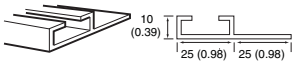
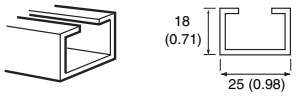
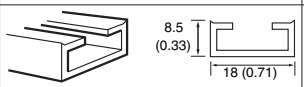
Code (See page 2-112)	Approx. Dimensions [mm (in.)]	Safedge Profile	Description	Cushion Factor	Length [m (ft)]	Cat. No.
A		0110S	Black, EPDM, Weight: 463 g/m (0.33 lbs/ft)	5 mm (0.20 in.)	5 (16.4)	440F-E0110S05
					10 (32.8)	440F-E0110S10
					20 (65.6)	440F-E0110S20
C		0110N	Black, NBR/CR, Weight: 460 g/m (0.31 lbs/ft)	5 mm (0.20 in.)	5 (16.4)	440F-E0110N05
					10 (32.8)	440F-E0110N10
					20 (65.6)	440F-E0110N20
B		0110R	Red, EPDM, Weight: 502 g/m (0.34 lbs/ft)	5 mm (0.20 in.)	5 (16.4)	440F-E0110R05
					10 (32.8)	440F-E0110R10
					20 (65.6)	440F-E0110R20
E		1610S	Black, EPDM, Weight: 843 g/m (0.57 lbs/ft)	19 mm (0.75 in.)	5 (16.4)	440F-E1610S05
					10 (32.8)	440F-E1610S10
					20 (65.6)	440F-E1610S20
F		1610N	Black, NBR/CR, Weight: 837 g/m (0.56 lbs/ft)	19 mm (0.75 in.)	5 (16.4)	440F-E1610N05
					10 (32.8)	440F-E1610N10
					20 (65.6)	440F-E1610N20
H		0310S	Black, EPDM, Weight: 1209 g/m (0.81 lbs/ft)	41 mm (1.61 in.)	5 (16.4)	440F-E0310S05
					10 (32.8)	440F-E0310S10
					20 (65.6)	440F-E0310S20
D, J		0510S	Black, EPDM, with Sealing Lip, Weight: 545 g/m (0.37 lbs/ft)	5 mm (0.20 in.)	5 (16.4)	440F-E0510S05
					10 (32.8)	440F-E0510S10
					20 (65.6)	440F-E0510S20
G, K		0804S	Black, EPDM, with Sealing Lip, Weight: 1013 g/m (0.68 lbs/ft)	19 mm (0.75 in.)	5 (16.4)	440F-E0804S05
					10 (32.8)	440F-E0804S10
					20 (65.6)	440F-E0804S20

Note: Maximum roll size before axial connector needed is 20 m (65.6 ft).

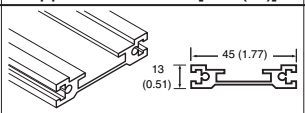
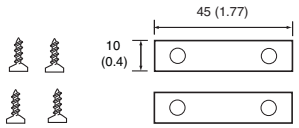
Code (See page 2-112)	Approx. Dimensions [mm (in.)]	Safedge Profile	Description	Cushion Factor	Length [m (ft)]	Cat. No.
I, L		0210S	Black, EPDM, with Sealing Lip, Weight: 1291 g/m (0.87 lbs/ft)	41 mm (1.61 in.)	5 (16.4)	440F-E0210S05
					10 (32.8)	440F-E0210S10
					20 (65.6)	440F-E0210S20
M		0118S	Black, EPDM, Weight: 242 g/m (0.163 lbs/ft) (mini profile)	3.75 mm (0.15 in.)	5 (16.4)	440F-E0118S05
					10 (32.8)	440F-E0118S10
					20 (65.6)	440F-E0118S20
N, O		1111S	Black, EPDM, Weight: 680 g/m (0.457 lbs/ft)	NA	5 (16.4)	440F-E1111S05
					10 (32.8)	440F-E1111S10
					20 (65.6)	440F-E1111S20

Note: Maximum roll size before axial connector needed is 20 m (65.6 ft).

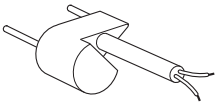
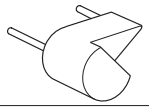
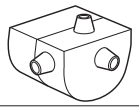
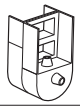
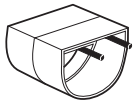
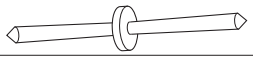
Product Selection—C-Rails

Code	Approx. Dimension [mm (in.)]	Description	Cat. No.
A		Aluminium type, Type C112/A. Suitable for all profiles. Length: 3 m (9.8 ft) Weight: 258 g/m (0.17 lbs/ft)	440F-R1212
B		Zinc-Coated Steel; Type C112/S. Suitable for all profiles. Length: 2 m (6.5 ft) Weight: 663 g/m (0.45 lbs/ft)	440F-R1112
C		PVC Black; Type C112/PB. Suitable for all profiles. Length: 3 m (9.8 ft) Weight: 111 g/m (0.07 lbs/ft)	440F-R1212PB
D		PVC Red; Type C112/PR. Suitable for all profiles. Length: 3 m (9.8 ft) Weight: 111 g/m (0.07 lbs/ft)	440F-R1212PR
E		PVC Yellow; Type C112/PY. Suitable for all profiles. Length: 3 m (9.8 ft) Weight: 111 g/m (0.07 lbs/ft)	440F-R1212PY
F		Aluminium Vertical Lip; Type C112/A2. Suitable for all profiles. Length: 2 m (6.5 ft) Weight: 368 g/m (0.25 lbs/ft)	440F-R1214
G		Aluminium Horizontal Lip; Type C112/A3. Suitable for all profiles. Length: 2 m (6.5 ft) Weight: 388 g/m (0.26 lbs/ft)	440F-R1215
H		Aluminium Deep Channel; Type C112/A4. Suitable for all profiles. Length: 2 m (6.5 ft) Weight: 345 g/m (0.23 lbs/ft)	440F-R1216
I		Aluminium; Suitable for Mini Profile Only. Length: 2 m (6.5 ft) Weight: 150 g/m (0.10 lbs/ft)	440F-R1219

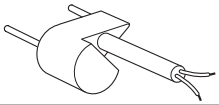
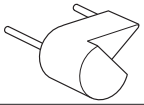
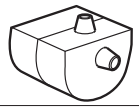
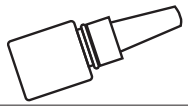
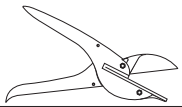
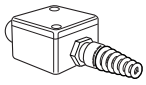
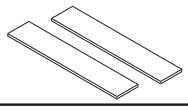
Safedge™ Profiles

Code	Approx. Dimension [mm (in.)]	Description	Cat. No.
J		Aluminium; Suitable for Rubber Boot Only. Length: 2 m (6.5 ft) Weight: 667 g/m (0.448 lbs/ft)	440F-R2151
NA		Aluminium End Plate for C-Rail Option J; 2 Plates; 4 Screws, flat head Philips, 10mm, #6 Weight: 7g (0.01 lbs)	440F-R2152

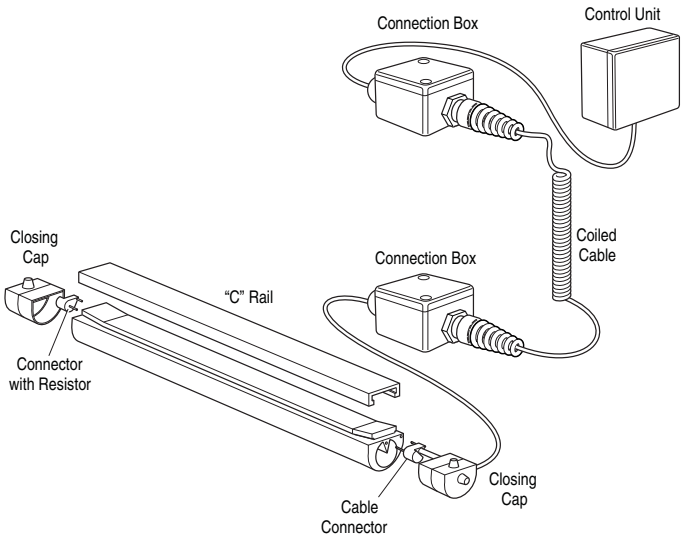
Product Selection—Component Parts

Description		Product Selection Criteria	Cat. No.
	Connector and Cable (diameter = 5 mm (0.20 in.)	1 m (3.2 ft)	440F-A1301
		2 m (6.56 ft)	440F-A1302
		5 m (16.4 ft)	440F-A1305
		10 m (32.8 ft)	440F-A1306
		15 m (49.2 ft)	440F-A1307
	Terminator	6 kΩ (yellow) resistor for series termination	440F-A1308
		15 kΩ (blue) for parallel termination	440F-A1309
	Closing Cap for profile codes (A, B, C, D, J)	Closing Cap material: EPDM	440F-A1302S
		Closing Cap material: NRB	440F-A1302N
	Closing Cap for profile codes (E, F, G, H, K)	Used to close profiles 440F-E0310S and 440F-E1610S.	440F-A1303S
		Used to close profile 440F-E1610N.	440F-A1303N
	Axial Connector	With this connector you can directly connect two profiles. Suitable for 440F-E0110S profiles.	440F-A0061S
		With this connector you can directly connect two profiles. Suitable for 440F-E0110R profiles.	440F-A0061N
	Straight Pin Connector	Kit contains one pair of pins suitable for one joint.	440F-A0004
	90° Corner Connector	For use with profile 440F-E0110S	440F-A0071S
		For use with profile 440F-E0110R	440F-A007IS
		For use with profile 440F-E0110N	440F-A007IN
		For use with profile 440F-E0310S	440F-A0073S
		For use with profile 440F-E1610S	440F-A0074S
		For use with profile 440F-E1610N	440F-A0074N
	90° Corner Connector (vertical)	For use with profile 440F-E0110N	440F-A0072N
		For use with profile 440F-E0110S or 440F-E0110R	440F-A0072S
		For use with profile 440F-E1610N	440F-A0075N
		For use with profile 440F-E1610S	440F-A0075S
		For use with profile 440F-E0310S	440F-A0076S
	45° Corner Connector	For use with profile 440F-E0110N	440F-A0071N45 *

* Includes two rubber strips (440F-A0005) when using profile 440F-E0110N.

Description		Product Selection Criteria	Cat. No.
	60° Corner Connector	When using profile 440F-E0110N	440F-A0071N60 ✶
	30° Corner Connector	When using profile 440F-E0110N	440F-A24007130 ✶
	Connector and Cable	Use only on Mini Profile—1 m (3.3 ft)	440F-A1181
		Use only on Mini Profile—3 m (9.8 ft)	440F-A1183
		Use only on Mini Profile—5 m (16 ft)	440F-A1185
	Terminator	Use only on Mini Profile—8 kΩ (yellow) resistor for series termination	440F-A1186
	Closing Cap	Use only on Mini Profile—Closing Cap material: EPDM	440F-A1318
	Cyanocrylate Adhesive	Use Loctite 401 for dry applications. Use Loctite 380E for wet applications.	NA
	Shears	Use to cut profiles.	440F-A3084
	Connection Box	Polycarbonate housing 53 x 53 x 35 mm (2.09 x 2.09 x 1.38 in.) complete with two pole terminal and trumpet type screw on connector with strain and relief clamp. For use with coiled cable.	440F-A0116
	Coiled Connection Cable	2.5 m (8.2 ft) (extended) of flexible coiled cable. Shelf length is 889 mm (35 in.) long. OD of coil is 22 mm (0.86 in.) and OD of cable is 5 mm (0.20 in.).	440F-A2450
		3.5 m (11.5 ft) (extended) of flexible coiled cable. Shelf length is 1270 mm (50 in.) long. OD of coil is 22 mm (0.86 in.) and OD of cable is 5 mm (0.20 in.).	440F-A2700
	Two rubber strips	When using profile 440F-E0110N shelf length is 175 x 10 x 0.7 mm (6.89 x 0.39 x 0.03 in.).	440F-A0005

✶ Includes two rubber strips (440F-A0005) when using profile 440F-E0110N.



Example application of profile using coiled cable. The coiled cable can not be directly connected to the profile due to the weight of the cable. The proper use of the coiled cable is to connect the coiled cable to the profile through the connection box. The coiled cable should be secured to both the moving and stationary objects so as to prevent straining of the terminal connections.

Safedge™ Profiles

Factory Assembled Product Selection (standard profile)

440F -	E*	C	A	M	V	01270
	a	*b*	*c*	*d*		*e*

a

Profile	
Code	Description
A	0110S
B	0110R
C	0110N
D	0510S with Sealing Lip on Right Side
E	1610S
F	1610N
G	0804S with Sealing Lip on Right Side
H	0310S
I	0210S with Sealing Lip on Right Side
J	0510S with Sealing Lip on Left Side
K	0804S with Sealing Lip on Left Side
L	0210S with Sealing Lip on Left Side
N	Rubber Boot over 0110S
O	Rubber Boot over 1610S
P	No Profile

b

C-Rail	
Code	Description
A	1212 aluminium for profile codes A-L
B	1112 zinc coated steel for profile codes A-L
C	1212PB PVC black for profile codes A-L
D	1212PR PVC red for profile codes A-L
E	1212PY PVC yellow for profile codes A-L
F	1214 aluminium with vertical lip for profile codes A-L
G	1215 aluminium with horizontal lip for profile codes A-L
H	1216 aluminium deep rail for profile codes A-L
J	2151 aluminium for profile codes N and O
N	No C-Rail (not needed)

e

Length of Edge	
Code	Description
5 digit number	Enter length of edge in mm; for example: 50 m = 50000, 500 mm = 00500; 300 mm minimum; ± 2.5 mm tolerance

* Order Controller separately. Refer to SafeEdge Controllers product selection on page 2-115.

c

Cable Entrance	
Code	Description
A	LHT left entrance with 1 m cable
B	LHT left entrance with 2 m cable
C	LHT left entrance with 3 m cable
D	LHT left entrance with 5 m cable
E	LHT left entrance with 10 m cable
F	RHT right entrance with 1 m cable
G	RHT right entrance with 2 m cable
H	RHT right entrance with 3 m cable
I	RHT right entrance with 5 m cable
J	RHT right entrance with 10 m cable
K	SET straight entrance with 1 m cable
L	SET straight entrance with 2 m cable
M	SET straight entrance with 3 m cable
N	SET straight entrance with 5 m cable
O	SET straight entrance with 10 m cable
P	UNDER entrance with 1 m cable
Q	UNDER entrance with 2 m cable
R	UNDER entrance with 3 m cable
S	UNDER entrance with 5 m cable
T	UNDER entrance with 10 m cable
U	No entrance components

d

Termination	
Code	Description
A	LHT left exit with 1 m cable
B	LHT left exit with 2 m cable
C	LHT left exit with 3 m cable
D	LHT left exit with 5 m cable
E	LHT left exit with 10 m cable
F	RHT right exit with 1 m cable
G	RHT right exit with 2 m cable
H	RHT right exit with 3 m cable
I	RHT right exit with 5 m cable
J	RHT right exit with 10 m cable
K	SET straight exit with 1 m cable
L	SET straight exit with 2 m cable
M	SET straight exit with 3 m cable
N	SET straight exit with 5 m cable
O	SET straight exit with 10 m cable
P	UNDER exit with 1 m cable
Q	UNDER exit with 2 m cable
R	UNDER exit with 3 m cable
S	UNDER exit with 5 m cable
T	UNDER exit with 10 m cable
U	Parallel Termination—15 kΩ
V	Series Termination—6 kΩ
W	No exit components

Factory Assembled Product Selection (mini-profile)



440F	-	E*	M	I	M	V	01270
		a	*b*	*c*	*d*		*e*

a

Profile	
Code	Description
M	0118S 3.75 mm (0.15 in.) Cushion Factor Black, Mini Profile
P	No Profile

b

C-Rail	
Code	Description
I	1219 aluminium for “Profile” code M
N	No C-Rail (not needed)

c

Cable Entrance	
Code	Description
K	SET straight entrance 1 m cable
M	SET straight entrance 3 m cable
N	SET straight entrance 5 m cable
P	UNDER entrance 1 m cable
R	UNDER entrance 3 m cable
S	UNDER entrance 5 m cable
U	No entrance components

d

Termination	
Code	Description
K	SET straight entrance 1 m cable
M	SET straight entrance 3 m cable
N	SET straight entrance 5 m cable
P	UNDER entrance 1 m cable
R	UNDER entrance 3 m cable
S	UNDER entrance 5 m cable
V	Series Termination—8 kΩ
W	No Termination

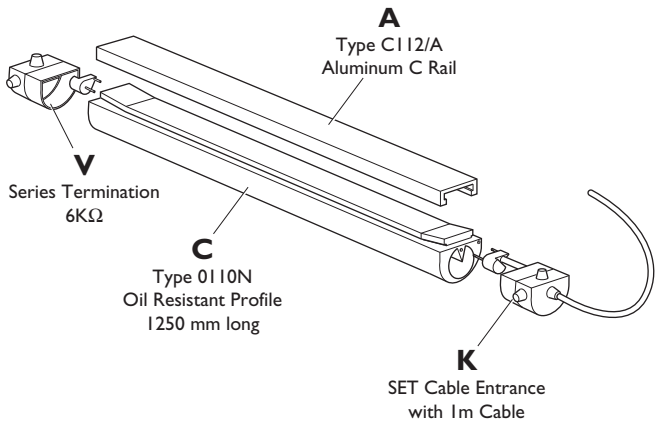
e

Length of Edge	
Code	Description
5 digit number	Enter length of edge in mm; for example: 50 m = 50000, 500 mm = 00500; 300 mm minimum; ± 2.58 mm tolerance

* Order Controller separately. Refer to SafeEdge Controllers product selection.

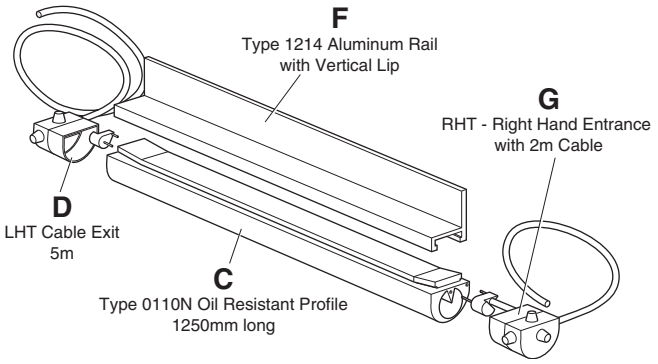
Factory Assembled Examples

440F-ECAKV01250



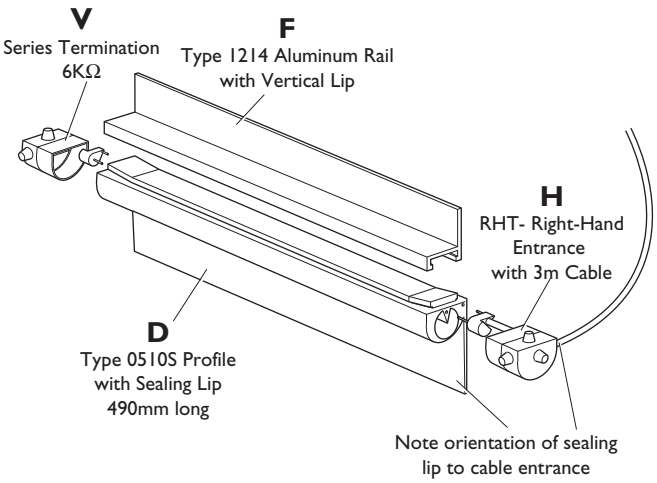
This is a single oil resistant profile which is 1250 mm (49.2 in.) long. The edge is terminated with a Series Termination. A 1 m (3.2 ft) cable enters straight into the closing cap. The profile is mounted on a standard aluminum C-rail.

440F-ECFGD01250



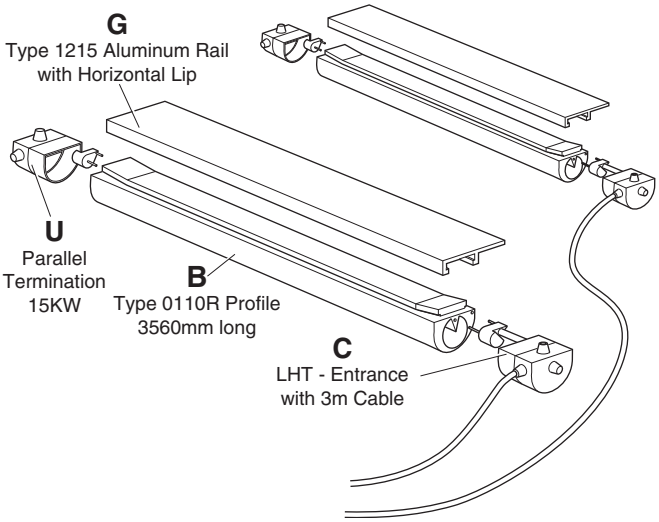
This is a single oil resistant profile which is 1250 mm (49.2 in.) long. The edge is terminated with a 1 m (3.2 ft) cable. A 1 m cable enters straight into the closing cap. The profile is mounted on an aluminum C-rail with a vertical mounting lip. A control unit is not included. This edge is intended to be used in series with another length of edge which has a terminating resistor.

440F-EDFHV00490



This single profile has a sealing lip and is 490 mm (19.2 in.) long. The profile is terminated with a Series Termination. A 3 m (9.8 ft) cable enters into the right hand side of the closing cap from a plastic surface mounted controller. The profile is mounted on an aluminum rail with a vertical lip for ease of mounting. The orientation of the sealing lip to the vertical lip can be reversed by the user by sliding the profile out of the C-rail, rotating the C-rail 180° and then re-inserting the profile back into the C-rail.

440F-EBGCU03560

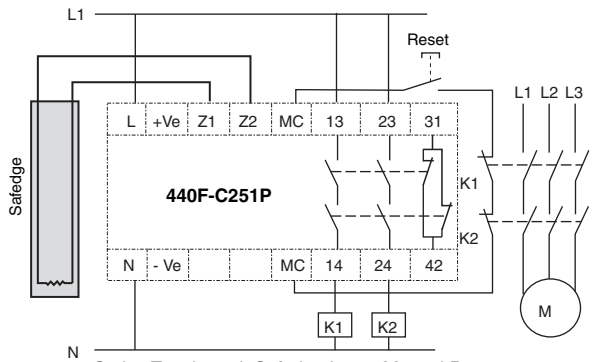


This is a red-colored single profile which is 3560 mm (140.15 in.) long. This profile is part of a parallel profile system, for ease of mounting, as it is terminated with a Parallel Termination. A 3 m (9.8 ft) cable enters into the left side of the closing cap. The profile is mounted on an aluminum C-rail with a horizontal lip for ease of mounting. The horizontal lip can be reversed by the user by sliding the profile out of the C-rail, rotating the C-rail and then re-inserting the profile back into the C-rail. A separate Cat. No. must be entered for the other profile.

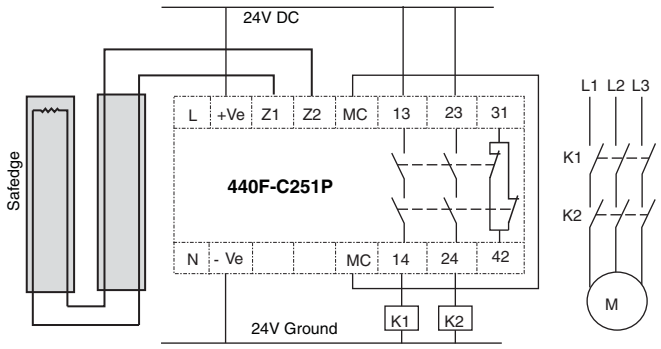
Product Selection—Relays

Single Function Safety Relays	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
	2 N.O.	1 N.C.	Fixed	Automatic/Manual	24V AC/DC or 115/230V AC	5-72	440F-C251D
	1 N.O.		Removable		24V AC/DC		440F-C252D
	2 N.O.		Fixed		24V AC/DC or 115/230V AC		440F-C251P

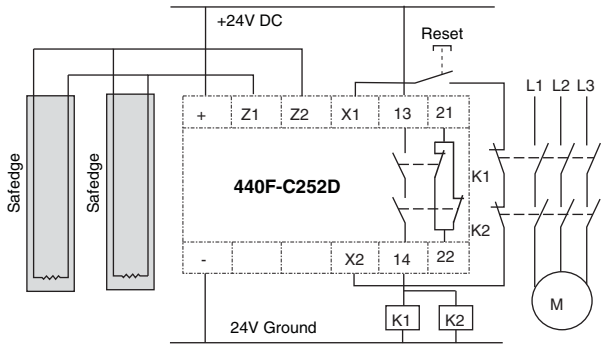
Typical Wiring Diagrams



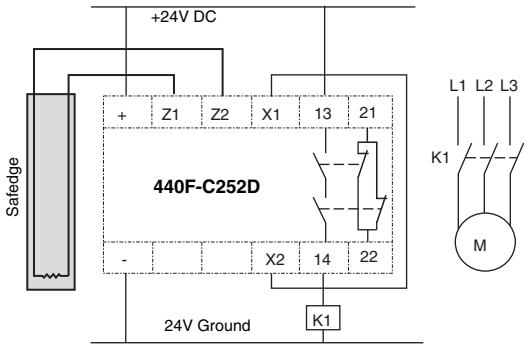
Series Terminated, Safedge Input, Manual Reset, Dual Channel Output, Monitored Output



Series Terminated, Cascaded, Safedge Input, Automatic Reset, Dual Channel Output, No Output Monitored



Parallel Terminated, Safedge Input, Manual Reset, Dual Channel Output, Monitored Output



Series Terminated, Safedge Input, Automatic Reset, Single Channel Output, No Output Monitored

Notes

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Publication S117-CA001A-EN-P

Safety Switches

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Safety Limit Switches

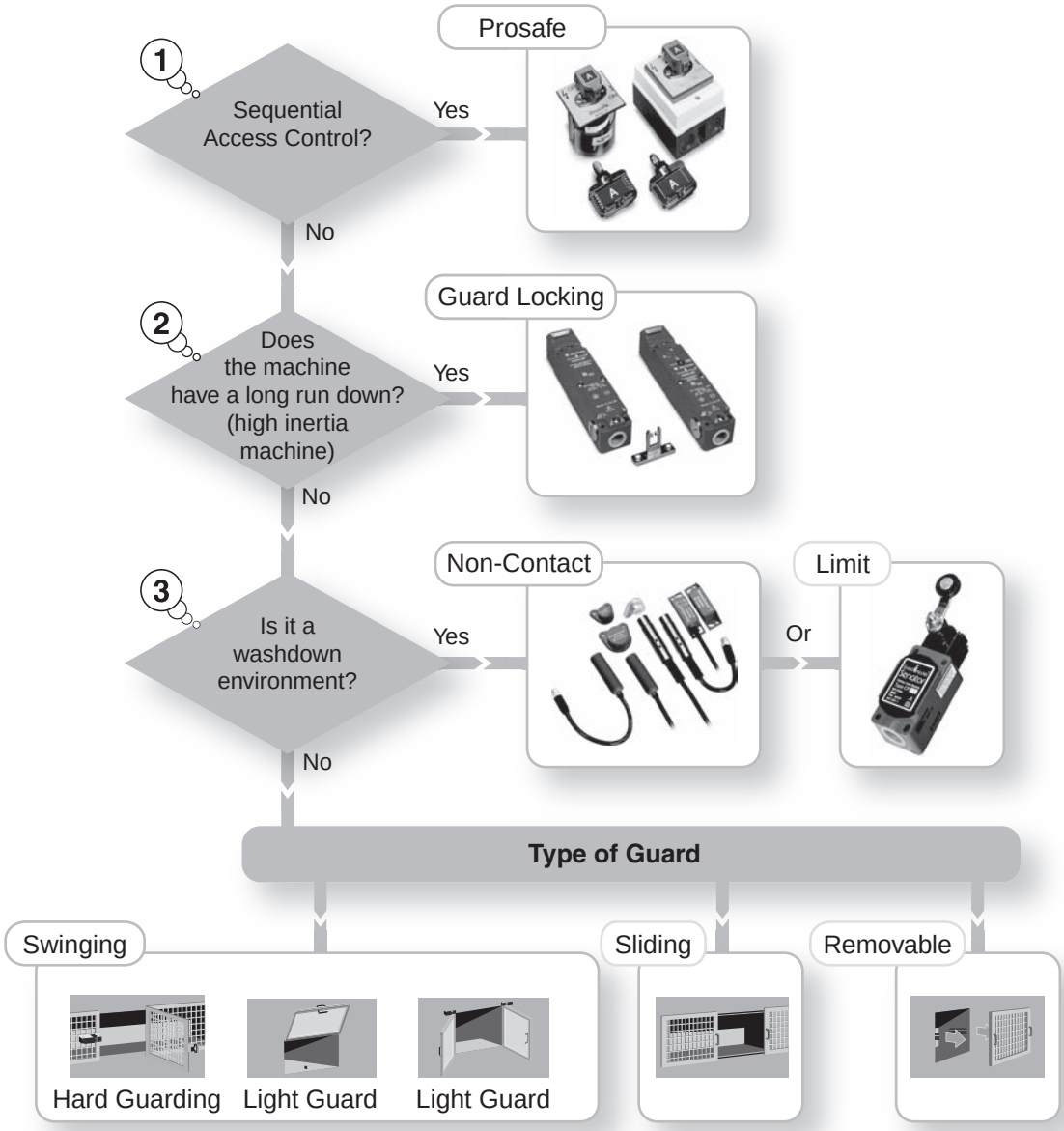
IEC Style Switches

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22 mm Plastic 3-134
30 mm Metal 3-139
15 mm Plastic 3-143

NEMA Style Switches

802T Direct Opening Action 3-145

Selection Flowchart



Recommended Product Type	Swinging			Sliding	Removable
Tongue	✓	✓		✓	
Guard Locking	✓			✓	
Non-Contact	✓	✓	✓	✓	✓
Hinge	✓		✓		

1 Sequential Access Control

A Sequential Access Control system requires that a predetermined sequence of events takes place or that hazards have been reduced before operators can become exposed to them. Prosafe trapped key interlocks are a mechanical system based on coded keys that achieves this via the premise that no single key can be used in two places at once. And because of their mechanical operation, Prosafe trapped key interlocks are widely used in applications where the location of plant, environment or explosive atmospheres make the use of electrical interlock systems unsuitable or expensive to install.

2 High Inertia Machine (Long Run Down Time)

A High Inertia Machine is one on which hazardous motion does not cease immediately when the safety measures are engaged. As a result, there is a possibility that an operator can reach the hazard while it is "running down" and is still dangerous. *Interlock switches with guard locking reduce the risk that the guard opens during hazardous machine motion.*

Alternative measures:

- Install a braking device which stops the machine motion in a shorter time span.
- Increase the distance between the guard door and the hazard such that the operator cannot physically reach the hazard before it has stopped.

3 Washdown Environments

In many applications, primarily those in the pharmaceutical and food/beverage industries, frequent washdown of the machinery with water and/or cleaning fluids is common. Therefore, it is important to select a safety switch with the appropriate environmental protection as indicated by the product's enclosure (Ingress Protection or IP) rating. Non-contact switches have no "traps" where debris can accumulate and are available in fully sealed versions (IP67/IP68/IP69K), making them ideal for washdown applications.

For details on enclosure ratings, refer to the General section of this catalog (page G-9) and IEC 529.

Other Application Considerations

	Non-Contact Switches	Hinge Switches	Tongue Switches	Limit Switches
Large Door	✓		✓	✓
Vibration	✓		✓	
Misalignment	✓	✓		
Debris	✓	✓		
Washdown	✓			✓

Tongue Interlock Switches



Features/Benefits

Tongue interlock switches are the most commonly used technology for door interlocking. They detect the movement of a guard using a key fitted to an opening in the switch body. Available in a variety of packages, contact configurations and degrees of holding force, these switches are generally the lowest-cost solution. The use of flexible keys also enhances tolerance to misalignment to address an even broader range of applications.

Applications

- Wide range of doors

Common Misapplications

- Washdown
- Heavy debris
- Cutting fluids
- Removable guards

Guard Locking Interlock Switches



Features/Benefits

Guard locking switches employ the same principle of operation as tongue interlocks, but feature an internal solenoid that locks the key—and therefore the guard—in place until the machine's power is isolated. Ideal for applications requiring controlled access to hazardous areas, guard locking switches are available in a variety of holding forces and with flexible actuators for optimal performance.

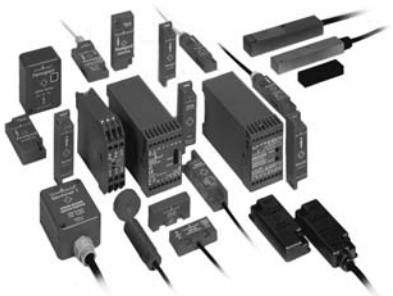
Applications

- Printing presses
- Large access doors
- Saws/cutting blades
- High inertia machinery
- Web machines

Common Misapplications

- Wet environments
- Improper holding force selected

Non-Contact Interlock Switches



Features/Benefits

Since there is no contact between actuator and switch, non-contact switches offer simple setup and alignment, less wear, and superior tamper-resistance as well as reduced installation cost. In addition, the IP67- and IP69K-sealed plastic or stainless steel housings make them ideal for food processing applications and other harsh environments.

Applications

- Hinged doors
- A wide range of doors

Common Misapplications

- Mounted at the door hinge
- Mounted to mild steel
- Exposed to rapid temperature changes

Hinge Interlock Switches



Features/Benefits

Hinge switches are designed to fit at the hinge point of swinging guards. Because they do not use keys which must slide into a slot in the switch body, hinge switches are ideal for machines with misaligned doors or applications with contaminants that could be caught in a key slot. Offering a higher integrity level than standard tongue interlocks, hinge switches are difficult to defeat and can be adjusted for the opening angle of the door.

Applications

- Hinged doors

Common Misapplications

- Large doors
- Doors with poor hinge alignment

Limit Switches



Features/Benefits

Available in a variety of actuators and contact configurations, safety position (limit) switches satisfy Machinery Directive requirements. 802T limit switches with direct opening action offer positive opening safety contacts in a rugged NEMA-style housing for use in control reliable and other safety applications, while 440P IEC limit switches provide safety function in a compact, economical package.

Applications

- Conveyors
- Slide doors
- Muting sensors
- Robot positioning

Common Misapplications

- Mounting a single limit switch on a guard door

Trapped Key Switches



Features/Benefits

Prosafe™ trapped-key interlock switches are designed to provide power isolation, key exchange and interlocking for safety applications requiring a pre-defined sequence of operations. Most of these rugged products do not require power to operate, making them ideal for applications in remote or intrinsically safe locations. Stainless steel construction also allows their use in harsh environments for process/valve control.

Applications

- Sequencing/process control
- Intrinsic safety
- 1/4 turn valves

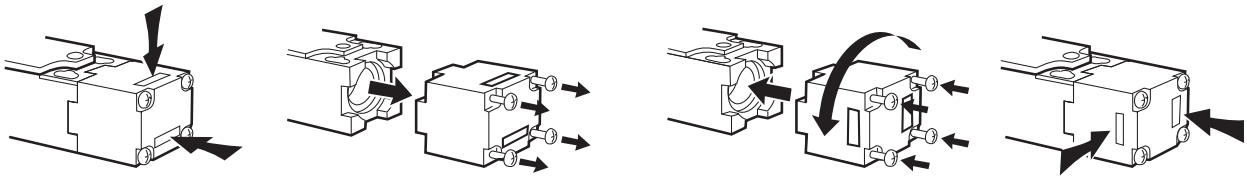
Common Misapplications

- Duplicate coded keys on the plant floor

Versatility

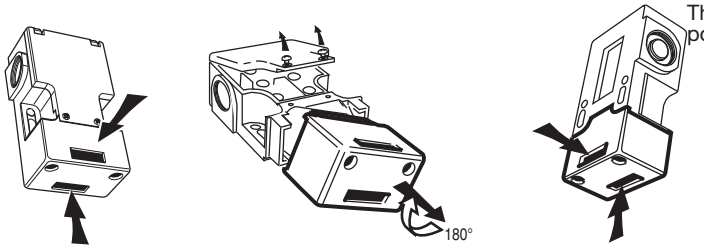
Many safety switches allow the head of the switch to rotate, offering different options on how the switch can be operated and mounted on the guard. This offers flexibility to best fit typical applications.

Elf, Cadet3, MT-GD2, 440G-MT



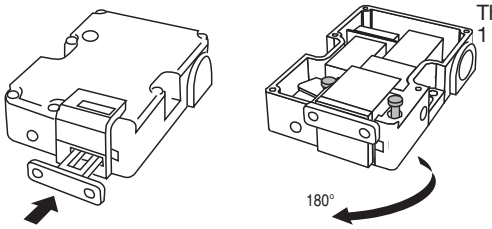
The head can be rotated 4 times at 90º allowing the key to fit the switch in 8 different positions.

Trojan T15, Trojan 5, Trojan 6 (Not GD2 Models)



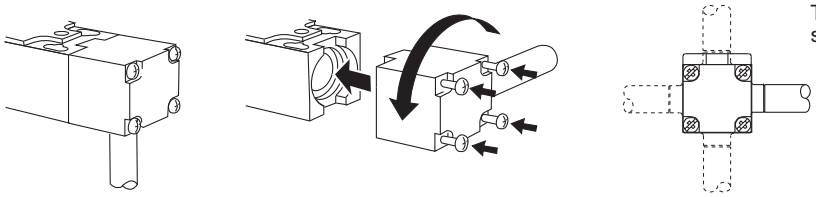
The head rotates 180º allowing the key to fit the switch in 4 different positions: 2 in the front, 1 in the top and 1 in the back.

TLS-GD2



The head rotates 180º allowing the key to fit the switch in 4 different positions: 2 in the front, 1 in the top and 1 in the back.

Sprite, Ensign



The head can be rotated 4 times at 90º allowing the switch to be mounted in 4 different positions.

Accessories for Tongue and Guard Locking Switches

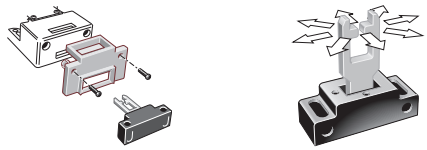
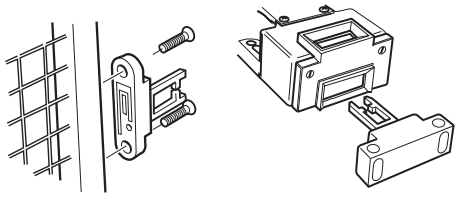
The correct actuator for your application

A large variety of tongue actuators are available:

Standard: 90°, Flat, Standard

Flexible: Semi and Fully

Specialty: Extended Flat and GD2 models

	*Standard type* actuators accommodate most of the applications. Their design allows for the actuator and the switch to be mounted in different position and the guard to work properly. The flat actuator is mounted on small rubber blocks allowing for some play when the guard closes. The 90° is typically used on sliding doors.
	*Flexible type* actuators are used when doors are sagging or are not sturdy enough to guarantee insertion of the actuator always in-line with the opening of the switch. The flexible actuator allows for some motion of the actuator to "self" align with the opening of the switch. Fully flexible actuators allow the actuator to move within a 15° angle in any direction. Semi-flexible actuators can be used for tight angles where the actuator enters the switch at an angle. This angle is adjustable on the actuator. The semi-flexible actuator moves only in a single plan direction.
	*GD2* actuators are dedicated actuators for GD2 models and are not suitable for use with standard models.
	*Extended flat type* actuator is used mostly when the actuator is mounted on a chain and inserted in the switch. The guard is latched and the key is just inserted in the switch attached to a chain. When the door opens, the chain pulls the actuator activating the safety contacts.

Product Selection

Description		Elf	Cadet 3	T15	T15 GD2	T5-T6	T5 GD2-T6 GD2	MT-GD2	TLS GD2	Atlas 5	440G-MT	Cat. No.
Standard actuator						✓						**440K-A11095**
Standard actuator				✓								440K-A11238
Standard actuator										✓		440G-A07136
GD2 standard actuator					✓		✓	✓	✓		✓	**440G-A27011**
Flat actuator, not to be used with metal alignment guide		✓	✓									**440K-A21014**
GD2 flat actuator					✓		✓	✓	✓		✓	**440K-A11112**
90° actuator, not to be used with metal alignment guide		✓	✓									**440K-A21006**
Fully flex actuator					✓		✓	✓	✓		✓	**440G-A27143**
Fully flex actuator										✓		440G-A07269
Extended flat actuator					✓		✓	✓	✓		✓	**440K-A17116**
Metal alignment guide with semi-flexible actuator		✓	✓									440K-A21030
Alignment guide with semi-flexible actuator				✓	✓	✓	✓	✓				440K-A11144
Alignment guide with fully-flexible actuator				✓		✓						440K-A27010
Catch and Retainer Kit						✓						440K-A11094
Replacement Alignment Guide						✓						440K-A11115

Safety Switches and Connectors

Many interlock switches are offered with connectors allowing easy installation and replacement on-site, reducing downtime. Standard cordsets and connectors can be used to connect these products directly to:

- Terminal Blocks
- Safety Distribution Boxes
- ArmorBlock™ Guard I/O (IP 67 Safety I/O Blocks on DeviceNet™ Safety)

Type of Connectors	Cordset Terminal Block	Patchcord Safety Distribution Box	ArmorBlock Guard I/O
4-Pin Micro (M12)	✓	✓	
5-Pin Micro (M12)	✓		✓
6-Pin Micro (M12)	✓	✓	
8-Pin Micro (M12)	✓		
12-Pin M23	✓		

Type of Connector by Product Family

Description	Interlock						Guard Locking		
	Elf	Cadet	Trojan T15	T5	T6	MT-GD2	TLS	Atlas 5	440G-MT
Connection to Distribution Box									
4-Pin Micro (M12)	✓		✓						
6-Pin MIcro (M12)		✓		✓					
Connection to ArmorBlock Guard I/O									
5-Pin Micro (M12)	✓	✓	✓	✓		✓			
Other Connectors									
8-Pin Micro (M12)					✓	✓	✓	✓	✓
12-Pin M23						✓	✓	✓	✓

Type of Connector by Product Family (continued)

Description	Non-Contact						Hinge			Cable Pull		
	Sensa-Guard	Ferrogard 2, 20	Ferrogard 21	Ferrogard 6, 9, SS	Sipha S3	Sipha SS S4	Sprite	Ensign	Rotacam	Lifeline 3	Lifeline 4	Lifeline SS 4
Connection to Distribution Box												
4-Pin Micro (M12)		✓		✓	✓		✓					
6-Pin MIcro (M12)			✓					✓				
Connection to ArmorBlock Guard I/O												
5-Pin Micro (M12)	✓						✓	✓		✓	✓	
Other Connectors												
8-Pin Micro (M12)	✓					✓			✓	✓	✓	
12-Pin M23										✓	✓	✓

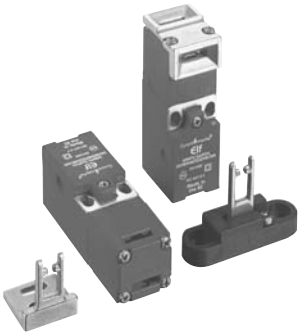
Note: All connectors on Safety Switches are male.

Connectors Ratings

	Max. Ratings		Applicable Standards
	AC	DC	
4-Pin Micro (M12)	250V, 4 A	250V, 4 A	IEC 61076-2-101:2003
5-Pin Micro (M12)	60V, 4 A	60V, 4 A	IEC 61076-2-101:2003
6-Pin Micro (M12)	30V, 2 A	30V, 2 A	IEC 61076-2-101:2003
8-Pin Micro (M12)	30V, 2 A	30V, 2 A	IEC 61076-2-101:2003
12-Pin M23	63V, 6 A	63V, 6 A	IEC 61984:2001

Tongue Switches

Elf™



Description

The Elf is a tongue-operated (or key-operated) safety interlock switch designed to fit at the leading edge of sliding, hinged or lift-off guards. The Elf's unique miniature housing (only 75 x 25 x 29 mm (2.95 x 0.98 x 1.14 in.)) makes it the smallest interlock currently available. It is designed for smaller machines such as printers, copiers and domestic machinery which, until now, have been unable to use safety interlocks due to space restrictions. With its dual entry slots and rotatable head, the versatile Elf can offer up to eight different actuator entry options.

Operation of the switch is achieved through the insertion of a specially-profiled stainless-steel key that is permanently mounted to the guard door. The semi-flexible key allows the Elf to be used on small-radii doors (60 mm or 2.36 in.).

The Elf is available with a variety of contact configurations, conduit entry types and connectors. It is sealed to IP67 (watertight and dustproof). A blanking plug is supplied for the unused key entry.

Features

- Ideal for small, lightweight guards
- The smallest interlock switch available
- Contacts, 2 N.C. or 1 N.O. and 1 N.C.
- Eight possible actuator entry points, easy to install
- Environmental protection: IP67
- GD2 style available for demanding applications

Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems			
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs					
Safety Contacts ❄ Direct Opening Action		1 N.C.		2 N.C.	
Auxiliary Contacts		1 N.O.		None	
Thermal Current I_{th}		5 A (10 A if A600)			
Rated Insulation Voltage		2500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Break Contact Force, Min.		6 N (1.35 lbf)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		2 cycles/s			
Operating Radius, Min		150 mm (5.90 in.) [60 mm (2.36 in.) with GD2 kit, min.]			
Operating Life @ 100 mA load		1 x 10^6 operations			
Environmental					
Enclosure Type Rating		IP67			
Operating Temperature [C (F)]		-20…+80° (-4…+176°)			
Physical Characteristics					
Housing Material		UL Approved glass-filled PBT			
Actuator Material		Stainless Steel			
Weight [g (oz)]		60 (2.11)			
Color		Red			

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Contact			Actuator Type	Cat. No.			
				M16 Conduit		Connector§	
Safety	Auxiliary	Action		M16	1/2 inch NPT Adaptor	Connect to Distribution Box 4-Pin Micro (M12)	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12) ♣
1 N.C.	1 N.O.	BBM	Flat	440K-E33036	440K-E33029	440K-E33074	—
			90°	**440K-E33040**	440K-E33030	440K-E33025	—
			GD2 Metal alignment guide w/semi-flex actuator	440K-E33034	440K-E33031	440K-E33075	—
			—	440K-E33014	440K-E33053	440K-E33076	—
2 N.C.	—	—	Flat	440K-E33080	440K-E33037	440K-E33077	440K-E2NNFPS
			90°	**440K-E33041**	440K-E33045	440K-E33024	—
			GD2 Metal alignment guide w/semi-flex actuator	—	440K-E33046	440K-E33078	440K-E2NNAPS
			—	**440K-E33047**	—	440K-E33079	—

§ For connector ratings see page 3-9.
§ With a 5-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-13 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-24	440R-N23135
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-24	440R-N23132
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Single-Function Safety Relays for 1 N.C. & 1 N.O. Contact Switch							
MSR9T	2 N.O.	1 N.C.	Fixed	Auto./Manual	24V AC/DC	5-14	440R-F23027
MSR33RT	2 N.O. Solid State	1 N.O.	Removable	Auto. or Monitored Manual	24V DC SELV	5-18	440R-F23200
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-74	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-78	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-94	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-98	440R-W23218

Note: For additional Safety Relays connectivity, see the Safety Relays section (page 5-8) of this catalog.
For additional Safety I/O and Safety PLC connectivity, see the Programmable Safety System section (page 5-107) of this catalog.
For application and wiring diagrams, see the Safety Applications section (page 10-1) of this catalog.

Connection Systems

Description	Connection to Distribution Box 4-Pin Micro (M12)		Connection to ArmorBlock Guard I/O 5-Pin Micro (M12)
	1 N.C. & 1 N.O.	2 N.C.	2 N.C.
Cordset	889D-F4AC-∗	889D-F4AC-∗	—
Patchcord	889D-F4ACDM-❄	889D-F4ACDM-❄	889R-F5ECRM-∗
Distribution Box	898D-P4‡KT-DM4	898D-4‡LT-DM4	—
Shorting Plug	898D-41KU-DM	898D-41LU-DM	—
T-Port	898D-43KY-D4	898D-43LY-D4	—

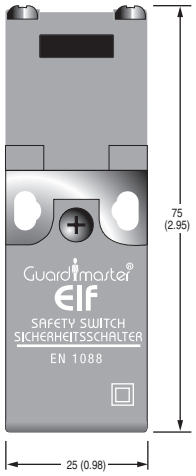
∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

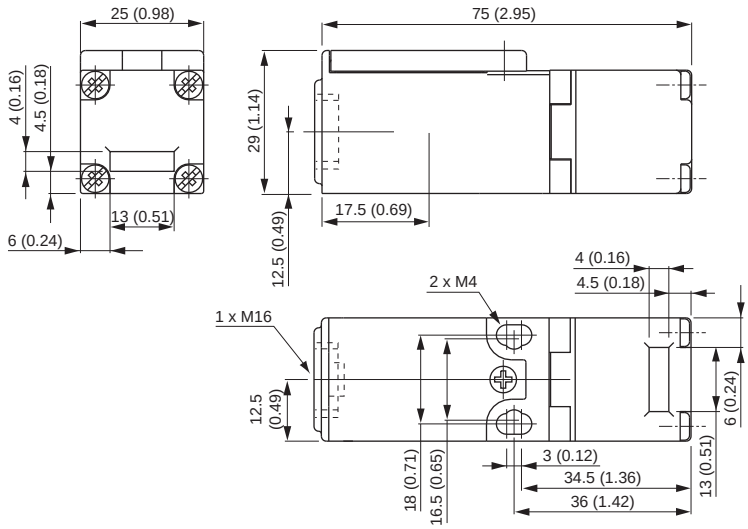
Accessories

Description		Dimensions	Cat. No.
	Flat actuator, not to be used with metal alignment guide	3-52	**440K-A21014**
	90° actuator, not to be used with metal alignment guide	3-52	**440K-A21006**
	Metal alignment guide with semi-flexible actuator	3-52	440K-A21030
	Metal Alignment Guide	3-52	440K-A21069
	Replacement Cover	—	440A-A33085
	Dust Cover	—	440K-A17182

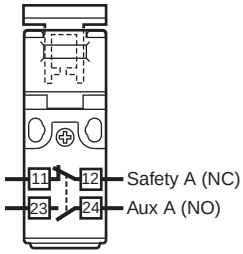
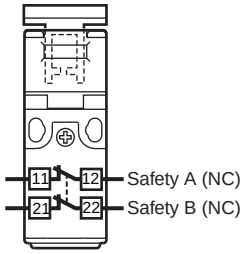
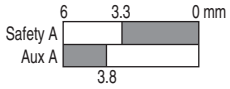
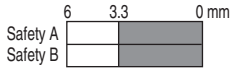
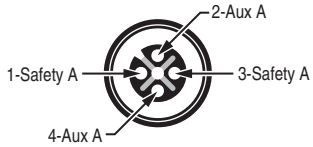
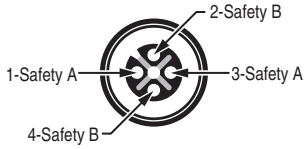
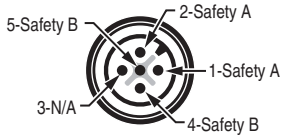
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.





Typical Wiring Diagrams

Description		1 N.C. & 1 N.O.	2 N.C.
Contact Configuration			
Contact Action □Open ■Closed		 BBM	
4-Pin Micro (M12)			
5-Pin Micro (M12) For ArmorBlock Guard I/O		—	
Cordset 889D-F4AC-∗	Brown	Safety A	Safety A
	Blue		
	White	Aux A	Safety B
	Black		

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Tongue Switches

Cadet™ 3



Description

The Cadet 3 is a tongue-operated (or key-operated) safety interlock switch designed to fit at the leading edge of sliding, hinged or lift-off guards. With its dual entry slots and rotatable head, the versatile Cadet 3 can offer up to eight different actuator entry options. The unique compact housing (90.5 x 31 x 30.4 mm (3.56 x 1.22 x 1.19 in.)) has industry standard DIN 50047 fixing centers for ease of mounting.

Operation of the switch is achieved through the insertion of a specially-profiled stainless-steel key that is permanently mounted to the guard door. A semi-flexible key allows the Cadet 3 to be used on small-radii doors (60 mm or 2.36 in.).

Available with a variety of contact configurations, the Cadet 3 is sealed to IP67. A blanking plug is supplied for the unused key entry.

Features

- Compact size
- Ideal for small, lightweight guards
- Contacts, 2 N.C. and 1 N.O. or 3 N.C.
- Sealed to IP67
- Eight possible actuator entry points, easy to install
- Industry standard fixing centres to DIN 50047
- GD2 style available for demanding applications

Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 device per EN 954-1 dual channel interlocks suitable for Cat. 3 or 4 systems			
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs					
Safety Contacts ❄ Direct Opening Action		2 N.C.		3 N.C.	
Auxiliary Contacts		1 N.O.		None	
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Break Contact Force, Min.		15 N (3.37 lbf)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		2 cycles/s			
Operating Radius, Min		150 mm (5.90 in.) [60 mm (2.36 in.) with GD2 kit]			
Operating Life @ 100 mA load		1 x 10^6 operations			
Environmental					
Enclosure Type Rating		IP67			
Operating Temperature [C (F)]		-20…+ 80° (-4…+176°)			
Physical Characteristics					
Housing Material		UL Approved glass-filled PBT			
Actuator Material		Stainless Steel			
Weight [g (lb)]		80 (0.176)			
Color		Red			

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Contact			Actuator Type	Cat. No.			
				M16 Conduit		Connector§	
Safety	Auxiliary	Action		M16	1/2 inch NPT Adaptor	Connect to Distribution Box 6-Pin Micro (M12)	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)♣
3 N.C.	—	—	Flat	440K-C21096	440K-C21048	440K-C21090	440K-C2NNFPS
			90°	440K-C21097	440K-C21057	440K-C21091	—
			GD2 Metal alignment guide w/semi-flex actuator	—	440K-C21062	440K-C21092	440K-C2NNAPS
			—	440K-C21070	—	—	—
2 N.C.	1 N.O.	BBM	Flat	440K-C21098	440K-C21050	440K-C21054	—
			90°	**440K-C21061**	440K-C21058	440K-C21067	—
			GD2 Metal alignment guide w/semi-flex actuator	—	**440K-C21074**	**440K-C21088**	—
			—	440K-C21055	—	—	—
		MBB	Flat	440K-C21052	440K-C21093	440K-C21060	—
			90°	440K-C21065	440K-C21094	440K-C21068	—
			GD2 Metal alignment guide w/semi-flex actuator	—	440K-C21095	440K-C21089	—
			—	440K-C21080	—	—	—

§ For connector ratings see page 3-9.
§ With a 5-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-17 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-24	440R-N23135
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-24	440R-N23132
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-22	440R-N23117
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-74	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-78	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-94	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-98	440R-W23218

Note: For additional Safety Relays connectivity, see the Safety Relays section (page 5-8) of this catalog.
For additional Safety I/O and Safety PLC connectivity, see the Programmable Safety System section (page 5-107) of this catalog.
For application and wiring diagrams, see the Safety Applications section (page 10-1) of this catalog.

Connection Systems

Description	6-Pin Micro (M12)	5-Pin Micro (M12)
Cordset	889R-F6ECA-✶	—
Patchcord	889R-F6ECRM-❄	889R-F5ECRM-✶
Distribution Box	898R-P68MT-A5	—
Shorting Plug	898R-P61MU-RM	—
T-Port	NA	—

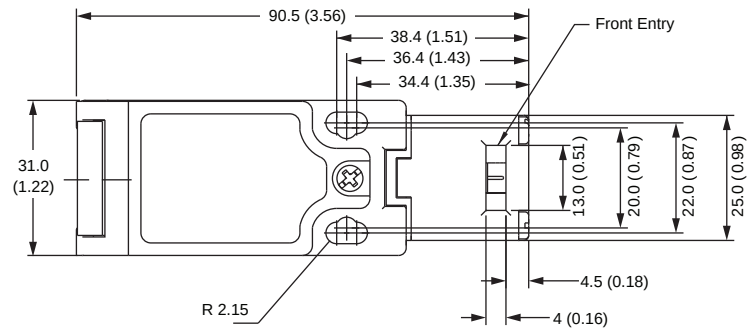
✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

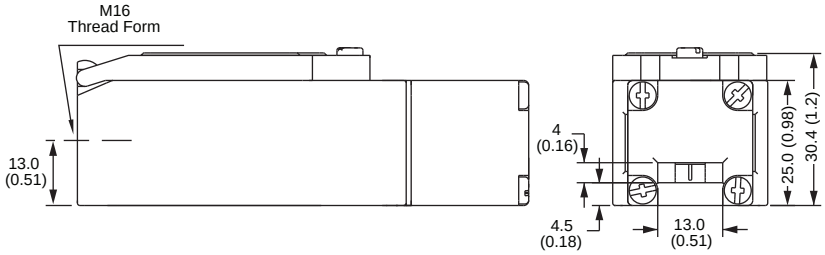
Accessories

Description		Dimensions	Cat. No.
	Flat actuator, not to be used with metal alignment guide	3-52	**440K-A21014**
	90° actuator, not to be used with metal alignment guide		**440K-A21006**
	Metal alignment guide with semi-flexible actuator		440K-A21030
	Replacement Cover	—	440A-A21115
	Dust Cover	—	440K-A17182

Approximate Dimensions

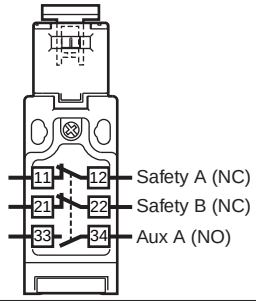
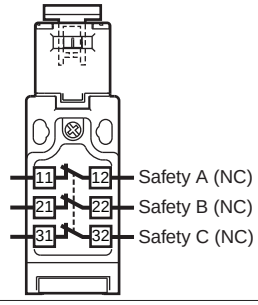
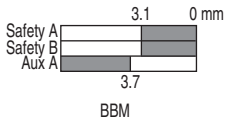
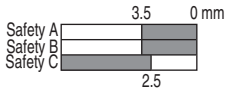
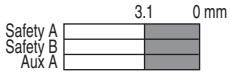
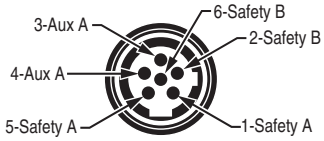
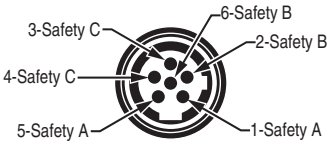
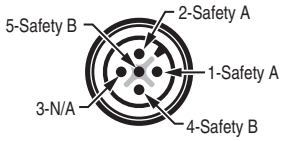
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.





***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

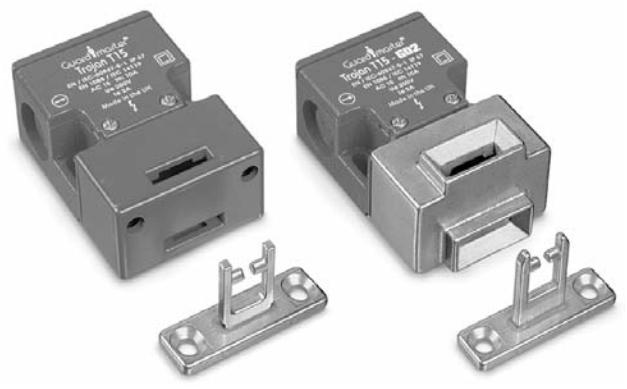
Typical Wiring Diagrams

Description		2 N.C. & 1 N.O.	3 N.C.
Contact Configuration			
Contact Action □Open ■Closed		 BBM  MBB	
6-Pin Micro (M12)			
5-Pin Micro (M12)		—	
Cordset 889R-F6ECA-∗	Red/White	Safety A	Safety A
	Red/Black		
	Red	Safety B	Safety B
	Red/Blue		
	Green	Aux A	Safety C
	Red/Yellow		

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Tongue Switches

Trojan™ T15



Description

The Trojan T15 is a compact universal tongue-operated (or key-operated) safety interlock switch designed to fit at the leading edge of sliding, hinged or lift-off guards. With its dual entry slots and rotatable head, movable only by releasing the cover screws, the Trojan T15 can offer four different options for actuator entry.

The Trojan T15 features a compact housing, only 75 x 52 x 32 mm (2.95 x 2.04 x 1.25 in.) and includes direct opening action contacts and a tamper-resistant mechanism. The Trojan T15 has 2 N.C. safety contacts or 1 N.C. safety contact and 1 N.O. auxiliary contact. The unit is sealed to IP67 and has three M20 conduit entries.

Operation of the switch is achieved by the insertion of the specially-profiled stainless-steel actuator which should be permanently fixed to the leading edge of the guard door. The standard T15 incorporates actuator retention force of 30N. An optional catch mechanism helps keep doors shut on vibrating machinery.

Features

- Compact size, 75 x 52 x 32 mm (2.95 x 2.05 x 1.26 in.) case
- 30 N actuator retention force
- Strong and versatile, can be used in most applications
- Contacts: 2 N.C. safety or 1 N.C. safety & 1 N.O. auxillary
- GD2 style available for demanding applications

Specifications

Safety Ratings				
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1		
Safety Classification		Cat. 1 device per EN 954-1 dual channel interlocks suitable for Cat. 3 or 4 systems		
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC		
Outputs				
Safety Contacts ❄ Direct Opening Action		2 N.C.		1 N.C.
Auxiliary Contacts		None		1 N.O.
Thermal Current I_{th}		10 A		
Rated Insulation Voltage		(Ui) 500V		
Switching Current @ Voltage, Min.		5 mA @ 5V DC		
Utilization Category				
A600/AC-15 (Ue)	(Ue)	600V	500V	240V	120V
(Ie)	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
DC-13 (Ue)	(Ue)	24V			
(Ie)	(Ie)	2 A			
Operating Characteristics				
Break Contact Force, Min.		30 N (6.70 lbf)		
Actuation Speed, Max.		160 mm (6.29 in.)/s		
Actuation Frequency, Max.		2 cycles/s		
Operating Radius, Min		175 mm (6.89 in.) [60 mm (2.36 in.) with flexible actuator]		
Operating Life @ 100 mA load		1 x 10^6 operations		
Environmental				
Enclosure Type Rating		IP67		
Operating Temperature [C (F)]		-20…+80° (-4…+176°)		
Physical Characteristics				
Housing Material		UL Approved glass-filled PBT		
Actuator Material		Stainless Steel		
Weight [g (lb)]		120 (0.265)		
Color		Red		

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Type	Contact		Contact Action	Actuator Type	Cat. No.			
					M20 Conduit		Connector§	
	Safety	Auxiliary			M20	1/2 inch NPT Adaptor	Connect to Distribution Box 4-Pin Micro (M12)	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)
Trojan T15 Standard	2 N.C.	—	—	Standard	440K-T11303	440K-T11267	440K-T11307	440K-V2NNSPS
				Fully-Flex	440K-T11395	440K-T11273	440K-T11384	440K-V2NNBPS
				—	**440K-T11269**	—	440K-T11385	—
	1 N.C.	1 N.O.	BBM	Standard	440K-T11305	440K-T11268	440K-T11386	—
				Fully-Flex	440K-T11396	440K-T11276	440K-T11387	—
				—	440K-T11270	—	440K-T11388	—
Trojan T15 GD2	2 N.C.	—	—	GD2 Standard	440K-T11463	440K-T11288	440K-T11389	440K-V2NNGPS-NG
				Fully-Flex	440K-T11397	440K-T11287	440K-T11390	—
				—	440K-T11280	—	440K-T11391	—
	1 N.C.	1 N.O.	BBM	GD2 Standard	440K-T11398	440K-T11284	440K-T11392	—
				Fully-Flex	440K-T11399	440K-T11283	440K-T11393	—
				—	440K-T11279	—	440K-T11394	—

§ For connector ratings see page 3-9.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-24	440R-N23135
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-24	440R-N23132
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Single-Function Safety Relays for 1 N.C. & 1 N.O. Contact Switch							
MSR9T	2 N.O.	1 N.C.	Fixed	Auto./Manual	24V AC/DC	5-14	440R-F23027
MSR33RT	2 N.O. Solid State	1 N.O.	Removable	Auto. or Monitored Manual	24V DC SELV	5-18	440R-F23200
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-74	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-78	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-94	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-98	440R-W23218

Note: For additional Safety Relays connectivity, see the Safety Relays section (page 5-8) of this catalog.
For additional Safety I/O and Safety PLC connectivity, see the Programmable Safety System section (page 5-107) of this catalog.
For application and wiring diagrams, see the Safety Applications section (page 10-1) of this catalog.

Connection Systems

Description	Connection to Distribution Box 4-Pin Micro (M12)		Connection to ArmorBlock Guard I/O 5-Pin Micro (M12)
	2 N.C.	1 N.C. & 1 N.O.	2 N.C.
Cordset	889D-F4AC-∗	889D-F4AC-∗	—
Patchcord	889D-F4ACDM-❄	889D-F4ACDM-❄	889D-F5ACDM-∗
Distribution Box	898D-4‡LT-DM4	898D-P4‡KT-DM4	—
Shorting Plug	898D-41LU-DM	898D-41KU-DM	—
T-Port	898D-43LY-D4	898D-43KY-D4	—

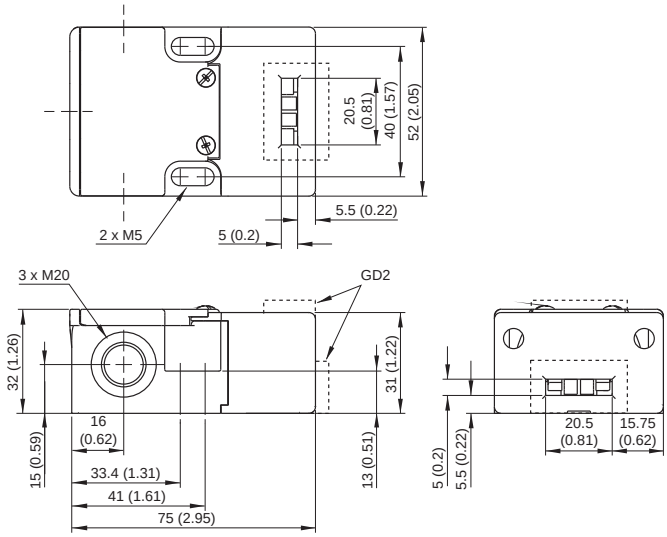
∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

Accessories

Description		To Be Used With:	Dimensions	Cat. No.
	Standard actuator	Trojan T15 Standard Models Only	3-51	440K-A11238
	GD2 standard actuator	Trojan GD2 Models Only	3-50	**440G-A27011**
	GD2 flat actuator	Trojan GD2 Models Only	3-51	**440K-A11112**
	Alignment guide with semi-flexible actuator	Discard Alignment Guide for GD2 Models		440K-A11144
	Alignment guide with fully-flexible actuator	Discard Alignment Guide for GD2 Models	3-52	440K-A27010
	Sliding bolt actuator	Trojan GD2 Models Only	3-55	440G-A27163
	Catch and Retainer Kit	Trojan T15 Standard Models Only	3-50	440K-A11094
	Replacement Cover	All Models	—	440A-A11499
	Dust Cover	All Models	—	440K-A17180

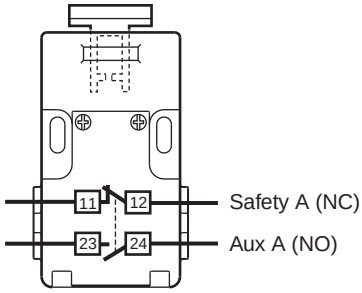
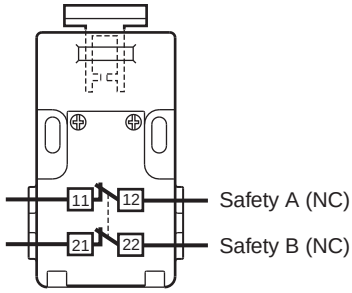
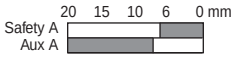
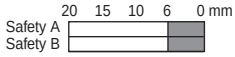
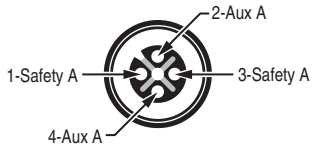
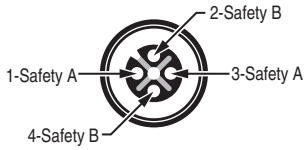
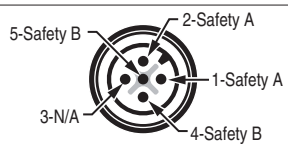
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

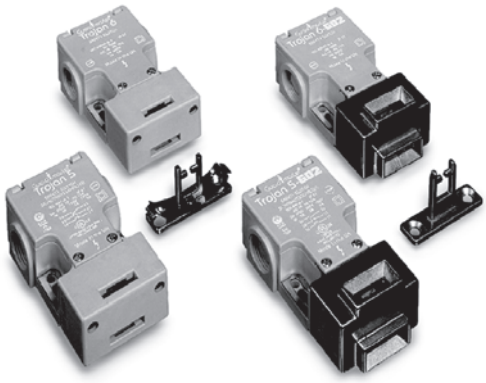
Typical Wiring Diagrams

Description		1 N.C. & 1 N.O.	2 N.C.
Contact Configuration			
Contact Action □Open ■Closed		 BBM	
4-Pin Micro (M12)			
5-Pin Micro (M12) For ArmorBlock Guard I/O		—	
Cordset 889D-F4AC-∗	Brown	Safety A	Safety A
	Blue		
	White	Aux A	Safety B
	Black		

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Tongue Switches

Trojan™ 5 & 6



Description

The Trojan family is a universal tongue-operated (or key-operated) safety-interlock switch designed to fit at the leading edge of sliding, hinged or lift-off guards. The dual key entry slots and rotatable head, movable only by releasing the cover screws, allow four actuator entry options. The Trojan contains all of the safety related functions—i.e., forced guided contacts, tamper resistant mechanism—allowing the machine to be safeguarded in compliance with the machine directive.

Operation of the switch is achieved through the insertion of a specially-profiled stainless-steel key that is permanently mounted to the leading edge of the guard door. The standard (not GD2) Trojan actuator includes a self-ejecting mechanism that prevents operation of the switch if the actuator is not mounted to the guard door (e.g., if the operator uses a spare key).

Features

- Strong and versatile, can be used in most applications
- Self-ejecting tamper resistant actuator, only operates when mounted to the guard (not with GD2 models)
- Four possible actuator entry points, easy to install
- GD2 style available for demanding applications

Specifications

Safety Ratings				
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, NFPA 79, EN 1088, ISO 14119, IEC/EN 60947-5-1, ANSI B11.19, AS 4024.1			
Safety Classification	Cat. 1 device per EN 954-1 dual channel interlocks suitable for Cat. 3 or 4 systems			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. load PFH_D: > 3 x10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels Ple or Pld (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics			
Certifications	CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs				
Safety Contacts ❄ Direct Opening Action	3 N.C.	2 N.C.	2 N.C.	
Auxiliary Contacts	1 N.O.	2 N.O.	1 N.O.	
Thermal Current I_{lth}	10 A			
Rated Insulation Voltage	(Ui) 500V			
Switching Current @ Voltage, Min.	5 mA @ 5V DC			
Utilization Category				
Trojan 5 A300/AC-15 (Ue)	240V	120V		
(Ie)	3 A	6 A		
DC-13 (Ue)	24V	24V		
(Ie)	2 A			
Trojan 6 A600/AC-15 (Ue)	600V	500V	240V	120V
(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13 (Ue)	24V			
(Ie)	2 A			
Operating Characteristics				
Break Contact Force, Min.	Trojan 5: 12 N (2.7 lbf) & 30 N (6.75 lbf)			
	Trojan 6: 20 N (4.5 lbf)			
Actuation Speed, Max.	160 mm (6.29 in.)/s			
Actuation Frequency, Max.	2 cycles/s			
Operating Radius, Min	175 mm (6.89 in.) [60 mm (2.36 in.) with flexible actuator]			
Operating Life @ 100 mA load	1 x 10^6 operations			
Environmental				
Enclosure Type Rating	IP67			
Operating Temperature [C (F)]	-20…+80° (-4…+176°)			
Physical Characteristics				
Housing Material	UL Approved glass-filled PBT			
Actuator Material	Stainless Steel			
Weight [g (lb)]	160 (0.35)			
Color	Red			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Type	Contact			Actuator Type	Cat. No.			
					M20 Conduit		Connector§	
	Safety	Auxiliary	Action		M20	1/2 inch NPT Adaptor	Connect to Distribution Box 6-Pin Micro (M12)	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)♣
Trojan 5 Standard	2 N.C.	1 N.O.	BBM	Standard	**440K-T11090**	**440K-T11202**	440K-T11205	—
				Guide/Semi-Flex	440K-T11110	440K-T11203	440K-T11206	—
				Guide/Fully-Flex	**440K-T11467**	440K-T11204	440K-T11207	440K-T2NNBPS
				—	**440K-T11089**	—	440K-T11129	—
			BBM Gold Contacts	Standard	440K-T11085	—	—	—
			MBB	Standard	**440K-T11118**	440K-T11208	440K-T11224	—
				Guide/Semi-Flex	440K-T11123	440K-T11209	440K-T11363	—
				Guide/Fully-Flex	440K-T11468	440K-T11210	440K-T11364	—
				—	440K-T11146	440K-T11469	440K-T11365	—
Trojan 5 GD2			BBM	GD2 Standard	440K-T11336	440K-T11211	440K-T11366	440K-T2NNGPS-NG
				Guide/Semi-Flex	440K-T11337	440K-T11212	440K-T11367	—
				Guide/Fully-Flex	440K-T11338	440K-T11213	440K-T11368	—
				—	**440K-T11147**	—	440K-T11226	—
			MBB	GD2 Standard	440K-T11339	440K-T11470	440K-T11369	—
				Guide/Semi-Flex	440K-T11340	440K-T11471	440K-T11370	—
				Guide/Fully-Flex	440K-T11341	440K-T11472	440K-T11371	—
				—	440K-T11167	—	440K-T11372	—
Trojan 5 30 N			BBM	Standard	440K-T11333	440K-T91024	440K-T11492	—

§ For connector ratings see page 3-9.
§ With a 5-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-27 for wiring details.

Type	Contact			Actuator Type	Cat. No.		
					M20 Conduit		Connector§
	Safety	Auxiliary	Action		M20	1/2 inch NPT Adaptor	8-Pin Micro (M12)♣
Trojan 6	3 N.C.	1 N.O.	BBM	Standard	440K-T11171	440K-T11435	—
				—	440K-T11449	440K-T11408	—
	2 N.C.	2 N.O.	BBM	Standard	440K-T11174	440K-T11438	—
				—	440K-T11452	440K-T11416	440K-W21BNPH
			MBB	—	440K-T11453	440K-T11454	440K-W21MNPH
Trojan 6 GD2	3 N.C.	1 N.O.	BBM	GD2 Standard	440K-T11418	440K-T11466	—
				—	440K-T11188	440K-T11444	—
			MBB	—	440K-T11456	440K-T11457	—
	2 N.C.	2 N.O.	BBM	GD2 Standard	440K-T11445	440K-T11425	—
				—	440K-T11459	440K-T11433	440K-W21BNPH-NG
			MBB	—	440K-T11460	440K-T11461	440K-W21MNPH-NG

§ For connector ratings see page 3-9.
§ With an 8-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-27 for wiring details.

Tongue Switches

Trojan™ 5 & 6

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-24	440R-N23135
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-24	440R-N23132
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-22	440R-N23117
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-74	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-78	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-94	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-98	440R-W23218

Note: For additional Safety Relays connectivity, see the Safety Relays section (page 5-8) of this catalog.
For additional Safety I/O and Safety PLC connectivity, see the Programmable Safety System section (page 5-107) of this catalog.
For application and wiring diagrams, see the Safety Applications section (page 10-1) of this catalog.

Connection Systems

Description	Trojan 5		Trojan 6
	5-Pin Micro (M12)	6-Pin Micro (M12)	8-Pin Micro (M12)
Cordset	—	889R-F6ECA-✶	889D-F8AB-✶
Patchcord	889R-F5ECRM-✶	889R-F6ECRM-❄	889D-F8ABDM-❄
Distribution Box	—	898R-F68MT-A5	—
Shorting Plug	—	898R-P61MU-RM	—
T-Port	—	—	—

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

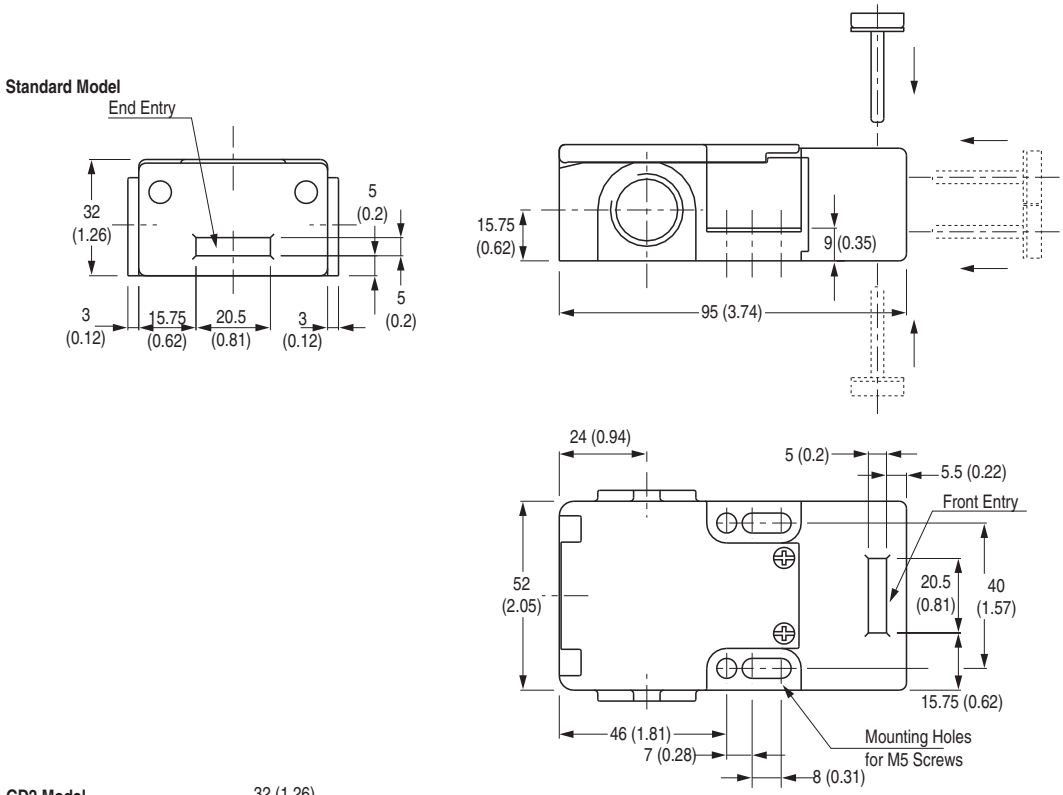
Accessories

Description		To Be Used With:	Dimensions	Cat. No.
	Standard actuator	Trojan T5 and T6 Standard Models Only	3-51	**440K-A11095**
	GD2 standard actuator	GD2 Models Only	3-50	**440G-A27011**
	GD2 flat actuator	GD2 Models Only	3-51	**440K-A11112**
	Alignment guide with semi-flexible actuator	Discard Alignment Guide for GD2 Models	3-51	440K-A11144
	Alignment guide with fully-flexible actuator	Discard Alignment Guide for GD2 Models	3-52	440K-A27010
	Sliding bolt actuator	GD2 Models Only	3-55	440G-A27163
	Catch and Retainer Kit	Trojan T5 and T6 Standard Models Only	3-50	440K-A11094
	Replacement Cover	Trojan T5 Standard Models Only	—	440A-A11495
		Trojan T5 GD2		440A-A11496
		Trojan T6 Standard Models Only		440A-A11497
		Trojan T6 GD2		440A-A11498
	Dust Cover	All Models	—	440K-A17180

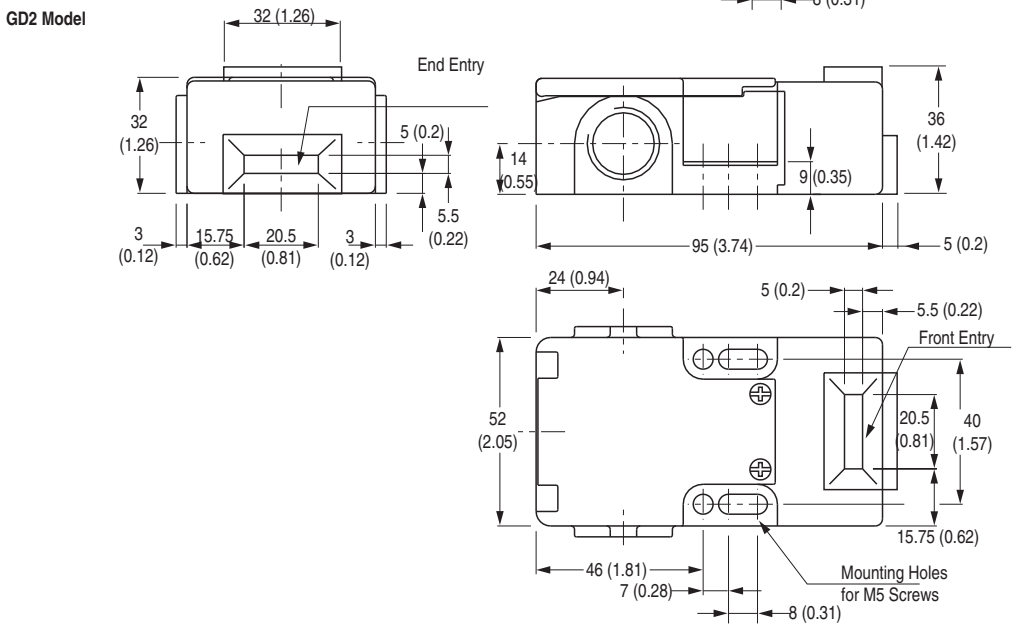
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Standard Model

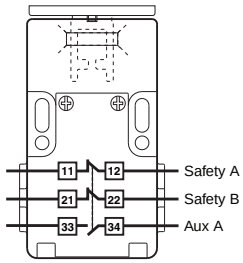
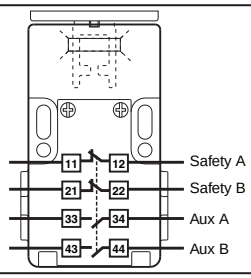
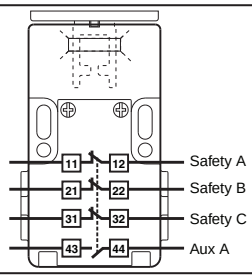
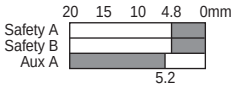
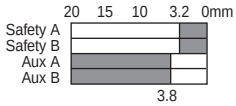
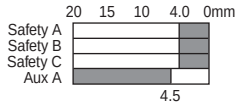
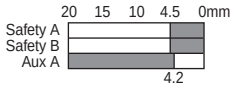
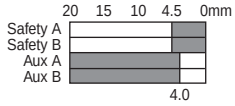
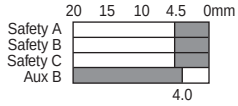
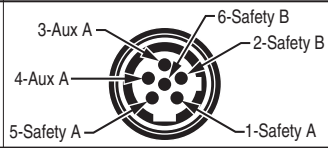
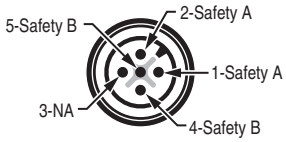
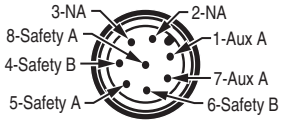


GD2 Model



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Typical Wiring Diagrams

Description		Trojan 5	Trojan 6	
		2 N.C. & 1 N.O.	2 N.C. & 2 N.O.	3 N.C. & 1 N.O.
Contact Configuration				
Contact Action ☐Open ■Closed	BBM			
	MBB			
6-Pin Micro (M12)			—	—
5-Pin Micro (M12) for ArmorBlock Guard I/O			—	—
8-Pin Micro (M12)		—		—
6-Pin Cordset 889R-F6ECA-∗	Red/White	Safety A	—	—
	Red/Black			
	Red	Safety B	—	—
	Red/Blue			
	Green	Aux	—	—
	Red/Yellow			
8-Pin Cordset 889D-F8AB-∗	Grey Red	—	Safety A	—
	Yellow Pink	—	Safety B	—
	White Blue	—	Aux A	—
	Green Brown	—	NA	—

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Tongue Switches

MT-GD2



Description

The MT-GD2 family is a robust, tongue-operated (or key-operated) safety-interlock switch designed to fit at the leading edge of sliding, hinged or lift-off guards. With its dual entry slots and rotatable head, the MT-GD2 can offer eight different options for actuator entry.

The MT-GD2 features a compact housing of only 117 x 40 x 43 mm (4.60 x 1.57 x 1.69 in.) with DIN 50041 standard fixing centres and includes forced guided contacts and a tamper-resistant mechanism.

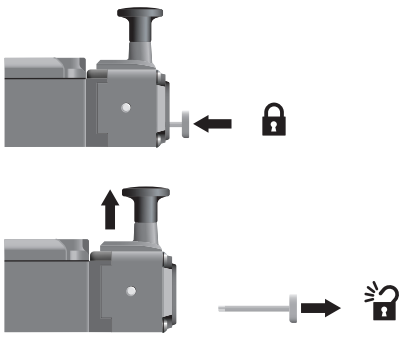
The MT-GD2 is available with a variety of contact configurations enabling it to be used as part of a system for higher-risk applications. Operation of the switch is achieved by the insertion of the specially-profiled stainless-steel actuator which should be permanently fixed to the leading edge of the guard door. An optional flexible actuator allows the MT-GD2 to operate on smaller-radii doors (≥60 mm) and a flat actuator gives additional mounting options, for example, on a chain.

A style incorporating a latch release mechanism allows manual retention of the actuator in the switch until the release mechanism is manually activated.

Features

- Strong and versatile, can be used in most applications
- Eight possible actuator entry points, easy to install
- Variety of contact configurations
- Snap acting MT-GD2 gives a min. break contact force of 40 N
- Optional latch release styles
- Industry standard fixing centers to DIN/EN50041

MT-GD2 Latch Release Style



Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 device per EN 954-1 dual channel interlocks suitable for Cat. 3 or 4 systems			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: > 3 x10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels Ple or Pld (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics			
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs					
Safety Contacts ❄		Standard: 3 N.C. or 2 N.C. direct opening action Snap acting: 2 N.C. direct opening forced disconnection			
Auxiliary Contacts		Standard: 1 N.O. or 2 N.O. Snap Acting: 2 N.O.			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
Standard—DC-13	(Ue)	24V			
	(Ie)	2 A			
Snap-Acting—A300/AC-15	(Ue)	240V	120V		
	(Ie)	3 A	6 A		
Snap-Acting—DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Break Contact Force, Min.		BBM & MBB: 12 N (2.7 lbf) BBM & Extended Flat Actuator: 32 N (7.2 lbf) Snap acting: 40 N (9.0 lbf)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		2 cycles/s			
Operating Life @ 100 mA load		1 x 10^6 operations			
Environmental					
Enclosure Type Rating		IP67			
Operating Temperature [C (F)]		-20…+80° (-4…+176°)			
Physical Characteristics					
Housing Material		Painted zinc			
Actuator Material		Stainless Steel			
Weight [g (lb)]		520 (1.15)			
Color		Yellow or Red			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Red Body Switches

Type	Contact			Actuator Type	Cat. No.				
					Conduit		Connector§		
	Safety	Auxiliary	Action		M20	1/2 in NPT	12-Pin M23	8-Pin Micro (M12)❄	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)∗
MT-GD2	3 N.C.	1 N.O.	BBM	—	**440K-MT55002**	440K-MT55085	440K-MT55094	—	—
				GD2 Standard	440K-MT55074	**440K-MT55022**	**440K-MT55095**	—	—
				Fully Flexible	440K-MT55075	**440K-MT55029**	**440K-MT55096**	—	—
			MBB	—	440K-MT55004	**440K-MT55088**	440K-MT55100	—	—
	2 N.C.	2 N.O.	BBM	—	**440K-MT55005**	440K-MT55086	440K-MT55097	440K-M21BNDH	—
				GD2 Standard	**440K-MT55076**	**440K-MT55026**	440K-MT55098	—	—
				Fully Flexible	440K-MT55077	**440K-MT55087**	440K-MT55099	—	—
			MBB	—	440K-MT55006	440K-MT55089	440K-MT55101	—	—
			Snap Acting	—	—	440K-M22ANDT	440K-M22ANDL	440K-M21ANDH	440K-M2NNNDS
				Extended Flat	440K-M22AEDM	**440K-M22AEDT**	—	—	—
				GD2 Standard	440K-M22ASDM	440K-M22ASDT	—	—	—
				Fully Flexible	440K-M22ABDM	440K-M22ABDT	—	—	—
MT-GD2 Latch Release	3 N.C.	1 N.O.	BBM	—	**440K-MT55039**	440K-MT55062	440K-MT55042	—	—
				GD2 Standard	**440K-MT55078**	440K-MT55041	440K-MT55070	—	—
				Fully Flexible	440K-MT55079	440K-MT55045	440K-MT55103	—	—
			MBB	—	440K-MT55082	440K-MT55091	440K-MT55106	—	—
	2 N.C.	2 N.O.	BBM	—	440K-MT55063	440K-MT55065	440K-MT55066	440K-M21BNDH-N5	440K-M2NNNDS-N5
				GD2 Standard	440K-MT55080	**440K-MT55050**	440K-MT55104	—	—
				Fully Flexible	440K-MT55081	440K-MT55051	440K-MT55052	—	—
			MBB	—	440K-MT55083	440K-MT55092	440K-MT55105	440K-M21MNDH-N5	—

§ For connector ratings see page 3-9.
∗ With a 5-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-32 for wiring details.
❄ With an 8-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-32 for wiring details.

Yellow Body Switches

Type	Contact			Actuator Type	Cat. No.		
					Conduit	Connector§	
	Safety	Auxiliary	Action		1/2 in NPT	12-Pin M23	5-Pin Micro (M12)∗
MT-GD2	2 N.C.	2 N.O.	Snap Acting	—	**440K-M22ANYT**	—	—
				Extended Flat	**440K-M22AEYT**	440K-M22AEYL	440K-M2NAEYS
—	2 N.C.	2 N.O.	MBB	—	440K-M22MNYT-N5	—	440K-M2NNNYS-N5

§ For connector ratings see page 3-9.
∗ With a 5-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-32 for wiring details.
❄ With an 8-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 3-32 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-24	440R-N23135
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-24	440R-N23132
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-22	440R-N23117
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-74	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-78	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-94	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-98	440R-W23218

Note: For additional Safety Relays connectivity, see the Safety Relays section (page 5-8) of this catalog.
For additional Safety I/O and Safety PLC connectivity, see the Programmable Safety System section (page 5-107) of this catalog.
For application and wiring diagrams, see the Safety Applications section (page 10-1) of this catalog.

Connection Systems

Description	4-Pin Micro (M12)	5-Pin Micro (M12)	8-Pin Micro (M12)	12-Pin M23
Cordset	889D-F4AC-✶	—	889D-F8AB-✶	889M-FX9AE-✶
Patchcord	889D-F4ACDM-❄	889D-F5ACDM-✶	889D-F8ABDM-❄	—
Distribution Box	898D-P4‡LT-DM4	—	—	—
Shorting Plug	898D-41LU-DM	—	—	—
T-Port	898D-43LY-D4	—	—	—

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

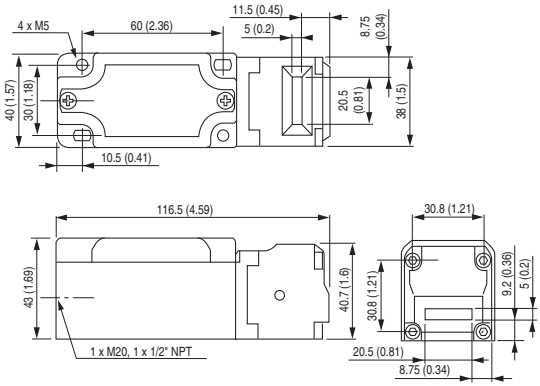
Accessories

Description		Dimensions	Cat. No.
	GD2 standard actuator	3-50	**440G-A27011**
	GD2 flat actuator	3-51	**440K-A11112**
	Fully flex actuator	3-50	**440G-A27143**
	Sliding bolt actuator	3-55	440G-A27163
	Extended flat actuator	3-51	**440K-A17116**
	Dust Cover	—	440K-A17180

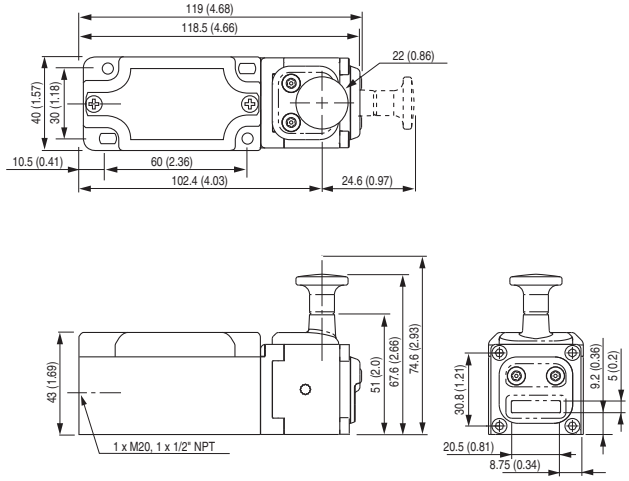
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

MT-GD2

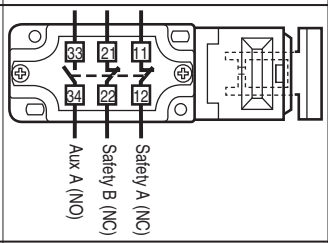
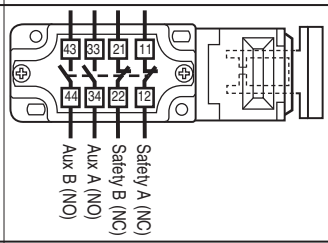
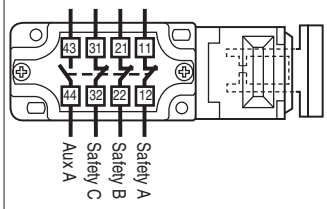
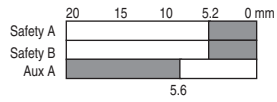
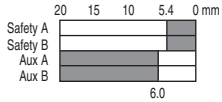
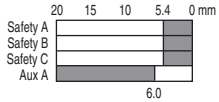
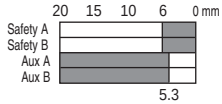
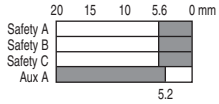
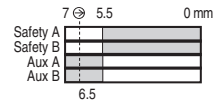
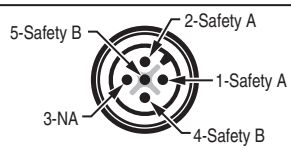
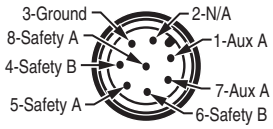
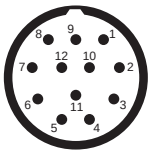


MT-GD2 Latch Release



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Typical Wiring Diagrams

Description		2 N.C. & 1 N.O.	2 N.C. & 2 N.O.	3 N.C. & 1 N.O.
Contact Configuration				
Contact Action ☐Open ■Closed		 BBM	 BBM	 BBM
		—	 MBB	 MBB
		—	 Snap Acting	—
5-Pin Micro (M12) for Connection to ArmorBlock Guard I/O		—		—
8-Pin Micro (M12)		—		—
12-Pin Cordset  Pins 2, 5 and 11 are not connected.	1 and 3	Safety A	Safety A	Safety A
	4 and 6	Safety B	Safety B	Safety B
	7 and 8	NC	Aux A	Safety C
	9 and 10	Aux A	Aux B	Aux A
	12	Ground	Ground	Ground
8-Pin Cordset 889D-F8AB-∗	Grey Red	—	Safety A	—
	Yellow Pink	—	Safety B	—
	White Blue	—	Aux A	—
	Green	—	Ground	—
	Brown	—	Not Used	—
12-Pin Cordset 889M-FX9AE-∗	Brown Blue	Safety A	Safety A	Safety A
	White Green	Safety B	Safety B	Safety B
	Yellow Grey	Not Used	Aux A	Safety C
	Pink Red	Aux A	Aux B	Aux A
	Green/Yellow	Ground	Ground	Ground

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

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Overview

Guard locking switches are used to protect hazardous areas where a danger is not immediately removed after a stop request. On many machines removal of power of the motor or actuator will not necessarily cause a reliable and immediate stopping of the dangerous motion. Typical applications are: high inertia rotating machines, fast rotating machines, and machines where high pressure needs to be released from pneumatic valves.

Gates protected with guard locking switches are usually opened on exception basis. For example: to clear a jam or to regularly maintain the machine. This type of switch should not be used for frequent access during normal operation of the machine.

Guard locking switches use a solenoid to activate a lock which blocks or releases the tongue from the switch.

Rockwell Automation offers two different types of guard locking switches:

Power to Lock

When power is applied to the solenoid, the tongue is locked in the switch. When power is removed, the lock is released allowing the tongue to be extracted from the switch.

Power to Release

When power is applied to the solenoid the lock is released allowing the tongue to be extracted from the switch. When power is removed, the tongue is locked in the switch.

Why Use Power to Lock or Power to Release?

	Power to Lock	Power to Release
Advantage	When the power is removed from the cell after a "controlled stop," the doors unlock allowing maintenance personnel to go in easily.	Power is not applied to the switch all the time, only when the door needs to be opened. Sudden lose of power does not compromise safety of personnel, as the doors stay closed.
Disadvantage	Sudden lose of power will unlock the door allowing personnel to go in the hazardous area and the machine may not be stopped.	Loss of power will not unlock the door and maintenance personnel will not be able to go inside the cell.

Different methodologies can help decrease the risk that the danger is removed before the operator has access to the hazardous area:

Time based

The risk assessment process and stop time measurement will determine the maximum time for the machine to stop from its normal speed of operation. This time defines the delay between the request to open the gate and the authorization to access the zone by unlocking the gate by energizing (Power to Release) or de-energizing (Power to Lock) the solenoid.

This time delay can be implemented by using any of our time delay units such as the MSR178 or MSR138 safety relay or by software in one of our Safety PLC.

Stop motion

Another methodology is to measure when the motion is stopped. When the no-motion is detected, the lock is released to allow personnel to enter the hazardous zone.

The CU2, CU3, or MSR57 safety relay will be used to detect the motion is stopped.

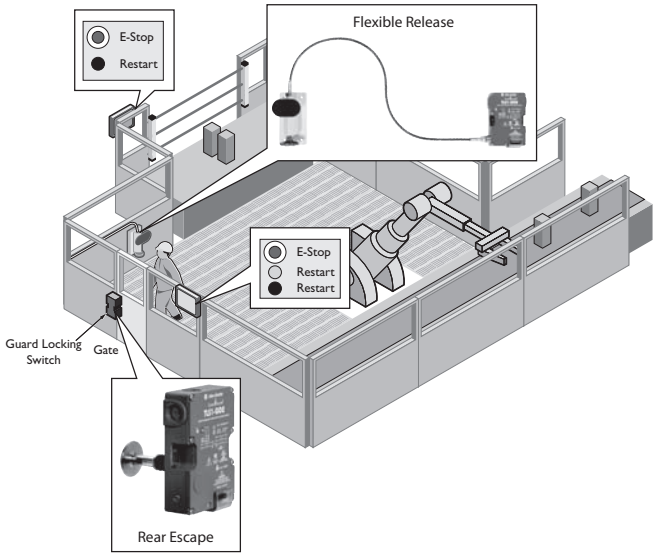
Safe speed conditions

In some applications, the user may need access while the machine is running at a safe speed. The MSR57P used with encoder technology can handle this application. It will verify the speed of the motion and allow access only if the speed does not exceed a preconfigured limit or otherwise the machine will enter a stop condition.

Typical Sequence of Actions

1. The operator requests to enter the hazardous area
2. A controlled or immediate stop of the machine is initiated
3. The machine is stopped: time delay expired or stop motion detected
4. The gate is unlocked by either energizing (Power to Release) or de-energizing (Power to Lock) the solenoid
5. The operator opens the gate and works in the hazardous area
6. The operator exits the hazardous area and closes the gate
7. The operator restarts the machine
8. The gate is locked by either de-energizing (Power to Release) or energizing (Power to Lock) the solenoid
9. The machine returns to its normal speed

Manual Override



In the situation where a person is still in the hazardous area, the door is locked and the machine restarts, the TLS guard locking switch product family provides two options for the person to escape the hazard (in addition of an Emergency Stop located outside of the hazardous area):

Option 1: Rear Escape (Not Latched)

A 40 mm push button is mounted on the back of the TLS and is accessible from the inside of the cell. Pushing the rear escape push button releases the lock mechanism inside the TLS guard locking switch allowing the door to be opened, the machine to stop and the person to escape the hazardous area.

Option 2: Flexible Release (Latched)

The flexible release push button accessory is designed to be installed inside the hazardous area to provide a means of escape for personnel who become trapped there. It provides remote access to the manual release mechanism within the TLS-GD2 switch in the event of an emergency situation. The flexible release can be retro-fitted to existing TLS1-GD2 and TLS3-GD2 switches or installed along with a new switch.

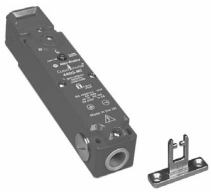
The unit is installed at an accessible height next to the guard door, inside the guarded area, while the TLS-GD2 can be mounted outside the guarded area. The flexible release is available with either a 1 m (3.28 ft) or a 3 m (9.84 ft) cable.

Pushing the black button on the flexible release, the movement of the cable activates the release mechanism within the switch, allowing the door to be opened, the machine to stop and the person to escape the hazardous area. The flexible release is then reset using the blue reset handle.

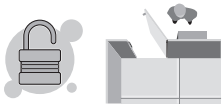
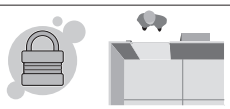
Guard Locking Switches

Overview

Selection Guide

Product	440G-MT		TLS1-GD2	TLS2-GD2	TLS3-GD2	Atlas 5
						
Holding Force	1600 N (360 lb)		2000 N (450 lb)			5000 N (1124 lb)
Housing Material	Metal		Plastic			Metal
Locking Mechanism	Power to Release		Power to Release	Power to Lock	Power to Release	Power to Release
Escape Release	None		Rear Escape and Flexible Release	None	Rear Escape and Flexible Release	None
Safety Contacts	2 N.C.	3 N.C.	2 N.C.			2 N.C.
Aux Contacts	2 N.O.	1 N.O.	1 N.O.			1 N.O.
Solenoid Monitoring	Direct Drive		1 N.O. & 1 N.C.		2 N.C.	2 N.C.

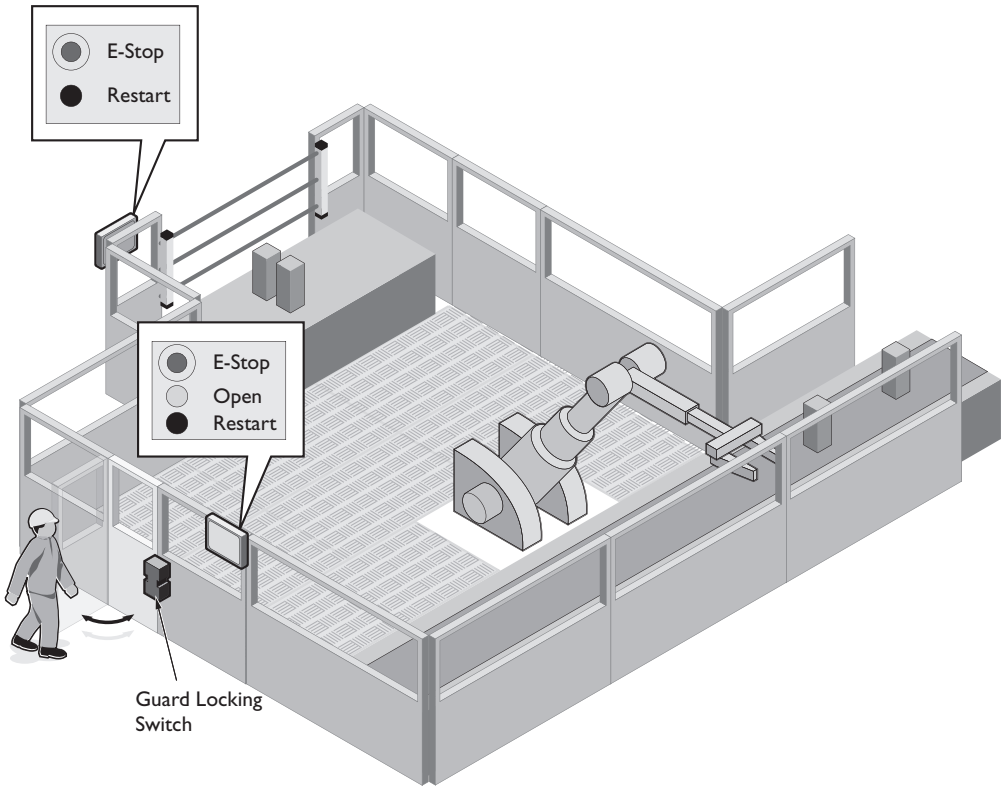
Typical Sequence of Actions and Contact Status

Step		440G-MT	TLS1	TLS2	TLS3	Atlas 5
Step 1—Hazardous Area Protected	**Solenoid Power**	**De-energized**	**De-energized**	**Energized**	**De-energized**	**De-energized**
	Solenoid Feedback A/B	Not Available	Closed/Open	Open/Closed	Closed/Closed	Closed/Closed
	Safety A/B	Closed	Closed	Closed	Closed	Closed
	Aux A (/B✶)	Open	Open	Open	Open	Open/Open
Step 2—Access to Hazardous Area Authorized	**Solenoid Power**	**Energized**	**Energized**	**De-energized**	**Energized**	**Energized**
	Solenoid Feedback A/B	Not Available	Open/Closed	Closed/Open	Open/Open	Open/Open
	Safety A/B	Open ✶	Closed	Closed	Closed	Closed
	Aux A (/B ❄)	Closed	Open	Open	Open	Open/Closed
Step 3—Access Authorized AND Door Open	**Solenoid Power**	**Energized**	**Energized**	**De-energized**	**Energized**	**Energized**
	Solenoid Feedback A/B	Not Available	Open/Closed	Closed/Open	Open/Open	Open/Open
	Safety A/B	Open	Open	Open	Open	Open
	Aux A (/B✶)	Closed	Closed	Closed	Closed	Open/Closed
Step 4—Gate Ready to Be Locked	**Solenoid Power**	**De-energized**	**De-energized**	**Energized**	**De-energized**	**De-energized**
	Solenoid Feedback A/B	Not Available	Closed/Open	Open/Closed	Closed/Closed	Closed/Closed
	Safety A/B	Open	Open	Open	Open	Open
	Aux A (/B✶)	Closed	Closed	Closed	Closed	Closed/Open
Step 5—Door Locked and Hazardous Area Protected	**Solenoid Power**	**De-energized**	**De-energized**	**Energized**	**De-energized**	**De-energized**
	Solenoid Feedback A/B	Not Available	Closed/Open	Open/Closed	Closed/Closed	Closed/Closed
	Safety A/B	Closed	Closed	Closed	Closed	Closed
	Aux A (/B✶)	Open	Open	Open	Open	Open/Open

✶ Direct drive of the contacts from the solenoid forces the safety contact to open even if the door is closed.
❄ Aux B solenoid auxiliary contact is available only on the Atlas 5 safety switch.

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Application Example



Operating Conditions

- The door is closed and locked with a 440G-MT safety switch.
- The robot is running.
- The GuardShield light curtain is muted when the robot is away from the assembly table.

Maintenance Conditions

- In order to clear the jam safely, the operator requests to unlock the door by activating the Open push button.
- The control system (MSR safety relay or SmartGuard 600) shuts down the robot and conveyor when the process conditions allow the robot and conveyor to be stopped without damaging the machine or the products (Controlled stop).
- When the robot and conveyor are stopped the control system allows the door to unlock by applying power to the solenoid in the 440G-MT safety switch.
- The maintenance person opens the door and clears the jam.
- When the task is done, the maintenance person exits the area, closes the door and activates the Restart push button.
- The control system restarts the robot and conveyor.

Remarks

- The safety mats are in place to avoid the machine restarting when the door is closed and the maintenance person is still in the hazardous area. Without the safety mats a Flexible Release can be mounted inside the hazardous area to unlock the door if this situation was to happen.
- The push of any E-Stop push buttons will stop the robot and the conveyor immediately (Immediate stop).

Guard Locking Switches

440G-MT



Description

The 440G-MT solenoid switch is a positive mode, tongue operated guard locking interlock switch that locks a machine guard closed until power is isolated while the guard is open. The guard may only be opened when a signal is applied to the internal solenoid which releases the lock mechanism. The 440G-MT locking mechanism is designed to withstand forces up to 1600 N (360 lb) and the die-cast alloy housing is ideal for use in harsh environments.

The 440G-MT solenoid switch is designed for machines that do not stop immediately or where premature interruption of the machine could cause damage to tooling and components or cause an additional hazard.

A 24V DC enhanced version is available with diagnostic output, which may be used by a control system to indicate whether a guard door is open or shut independently of the lock mechanism status. A built in LED further visually indicates the status of the switch as “door open,” “door shut and unlocked,” and “door shut and locked.”

This enhanced version is supplied with a metal manual override key to more easily enable manual unlocking in conditions when power is not available to electrically unlock the switch.

Features

- Mechanical lock
- High locking force—1600 N (360 lb)
- Heavy-duty die-cast alloy housing, ideal for harsh environments
- Diagnostic version available

Specifications

Safety Ratings						
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1				
Safety Classification		Cat. 1 Device per EN954-1 May be suitable for use in Cat 3 or Cat 4 systems depending on the architecture and application characteristics				
Functional Safety Data (related to Safety Contacts) ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics				
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC				
Outputs						
Safety Contacts ❄		3 N.C. or 2 N.C. direct opening action				
Auxiliary Contacts		1 N.O. or 2 N.O.				
Thermal Current I_{th}		10 A				
Rated Insulation Voltage		(Ui) 500V				
Switching Current @ Voltage, Min.		5 mA @ 5V DC				
Utilization Category						
A600/AC-15	(Ue)	600V	500V	240V	120V	
	(Ie)	1.2 A	1.4 A	3 A	6 A	
DC-13	(Ue)	24V				
	(Ie)	2 A				
Solenoid Characteristics						
Locking Type		Power to Release				
Holding Force, Max.		1600 N (360 lb)				
Power Supply		24V AC/DC or 110V AC or 230V AC				
Solenoid Power		13 W typical 100% ED				
Operating Characteristics						
Break Contact Force, Min.		6 N (1.35 lbf)				
Actuation Speed, Max.		160 mm (6.29 in.)/s				
Actuation Frequency, Max.		2 cycles/s				
Operating Radius, Min		60 mm (2.36 in.)				
Operating Life @ 100 mA load		1,000,000 operations				
Environmental						
Enclosure Type Rating		IP67				
Operating Temperature [C (F)]		-25…+60° (13…+140°)				
Physical Characteristics						
Housing Material		Painted zinc alloy				
Actuator Material		Stainless Steel				
Weight [g (lb)]		1400 (3.08)				
Color		Red				

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

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Product Selection

Solenoid Voltage	Contact			Actuator Type	Cat. No.			
					M20 Conduit		Connector§	
	Safety	Auxiliary	Action		M20	1/2 inch NPT	12-Pin M23	8-Pin Micro (M12)♣
24V AC/DC	3 N.C.	1 N.O.	BBM	GD2 standard	**440G-MT47037**	440G-MT47039	440G-MT47041	440G-M3NBGDH-AC
				Fully-flexible	440G-MT47038	440G-MT47040	440G-MT47042	440G-M3NBBDH-AC
				—	440G-MT47007	440G-MT47008	**440G-MT47043**	—
	2 N.C.	2 N.O.	BBM	GD2 standard	440G-MT47044	440G-MT47046	440G-MT47048	—
				Fully-flexible	440G-MT47045	440G-MT47047	440G-MT47049	—
				—	440G-MT47010	440G-MT47011	440G-MT47050	—
24V DC with diagnostic function and metal override key	3 N.C.	1 N.O.	BBM	GD2 standard	440G-MT47149	440G-MT47150	440G-MT47151	—
				Fully flexible	440G-MT47152	440G-MT47153	440G-MT47154	—
				No actuator	440G-MT47155	440G-MT47156	440G-MT47157	—
	2 N.C.	2 N.O.	BBM	GD2 standard	440G-MT47158	440G-MT47159	440G-MT47160	—
				Fully flexible	440G-MT47161	440G-MT47162	440G-MT47163	—
				No actuator	440G-MT47164	440G-MT47165	440G-MT47166	—
110V AC/DC	3 N.C.	1 N.O.	BBM	GD2 standard	440G-MT47070	440G-MT47073	—	—
				Fully-flexible	440G-MT47071	440G-MT47074	—	—
				—	440G-MT47013	440G-MT47009	—	—
	2 N.C.	2 N.O.	BBM	GD2 standard	440G-MT47077	440G-MT47079	—	—
				Fully-flexible	440G-MT47078	440G-MT47080	—	—
				—	440G-MT47012	440G-MT47014	—	—
230V AC/DC	3 N.C.	1 N.O.	BBM	—	440G-MT47016	440G-MT47017	—	—
	2 N.C.	2 N.O.		—	440G-MT47015	440G-MT47024	—	—

§ For connector ratings see page 3-9.
♣ With an 8-pin micro (M12) connector, not all contacts are connected. See page 3-39 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Time Delay	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays								
MSR127RP	3 N.O.	1 N.C.	—	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	—	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	—	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	—	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Specialty Safety Relays								
MSR178	3 N.O.	2 N.C.	0.5 s…30 min	Removable	Automatic	24V AC/DC, 115V AC or 230V AC	5-40	440R-M23227
CU2	2 N.O.	1 N.C.	0.1 s…40 min	Fixed	—	24V AC/DC	5-56	440R-S07281
CU3	2 N.O.	1 N.C.	—	Fixed	Automatic/Manual	110V AC	5-64	440R-S35002
Modular Safety Relays								
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	—	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	—	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	—	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Guard Locking Switches

440G-MT

Connection Systems

Description	8-Pin Micro	12-Pin M23
Cordset	889D-F8AB-✶	889M-F12AH-✶
Patchcord	889D-F8ABDM-❄	889M-F12AHMU-‡

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 0M3, (0.3 m), 0M6 (0.6 m), 1 (1 m), 2 (2 m) or 3 (3 m) for standard lengths.
Note: For additional information, see page 7-1.

Accessories

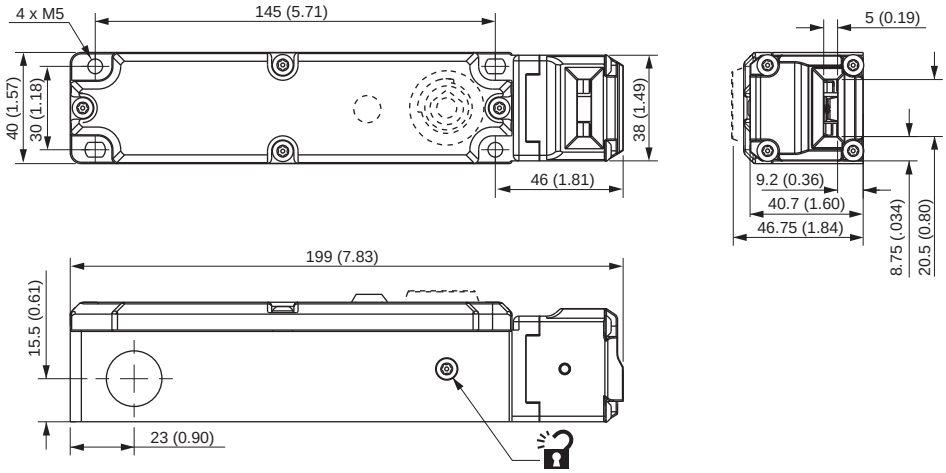
Description		Dimensions	Cat. No.
	GD2 standard actuator	3-50	**440G-A27011**
	GD2 flat actuator		**440K-A11112**
	Fully flex actuator		**440G-A27143**
	Sliding bolt actuator		440G-A27163
	Extended flat actuator		**440K-A17116**
	Replacement Cover, No LED, No Override Key	—	440G-MT47120
	Replacement Cover, LED, Override Key		440G-MT47123
	Emergency Override Key (See Warning below.)	—	440G-A36026
	Dust Cover	—	440K-A17180



WARNING: Do not attach the Emergency Override Key to the 440G-MT switch.

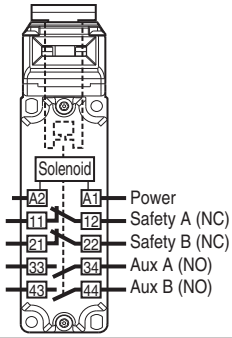
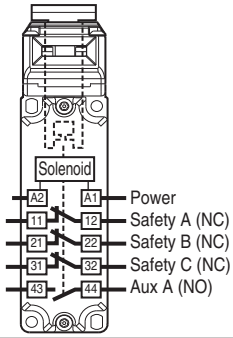
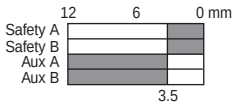
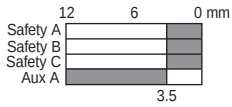
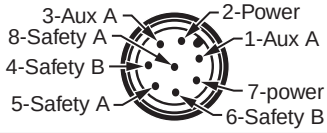
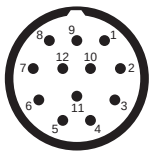
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Typical Wiring Diagrams

		2 N.C. & 2 N.O.	3 N.C. & 1 N.O.
Contact Configuration			
Contact Action □Open ■Closed		 BBM	 BBM
8-Pin Micro (M12)		—	
12-Pin M23 QD  Pin 11 not connected.	1 and 3	Solenoid Power	Solenoid Power
	4 and 6	Safety A	Safety A
	7 and 8	Safety B	Safety B
	2 and 5	Aux A	Safety C
	9 and 10	Aux B	Aux A
	12	Ground	Ground
8-Pin Cordset 889D-F8AB-∗	Brown Blue	—	Solenoid Power
	Grey Red	—	Safety A
	Yellow Pink	—	Safety B
	White Green	—	Aux A
12-Pin Cordset 889M-F12AH-∗	Brown Grey	Solenoid Power	Solenoid Power
	Pink Yellow	Safety A	Safety A
	White Red/Blue	Safety B	Safety B
	Blue Red	Aux A	Safety C
	Black Violet	Aux B	Aux A
Grey/Pink not connected.	Green	Ground	Ground

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Diagnostic Version

Actuator	LED Output Matrix	
	Solenoid Off	Solenoid On
In	Green	Amber
Out	Flashing Red	Red

Diagnostic Electrical Output

Actuator	Voltage
In	0V DC
Out	+24V DC

Electrical output independent of solenoid status. Maximum output is 100 mA.

Guard Locking Switches

TLS-GD2



Description

The TLS-GD2 is a positive mode, tongue operated guard locking interlock switch that locks a machine guard closed until power is isolated and ensures that it remains isolated while the guard is open. It has three safety (N.C.) contacts and two auxiliary (N.O.) contacts. The TLS-GD2 head has two entry slots and it can be rotated to provide four actuator entry points. A blanking plug is provided to seat the unused slot.

The guard may only be opened when a signal is applied to the TLS-GD2's internal solenoid which releases the lock mechanism. This signal can be via CU1 electronic timer relays or CU2 stopped motion detectors. Therefore the TLS-GD2 is ideal for machines which do not stop immediately or where premature interruption of the machine could cause damage to tooling and components or cause an additional hazard.

The TLS-GD2 is available in three types. The TLS-1 GD2 and TLS-3 GD2 incorporate a power-to-release function. Two manual release points with security screws allow the locked TLS-GD2 to be released in emergencies. An optional lid-mounted key-release style can also be supplied. The TLS-2 GD2 has a power-to-lock function. Each type of switch has five sets of contacts of various forms and are suitable for use with PLCs.

The TLS-1 GD2 and TLS-3 GD2 are both available with escape release options. They are intended for machine guarding with full body access. The switch is installed so that the escape release push button on the rear side is accessible from inside the hazardous area. This allows the intentional unlocking of the TLS-GD2 from inside a hazardous area, providing a means of escape for a person who may become trapped.

A stainless-steel actuator guide is fitted to protect the unit from actuator damage due to poor guard alignment or guard wear.

TLS-GD2 has an ingress protection rating of IP69K making it suitable for harsh washdown applications as found in the food and beverage, pharmaceutical, solar and semiconductor industries.

IMPORTANT: With the TLS-2 GD2 "power to lock" style, provisions may be required to ensure that a dangerous situation can not result from open circuit faults or power cuts.

Features

- Power to release or power to lock
- High locking force ≤2000 N (450 lb)
- Five contacts: 2 N.C. & 1 N.O. for door position monitoring 1 N.C. & 1 N.O. or 2 N.C. for lock monitoring
- Rotatable head: 4 possible key entry slots
- Conforms to EN 1088 & EN 60947-5-1
- Escape Release version available
- IP69K, suitable for high pressure, high temperature washdown

Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 device per EN 954-1 dual channel interlocks suitable for Cat. 3 or 4 systems			
Functional Safety Data (related to Safety Contacts) ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs					
Safety Contacts ❄		(TLS-1 & -2) 3 N.C. direct opening action (TLS-3) 4 N.C. direct opening action			
Auxiliary Contacts		(TLS-1 & -2) 2 N.O. (1 solenoid monitoring) (TLS-3 1 N.O.)			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Solenoid Characteristics					
Locking Type		TLS-1 & -3 Power-to-Release TLS-2 Power-to-Lock			
Holding Force, Max.		2000 N (450 lbf)			
Releasable Load, Max.		100 N (22.5 lbf)			
Power Supply		24V AC/DC or 110V AC or 230V AC (solenoid)			
Solenoid Power		Typically 7 W 100% ED			
Escape Release Button		Force max.: 50 N (11.25 lbs)			
Operating Characteristics					
Break Contact Force, Min.		20 N (4.5 lbf)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		1 cycle/s			
Operating Radius, Min		160 mm (6.3 in.) [80 mm (3.15 in.) with flexible actuator]			
Operating Life @ 100 mA load		1,000,000 operations			
Environmental					
Enclosure Type Rating		IP66, IP67 and IP69K			
Operating Temperature [C (F)]		-20…+60° (-4…+140°)			
Physical Characteristics					
Housing Material		UL Approved glass-filled PBT			
Actuator Material		Stainless Steel			
Weight [g (lb)]		400 (0.88)			
Color		Red			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10mins., 24hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Type	Contacts		Solenoid		Actuator Type	Cat. No.			
						Conduit		Connector§	
	Safety	Auxiliary	Contacts	Voltage		M20	1/2 inch NPT Adaptor	12-Pin M23	8-Pin Micro (M12)♣
TLS-1 GD2 Power to Release	2 N.C.	1 N.O.	1 N.C. & 1 N.O.	24V AC/DC	—	**440G-T27121**	—	440G-T27233	440G-T2NBBPH-1R
					GD2 Standard	440G-T27251	440G-T27169	440G-T27234	—
					Fully Flex	440G-T27252	**440G-T27171**	440G-T27235	—
				110V AC/DC	—	440G-T27124	—	—	—
					GD2 Standard	440G-T27253	440G-T27172	—	—
					Fully Flex	440G-T27254	440G-T27174	—	—
				230V AC/DC	—	440G-T27123	—	—	—
TLS-2 GD2 Power to Lock	2 N.C.	1 N.O.	1 N.C. & 1 N.O.	24V AC/DC	—	**440G-T27127**	—	440G-T27239	440G-T2NBBPH-1L
					GD2 Standard	440G-T27255	440G-T27175	440G-T27240	—
					Fully Flex	440G-T27256	**440G-T27177**	440G-T27241	—
				110V AC/DC	—	440G-T27132	—	—	—
					GD2 Standard	440G-T27257	440G-T27178	—	—
					Fully Flex	440G-T27258	440G-T27180	—	—
				230V AC/DC	—	440G-T27129	—	—	—
TLS-3 GD2 Power to Release	2 N.C.	1 N.O.	2 N.C.	24V AC/DC	—	**440G-T27134**	—	440G-T27245	440G-T2NBBPH-2R
					GD2 Standard	440G-T27259	440G-T27181	440G-T27246	—
					Fully Flex	440G-T27260	440G-T27183	440G-T27247	—
				110V AC/DC	—	440G-T27138	—	—	—
					GD2 Standard	440G-T27261	440G-T27184	—	—
					Fully Flex	440G-T27262	440G-T27186	—	—
				230V AC/DC	—	440G-T27136	—	—	—
TLS-1 GD2 Power to Release with Escape Release	2 N.C.	1 N.O.	1 N.C. & 1 N.O.	24V AC/DC	—	440G-T21BNPM-1B	440G-T21BNPT-1B	440G-T21BNPL-1B	440G-T2NBNPH-1B
					GD2 Standard	440G-T21BGPM-1B	440G-T21BGPT-1B	440G-T21BGPL-1B	—
				110V AC/DC	—	440G-T21BNPM-4B	440G-T21BNPT-4B	—	—
					GD2 Standard	440G-T21BGPM-4B	440G-T21BGPT-4B	—	—
TLS-3 GD2 Power to Release with Escape Release	2 N.C.	1 N.O.	2 N.C.	24V AC/DC	—	440G-T21BNPM-2B	440G-T21BNPT-2B	440G-T21BNPL-2B	440G-T2NBNPH-2B
					GD2 Standard	440G-T21BGPM-2B	440G-T21BGPT-2B	440G-T21BGPL-2B	—
				110V AC/DC	—	440G-T21BNPM-5B	440G-T21BNPT-5B	—	—
					GD2 Standard	440G-T21BGPM-5B	440G-T21BGPT-5B	—	—

§ For connector ratings, see page 3-9.
♣ With an 8-pin micro connector, not all contacts are connected. See page 3-45 for wiring details.



WARNING:

To monitor **independently** the safety contact(s) and the solenoid feedback (TLS 1, 2 and 3):

- The 12-wire cordset 889M-F12AH-∗ must be used

AND

- For the TLS1 and TLS2: the jumper between 12 and 41 must be removed
- For the TLS3: the jumpers between 12 and 41 and 22 and 51 must be removed



WARNING:

Monitoring of safety contact(s) and the solenoid feedback (in series) is available, when jumpers are in place:

AND

- For the TLS1 and TLS2: by using pins 4 and 6 on the 12-pin, M23 receptacle or Pink and Yellow wires on the 12-wire cordset (889M-F12AH-∗)
- For the TLS3: by using pins 4 and 6 and pins 7 and 8 on the 12-pin, M23 receptacle or Pink and Yellow and White and Red/Blue wires on the 12-wire cordset (889M-F12AH-∗)

∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.

Guard Locking Switches

TLS-GD2

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Time Delay	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays								
MSR127RP	3 N.O.	1 N.C.	—	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	—	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	—	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	—	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Specialty Safety Relays								
MSR178	3 N.O.	2 N.C.	0.5 s…30 min	Removable	Automatic	24V AC/DC, 115V AC or 230V AC	5-40	440R-M23227
CU2	2 N.O.	1 N.C.	0.1 s…40 min	Fixed	—	24V AC/DC	5-56	440R-S07281
CU3	2 N.O.	1 N.C.	—	Fixed	Automatic/Manual	110V AC	5-64	440R-S35002
Modular Safety Relays								
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	—	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	—	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	—	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

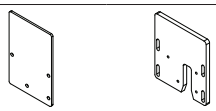
Description	8-Pin Micro (M12)	12-Wire, 12-Pin M23	9-Wire, 12-Pin M23§
Cordset	889D-F8AB-✶	889M-F12AH-✶	889M-FX9AE-✶
Patchcord	889D-F8ABDM-❄	889M-F12AHMU-‡	—

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 0M3, (0.3 m), 0M6 (0.6 m), 1 (1 m), 2 (2 m) or 3 (3 m) for standard lengths.
§ The 9-wire cordset can be used only with the TLS3 versions.
Note: For additional information, see page 7-1.

Visit our website: www.ab.com/catalog
Publication S117-CA001A-EN-P

Allen-Bradley
Guardmaster®

Accessories

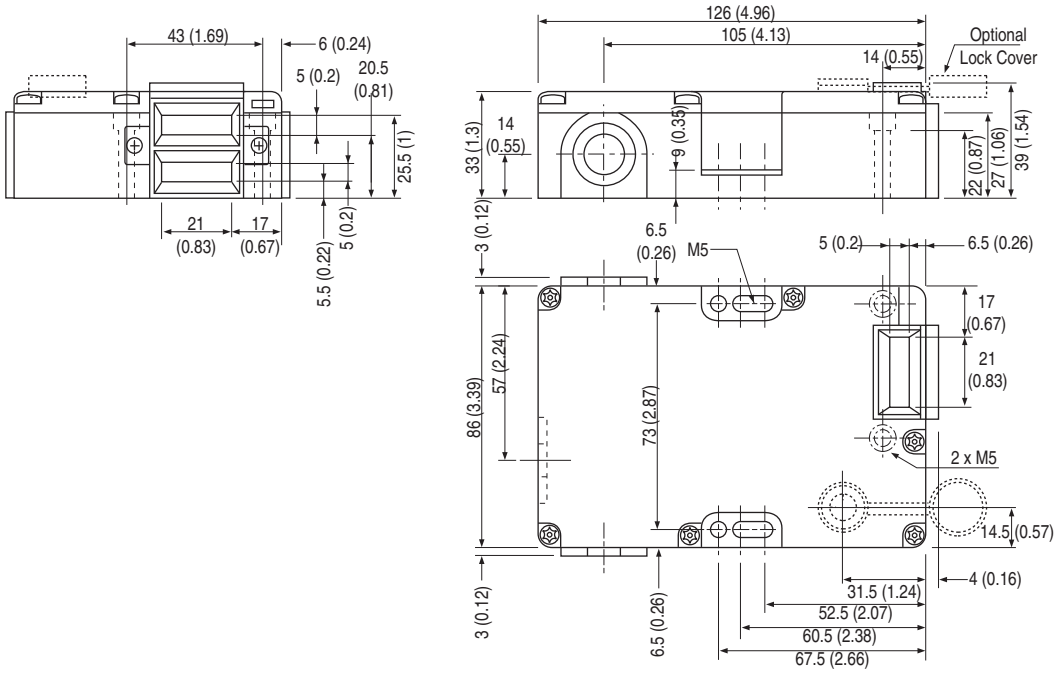
Description		Dimensions	Cat. No.
	GD2 standard actuator	3-50	**440G-A27011**
	GD2 flat actuator	3-51	**440K-A11112**
	Extended flat actuator	3-51	**440K-A17116**
	Fully flex actuator	3-50	**440G-A27143**
	Sliding bolt actuator not to be used with the Escape Release	3-55	440G-A27163
	Cover for TLS-1 with external override key for series D and earlier	—	440G-A27140
	Cover for TLS-3 with external override key for series D and earlier		440G-A27142
	Cover for TLS-1 with override key attached for series D and earlier		440G-A27207
	Cover for TLS-3 with override key attached for series D and earlier		440G-A27208
	Cover for TLS-1 with external override key for series E and later		440G-A27371
	Cover for TLS-3 with external override key for series E and later		440G-A27372
	Cover for TLS-1 with override key attached for series E and later		440G-A27373
	Cover for TLS-3 with override key attached for series E and later		440G-A27374
	Emergency Override Key (See Warning below.)	—	440G-A36026
	Flexible Release—1 m (3.28 ft) Cable	3-54	440G-A27356
	Flexible Release—3 m (9.84 ft) Cable		440G-A27357
	Dust Cover	—	440K-A17183
	Sliding Bolt	3-55	440K-AMDS
	Mounting Plate	3-55	440K-AMDSSMPB



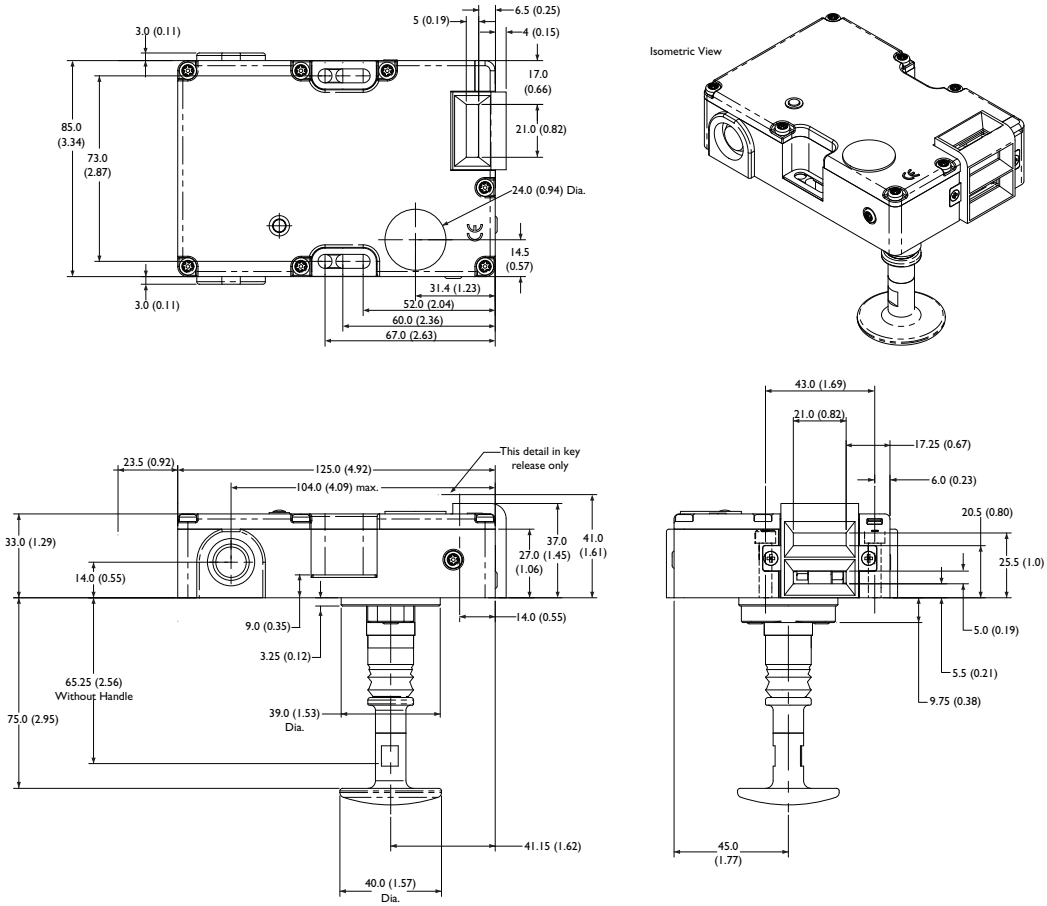
WARNING: Do not attach the Emergency Override Key to the TLS-GD2 switch.

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

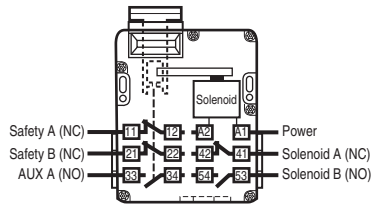


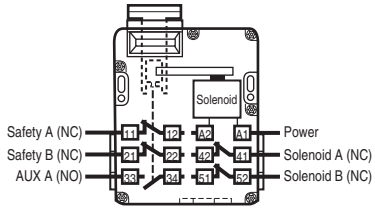
TLS-GD2 Escape Release



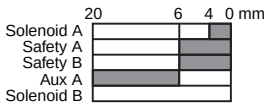
***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

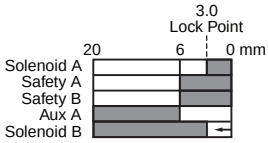
Typical Wiring Diagrams

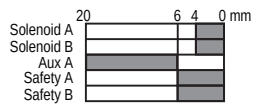
<table>
<tr><th>Red Switches</th><th colspan="2">TLS1</th><th colspan="2">TLS2</th><th colspan="2">TLS3</th></tr>
<tr><td>Contact Configuration</td><td colspan="2"> 

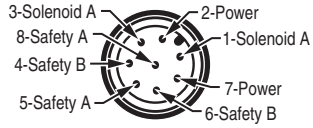
Jumper between 12 & 41</td><td colspan="2"></td><td colspan="2"> 

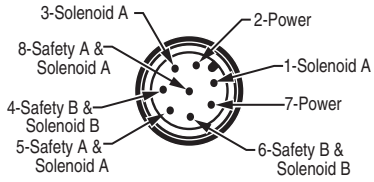
Jumper between 12 & 41 and 22 & 51</td></tr>
<tr><td>Contact Action

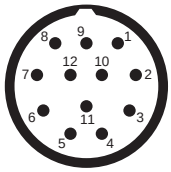
☐Open ■Closed</td><td colspan="2"> 

BBM</td><td colspan="2"> 

BBM</td><td colspan="2"> 

BBM</td></tr>
<tr><td>8-Pin Micro (M12)</td><td colspan="2"> 

No jumper on 12-41.</td><td colspan="2"> 

Jumper on 12-41 and 22-51.</td></tr>
<tr><td rowspan="5">12-Pin M23
 
</td><td>1 and 3</td><td>Solenoid Power</td><td>1 and 3</td><td>Solenoid Power</td></tr>
<tr><td>4 and 12</td><td>Safety A ❖</td><td>4 and 12</td><td>Safety A ❖</td></tr>
<tr><td>7 and 8</td><td>Safety B</td><td>7 and 5</td><td>Safety B ❖</td></tr>
<tr><td>9 and 10</td><td>Aux A</td><td>9 and 10</td><td>Aux A</td></tr>
<tr><td>6 and 11</td><td>Solenoid A ❖</td><td>6 and 11</td><td>Solenoid A ❖</td></tr>
<tr><td rowspan="4">8-Pin Cordset
889D-F8AB-∗</td><td>2 and 5</td><td>Solenoid B</td><td>2 and 8</td><td>Solenoid B ❖</td></tr>
<tr><td>Brown
Blue</td><td colspan="2">Solenoid Power</td><td colspan="2">Solenoid Power</td></tr>
<tr><td>Grey
Red</td><td colspan="2">Safety A</td><td colspan="2">Safety A & Solenoid A</td></tr>
<tr><td>Yellow
Pink</td><td colspan="2">Safety B</td><td colspan="2">Safety B & Solenoid B</td></tr>
<tr><td>White
Green</td><td colspan="2">Solenoid A</td><td colspan="2">Solenoid A</td></tr>
<tr><td rowspan="4">12-Pin, 9-Wire Cordset
889M-FX9AE-∗

Pink/Yellow: Not connected</td><td colspan="2" rowspan="4">Can not be used.</td><td>Brown
Blue</td><td>Solenoid Power</td></tr>
<tr><td>White
Green</td><td>Safety A & Solenoid A</td></tr>
<tr><td>Yellow
Grey</td><td>Safety B & Solenoid B</td></tr>
<tr><td>Pink
Red</td><td>Aux A</td></tr>
<tr><td rowspan="6">12-Pin, 12-Wire Cordset
889M-F12AH-∗</td><td>Brown
Grey</td><td>Solenoid Power</td><td>Brown
Grey</td><td>Solenoid Power</td></tr>
<tr><td>Pink
Green</td><td>Safety A ❖</td><td>Pink
Green</td><td>Safety A ❖</td></tr>
<tr><td>White
Red/Blue</td><td>Safety B</td><td>White
Red</td><td>Safety B ❖</td></tr>
<tr><td>Black
Violet</td><td>Aux A</td><td>Black
Violet</td><td>Aux A</td></tr>
<tr><td>Grey/Pink
Yellow</td><td>Solenoid A ❖</td><td>Grey/Pink
Yellow</td><td>Solenoid A ❖</td></tr>
<tr><td>Blue
Red</td><td>Solenoid B</td><td>Blue
Red/Blue</td><td>Solenoid B ❖</td></tr>
</table>

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.
❖ See **WARNING** notes on page 3-41.

Guard Locking Switches

Atlas™ 5



Description

The Atlas 5 is a positive-mode, tongue-operated guard-locking interlock switch that locks a machine guard closed until power is isolated to ensure that it remains isolated while the guard is open. A heavy-duty switch, the Atlas 5 locking mechanism is designed to withstand forces up to 5000 N (1124 lb) and the die-cast alloy housing is ideal for use in harsh environments. A unique feature of the Atlas 5 is a patented self-aligning head that tolerates actuator or guard misalignment, making it particularly useful for heavy machine guards.

The Atlas 5 is designed for machines that do not stop immediately or where premature interruption of the machine could cause damage to tooling and components or cause an additional hazard. With 2 safety (N.C.) contacts and 2 auxiliary (N.O.) contact, Atlas 5 is ideal for PLC controlled machines.

Features

- Mechanical lock
- High locking force—5000 N (1124 lb)
- Heavy duty die-cast alloy housing ideal for harsh environments
- Patented self-aligning head tolerates actuator misalignment

Specifications

Safety Ratings			
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification		Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems	
Functional Safety Data (related to Safety Contacts) ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications		CE Marked for all applicable directives, cULus, CSA, and TÜV	
Outputs			
Safety Contacts ❄		Atlas 5: 2 N.C. direct opening action; 1 N.O. direct opening action Atlas 5 trapped key (left hand): 2 N.C. direct opening action; 1 N.O. direct opening action	
Auxiliary Contacts		1 N.O.	
Thermal Current I_{lth}		10 A	
Rated Insulation Voltage		(Ui) 500V	
Switching Current @ Voltage, Min.		5 mA @ 5V DC	
Utilization Category			
AC-15	(Ue)	240V	120V
	(Ie)	1.5 A	3 A
DC-13	(Ue)	24V	
	(Ie)	2 A	
Solenoid Characteristics			
Locking Type		Power to Release	
Holding Force, Max.		5000 N (1124 lbf)	
Power Supply		24V AC/DC or 110V AC or 230V AC (solenoid)	
Solenoid Power		13 W typical 100% ED	
Operating Characteristics			
Break Contact Force, Min.		12 N (2.7 lbf)	
Actuation Speed, Max.∗		160 mm (6.29 in.)/s	
Actuation Frequency, Max.		2 cycles/s	
Operating Radius, Min		300 mm end entry, 800 mm entry front	
Operating Life @ 100 mA load		1,000,000 operations	
Environmental			
Enclosure Type Rating		IP65	
Operating Temperature [C (F)]		-10…+60° (+14…+140°)	
Physical Characteristics			
Housing Material		Die-cast alloy	
Actuator Material		Stainless Steel	
Weight [g (lb)]		1200 (2.65)	
Color		Red	

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10mins., 24hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

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Product Selection

Module Type	Actuator Type	Contact		Solenoid Contacts	Solenoid Voltage	Cat. No.			
						M20 Conduit		Connector§	
		Safety	Auxiliary			M20	1/2 inch NPT Adaptor	12-Pin M23	8-Pin Micro (M12)♣
Standard	Standard	2 N.C.	1 N.O.	2 N.C. & 1 N.O.	24V AC/DC	440G-L07264	440G-L07258	440G-L07298	440G-L2NNSDH-3N
					110V AC/DC	440G-L07263	440G-L07257	—	—
					230V AC/DC	440G-L07262	440G-L07256	—	—
LH Key Lock					24V AC/DC	440G-L07255	440G-L07249	440G-L07301	440G-L2NNSDH-38
					110V AC/DC	440G-L07254	440G-L07248	—	—
					230V AC/DC	440G-L07253	440G-L07247	—	—

§ For connector ratings, see 3-9.
♣ With an 8-pin micro connector, not all contacts are connected. See page 3-49 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Time Delay	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays								
MSR127RP	3 N.O.	1 N.C.	—	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	—	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	—	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	—	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Specialty Safety Relays								
MSR178	3 N.O.	2 N.C.	0.5 s…30 min	Removable	Automatic	24V AC/DC, 115V AC or 230V AC	5-40	440R-M23227
CU2	2 N.O.	1 N.C.	0.1 s…40 min	Fixed	—	24V AC/DC	5-56	440R-S07281
CU3	2 N.O.	1 N.C.	—	Fixed	Automatic/Manual	110V AC	5-64	440R-S35002
Modular Safety Relays								
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	—	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	—	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	—	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	8-Pin Micro (M12)	12-Pin M23
Cordset	889D-F8AB-✶	889M-F12AH-✶
Patchcord	889D-F8ABDM-❄	889M-F12AHMU-‡

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 0M3, (0.3 m), 0M6 (0.6 m), 1 (1 m), 2 (2 m) or 3 (3 m) for standard lengths.
Note: For additional information, see page 7-1.

Guard Locking Switches

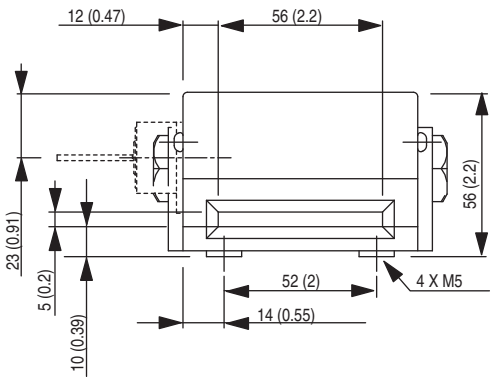
Atlas™ 5

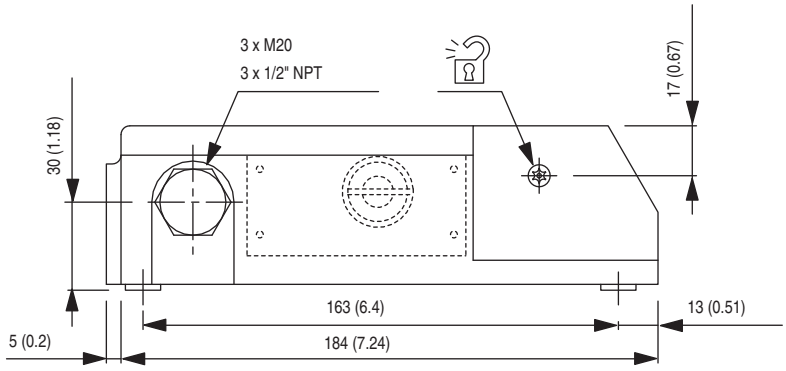
Accessories

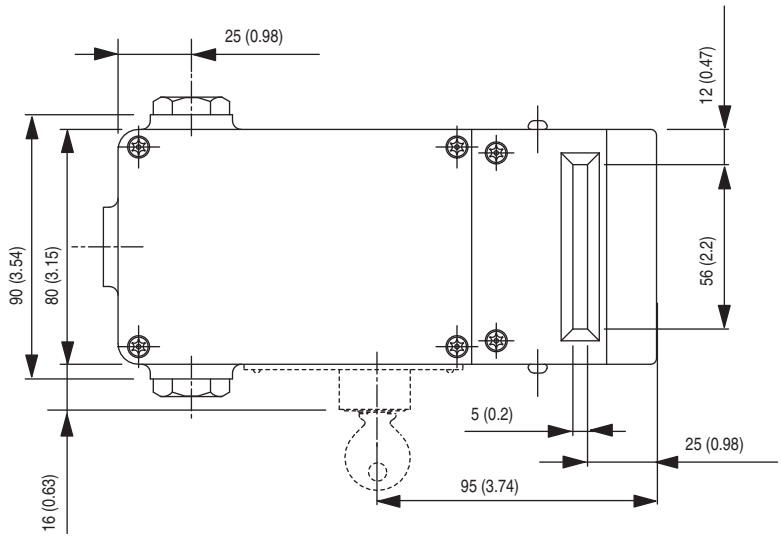
Description		Dimensions	Cat. No.
	Standard actuator	3-50	440G-A07136
	Atlas Replacement End Cap	—	440G-A07180
	Fully flex actuator	3-50	440G-A07269
	Dust Cover	—	440K-A17181

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

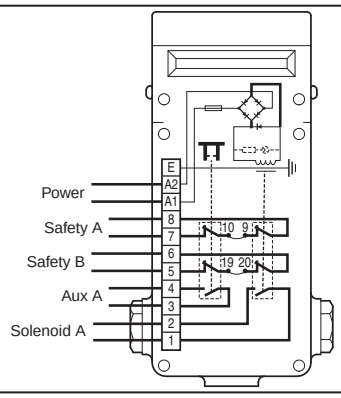
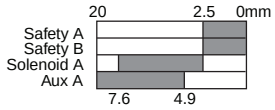
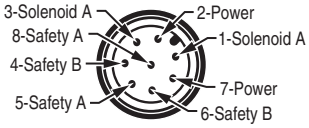
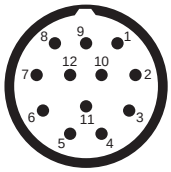






***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

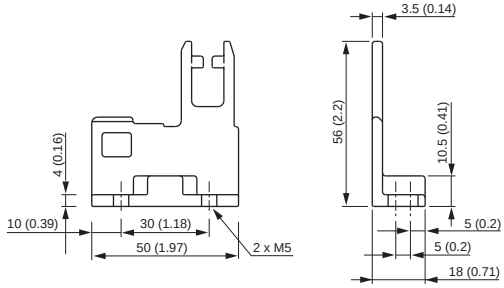
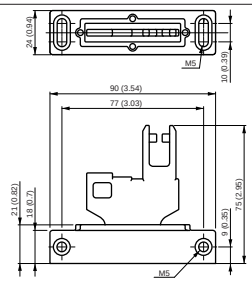
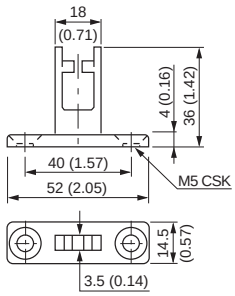
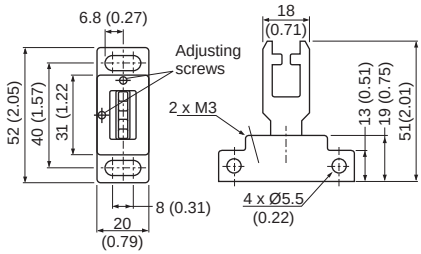
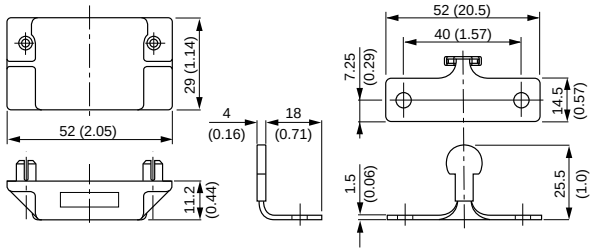
Typical Wiring Diagrams

		Atlas 5
Contact Configuration		
Contact Action □Open ■Closed		 BBM
8-Pin Micro (M12)		 Jumpers on 9-10 and 19-20.
12-Pin M23  Pin 11 not connected.	1 and 3	Solenoid Power
	4 and 6	Safety A
	7 and 8	Safety B
	2 and 5	Aux A
	9 and 10	Solenoid A
	12	Ground
8-Pin Cordset 889D-F8AB-∗	Brown Blue	Solenoid Power
	Grey Red	Safety A
	Yellow Pink	Safety B
	White Green	Solenoid A
12-Pin Cordset 889M-F12AH-∗	Brown Grey	Solenoid Power
	Pink Yellow	Safety A
	White Red/Blue	Safety B
	Blue Red	Aux A
	Black Violet	Solenoid A
	Green	Ground

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Accessories for Interlock and Guard Locking Switches

Actuators*

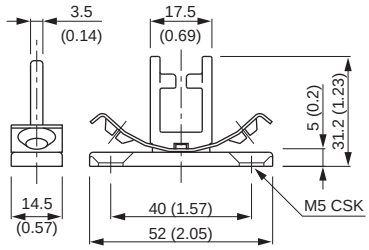
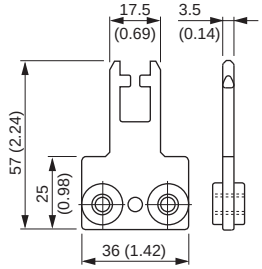
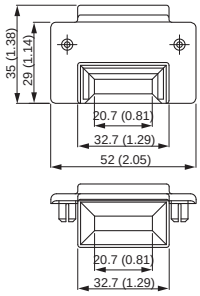
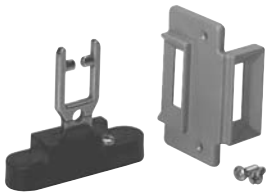
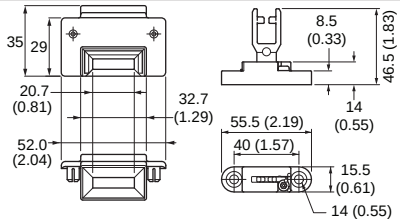
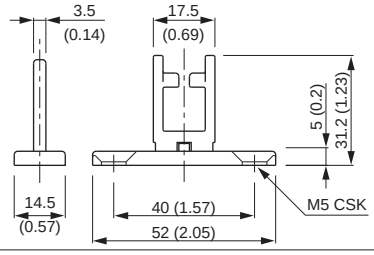
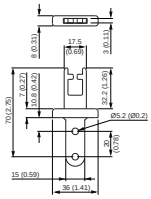
Item	Description	Approximate Dimensions [mm (in.)]	Cat. No.
	Standard actuator		440G-A07136
	Fully flex actuator		440G-A07269
	GD2 standard actuator		**440G-A27011**
	Fully flex actuator		**440G-A27143**
	Catch and Retainer Kit		440K-A11094

* See page 3-8 for Switch Compatibility table.

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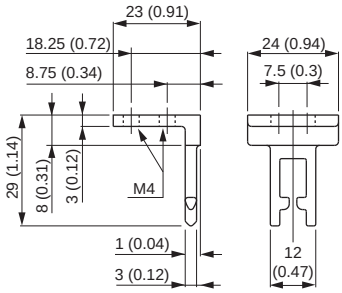
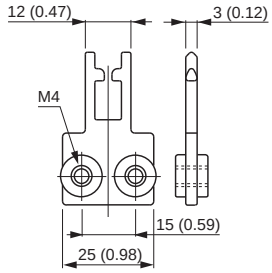
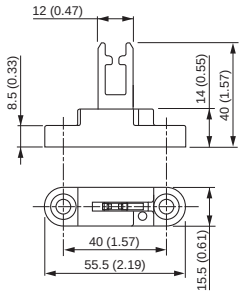
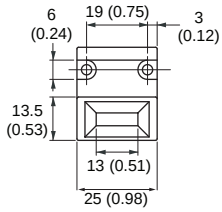
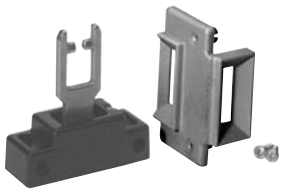
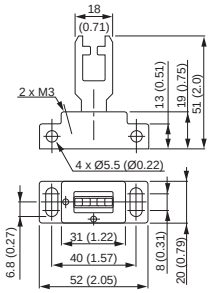
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Actuators* (continued)

Item	Description	Approximate Dimensions [mm (in.)]	Cat. No.
	Standard actuator		**440K-A11095**
	GD2 flat actuator		**440K-A11112**
	Replacement Alignment Guide		440K-A11115
	Alignment guide with semi-flexible actuator		440K-A11144
	Standard actuator		440K-A11238
	Extended flat actuator		**440K-A17116**

* See page 3-8 for Switch Compatibility table.

Actuators* (continued)

Item	Description	Approximate Dimensions [mm (in.)]	Cat. No.
	90° actuator, not to be used with metal alignment guide		**440K-A21006**
	Flat actuator, not to be used with metal alignment guide		**440K-A21014**
	Metal alignment guide with semi-flexible actuator		440K-A21030
	Metal Alignment Guide		440K-A21069
	Alignment guide with fully-flexible actuator		440K-A27010

* See page 3-8 for Switch Compatibility table.

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Beacons and Bulbs

Item	Description	Cat. No.
	Indicator, M20 Conduit Pilot Light—Amber Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19001
	Indicator, M20 Conduit Pilot Light—Red Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19002
	Indicator, 1/2 inch NPT Conduit Pilot Light—Amber Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19005
	Indicator, 1/2 inch NPT Conduit Pilot Light—Red Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19007
	Bulb, 24V for Conduit Pilot Light 2.8W T-3 1/4 Bulb, Miniature Screw Base	440A-A09056
	Bulb, 110V for Conduit Pilot Light 2.6W T-3 1/4 Bulb, Miniature Screw Base	440A-A09055
	Bulb, 240V for Conduit Pilot Light 0.75W T-3 1/4 Bulb, Miniature Screw Base	440A-A09054
	Red LED Bulb, 24V AC/DC for Conduit Pilot Light Bayonet Style Insert	800T-N319R
	Amber LED Bulb, 24V AC/DC for Conduit Pilot Light Bayonet Style Insert	800T-N319A
	Red LED Bulb, 120V AC for Conduit Pilot Light Bayonet Style Insert	800T-N320R
	Amber LED Bulb, 120V AC for Conduit Pilot Light Bayonet Style Insert	800T-N320A

Conduit Accessories

Item	Description	Cat. No.
	Blanking plug, M20 conduit	440A-A07265
	Cable Grip, M16 Conduit, Accommodates Cable Diameter 4…7 mm (0.27…0.16 in.)	440A-A09004
	Cable grip, M20 conduit, accommodates cable diameter 7…10.5 mm (0.27…0.41 in.)	440A-A09028
	Adaptor, conduit, M20 to 1/2 inch NPT, plastic	440A-A09042
	Adaptor, Conduit, 1/2 inch NPT to M16, Brass	440A-A09093
	Adaptor, Conduit, M16 to 1/2 inch NPT, Brass	440A-A09094

Accessories

Replacement and Dust Covers, Emergency Override, and Flex Release

Replacement Covers

Item	Description	Cat. No.
	Elf™	440A-A33085
	Cadet™	440A-A21115
	Trojan T15	440A-A11499
	Trojan 5 Standard Models Only	440A-A11495
	Trojan T5 GD2	440A-A11496
	Trojan T6 Standard Models Only	440A-A11497
	Trojan T6 GD2	440A-A11498
	440G-MT No LED, No Override	440G-MT47120
	440G-MT LED and Override	440G-MT47123
	Cover for TLS-1 with external override key for series D and earlier	440G-A27140
	Cover for TLS-3 with external override key for series D and earlier	440G-A27142
	Cover for TLS-1 with override key attached for series D and earlier	440G-A27207
	Cover for TLS-3 with override key attached for series D and earlier	440G-A27208
	Atlas Replacement End Cap	440G-A07180

Dust Covers

Item	Applicable Switch	Cat. No.
	Elf Cadet	440K-A17182
	Trojan T15, T5, and T6 All Models MT G2 440G-MT	440K-A17180
	TLS-GD2	440K-A17183
	Atlas 5	440K-A17181

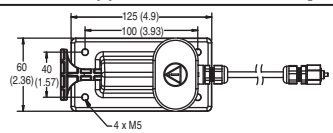
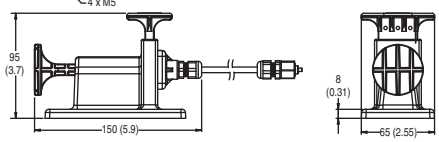
Emergency Override

Item	Description	Cat. No.
	TLS-GD2/440G-MT Solenoid Emergency Override (See Warning below.)	440G-A36026



WARNING: Do not attach the Emergency Override Key to the TLS-GD2/440G-MT switch.

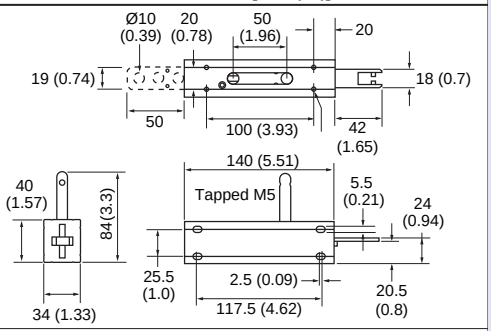
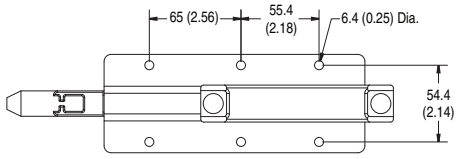
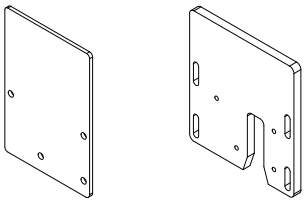
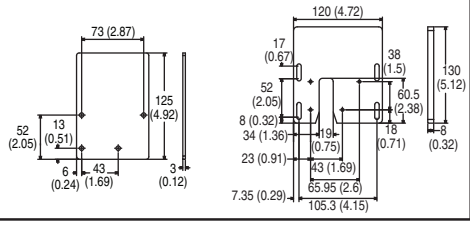
Flex Release

Item	Description	Approximate Dimensions [mm (in.)]	Cat. No.
	Flexible Release—1 m (3.28 ft) Cable		440G-A27356
	Flexible Release—3 m (9.84 ft) Cable		440G-A27357

Tools

Item	Description	Cat. No.
	Security Bit	440A-A09015
	Screwdriver Including Security Bit	440A-A09018

Door Handles

Item	Description	Dimensions [mm (in.)]	Cat. No.
	Sliding bolt actuator		440G-A27163
	Sliding Bolt		440K-AMDS
	Sliding Bolt Mounting Plate for TLS-GD2		440K-AMDSSMPB

Non-Contact Switches

SensaGuard™



Description

When it comes to machine safety, Rockwell Automation knows that protection of personnel and equipment is your main concern. At the same time, flexibility and productivity are points that must also be considered as you design your safety system. Optimize all of these with the new Allen-Bradley SensaGuard family of non-contact switches.

Featuring the latest generation of RFID technology for coding and inductive technology for sensing, SensaGuard's large sensing range and tolerance to misalignment is a cost-effective solution that is ideally suited for a wide range of industrial safety applications.

The SensaGuard product line is a Category 4/SIL 3 rated switch per EN954-1, TÜV functional safety approved to IEC 61508.

Features

- Switches can be connect to a standard safety relay, for example, the MSR126, MSR127, MSR200/300 Family, SmartGuard™ and Safety I/O Blocks
- Multiple actuator sizes for large sensing distance
- IP69K environmental rating
- Short-circuit and over-voltage protection
- LED located on the switch for door status and troubleshooting
- Unique coded version
  - Automatic learn process at unit power up
  - During commissioning you have the option to select if the sensor can learn a new actuator up to eight times or lock the unit so it can not learn another actuator
- Integrated latch version
  - Adjustable magnetic latch force 20…60N
  - Designed for easy mounting on aluminum profile

Benefits

- No dedicated controller required
- Cat 4/SIL 3 rating maintained even with multiple units connected in series
- Switches can be connected in series with other devices (light curtain, E-stops, key interlock switches)
- Extended diagnostics for easy troubleshooting
- Large sensing distances
- Tolerance to misalignment
- Multiple sensing directions
- Stainless steel version suitable for use in harsh environments
- Use standard proximity brackets

Specifications

Safety Ratings		
Standards	IEC 60947-5-3, IEC 61508, EN 954	
Safety Classification	Cat. 4/SIL3	
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: > 1.12 x 10^{-9} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics	
Certifications	CE Marked for all applicable directives, cULus (UL 508), and TÜV	
Outputs (Guard Door Closed, Actuator in Place)		
Safety Outputs	2 x PNP, 0.2 A, max.; Status: ON (+24V DC)	
Auxiliary Outputs	1 x PNP, 0.2 A max.; Status: OFF (0V DC)	
Operating Characteristics		
Sensing Distance (Assure)	18 mm Plastic Barrel/18 mm Target	15 mm (0.59 in.)
	18 mm Plastic Barrel/30 mm Target	25 mm (0.98 in.)
	18 mm Stainless Steel Barrel/Standard Target	10 mm (0.39 in.)
	Large Rectangular Flat Pack with Standard Target	15 mm (0.59 in.)
Misalignment Tolerance, Min	See misalignment curve	
Repeat Accuracy	10% of Sensing Range	
Output Current, Max.	200 mA (all outputs)	
Operating Voltage	24V DC, +10%/-15% Class 2	
Current Consumption	50 mA	
Frequency of Operating Cycle	1 Hz	
Response Time (Off)	54 ms	
Environmental		
Enclosure Type Rating	NEMA 3, 4X, 12, 13, IP69K	
Operating Temperature [C (F)]	-10…+55° (+14…+131°)	
Relative Humidity	5…95%	
Shock	IEC 68-2-27, 30 g, 11 ms	
Vibration	IEC 68-2-6 10…55 Hz	
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6	
Physical Characteristics		
Housing Material	VALOX® DR 48	
Actuator Material	VALOX® DR 48	
Color	Red	

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 30 years

Product Selection

Type	Assured Sensing Distance	LED Door Indication/ Diagnostic	Margin Indication	Magnetic Hold	Actuator Code Type	Cat. No.		
						Cable		Connector
						3 m	10 m	6 inch Pigtail, 8-pin Micro (M12)
18 mm plastic barrel/18 mm actuator	15 mm (0.59 in.)	Yes	—	—	Standard	440N-Z21S16A	440N-Z21S16B	**440N-Z21S16H**
					Unique	440N-Z21U16A	440N-Z21U16B	440N-Z21U16H
18 mm plastic barrel/30 mm actuator	25 mm (0.98 in.)	Yes	—	—	Standard	440N-Z21S26A	440N-Z21S26B	**440N-Z21S26H**
					Unique	440N-Z21U26A	440N-Z21U26B	440N-Z21U26H
18 mm stainless steel barrel/18 mm actuator	10 mm (0.39 in.)	Yes	—	—	Standard	440N-Z21S17A	440N-Z21S17B	**440N-Z21S17H**
					Unique	440N-Z21U17A	440N-Z21U17B	440N-Z21U17H
Plastic rectangular/ rectangular actuator	18 mm (0.71 in.)	Yes	—	—	Standard	440N-Z21SS2A	440N-Z21SS2B	**440N-Z21SS2H**
					Unique	440N-Z21US2A	440N-Z21US2B	440N-Z21US2H
			Yes	—	Standard	440N-Z21SS2AN	440N-Z21SS2BN	**440N-Z21SS2HN**
					Unique	440N-Z21US2AN	440N-Z21US2BN	440N-Z21US2HN
			Yes	Yes (9 N)	Standard	440N-Z21SS2AN9	440N-Z21SS2BN9	440N-Z21SS2HN9
					Unique	440N-Z21US2AN9	440N-Z21US2BN9	440N-Z21US2HN9
Plastic housing with integrated latch	Contact/ latched	Yes	—	Adjustable 20…60 N	Standard	440N-Z21SS3PA	440N-Z21SS3PB	440N-Z21SS3PH
					Unique	440N-Z21US3PA	440N-Z21US3PB	440N-Z21US3PH

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP				Auto./Manual		5-26	**440R-N23132**
Modular Safety Relays							
MSR211P Base 2 N.C. only	2 N.O.	1 N.C.	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-84	440R-H23177
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	Cat. No.
Cordset	889D-F8AB-✶
Patchcord	889D-F8ABDM-❄
Safety Wired T-Port	898D-438Y-D8
Safety Wired Shorting Plug	898D-418U-DM

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard lengths.
Note: For additional information, see page 7-1.

Non-Contact Switches

SensaGuard™

Accessories

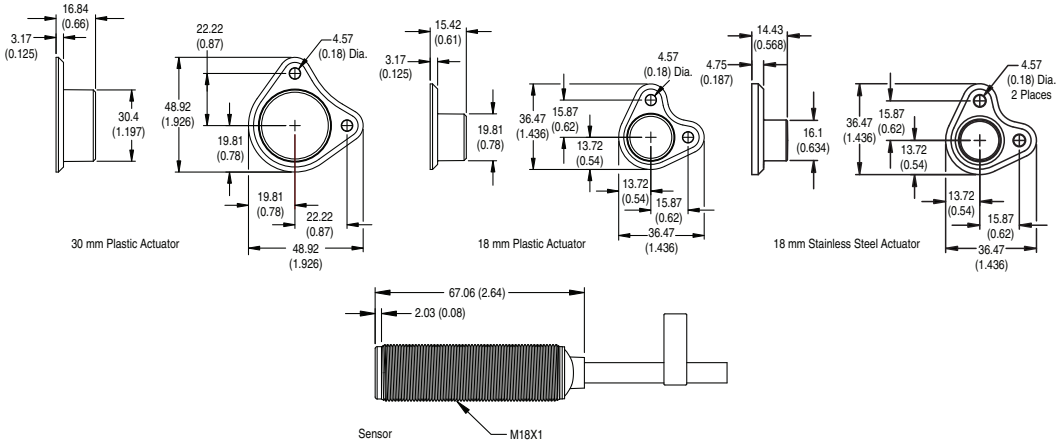
	Description	To Be Used With	Cat. No.
	18 mm plastic actuator	Standard coded models only	440N-Z18PT
		Unique coded models only	440N-Z18UPT
	30 mm plastic actuator	Standard coded models only	440N-Z30PT
		Unique coded models only	440N-Z30UPT
	18 mm stainless steel actuator	Standard coded models only	440N-Z18SST
		Unique coded models only	440N-Z18USST
	Rectangular plastic actuator	Standard coded models only	440N-ZPREC
		Unique coded models only	440N-ZUPREC
		Standard coded margin/magnetic hold models only	440N-ZPRECM
		Unique coded margin/magnetic hold models only	440N-ZUPRECM
	Integrated latch actuator	Standard coded models only	440N-ZLPREC
		Unique coded models only	440N-ZULPREC
	Mountingbracket for tubular proximity sensors—right angle style	18 mm barrel models	871A-BRS18
	Mounting bracket for tubular sensors—clamp style		871A-BP18
	Snap clamp mounting bracket		871A-SCBP18
	Swivel/tilt bracket allows ±10° vertical and 360° rotation adjustment		60-2649
	Mounting plate for vertically hinged doors	Integrated latch version only	440N-AHDB
	Mounting plate for slide and gull wing doors		440N-ASDB

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Publication S117-CA001A-EN-P

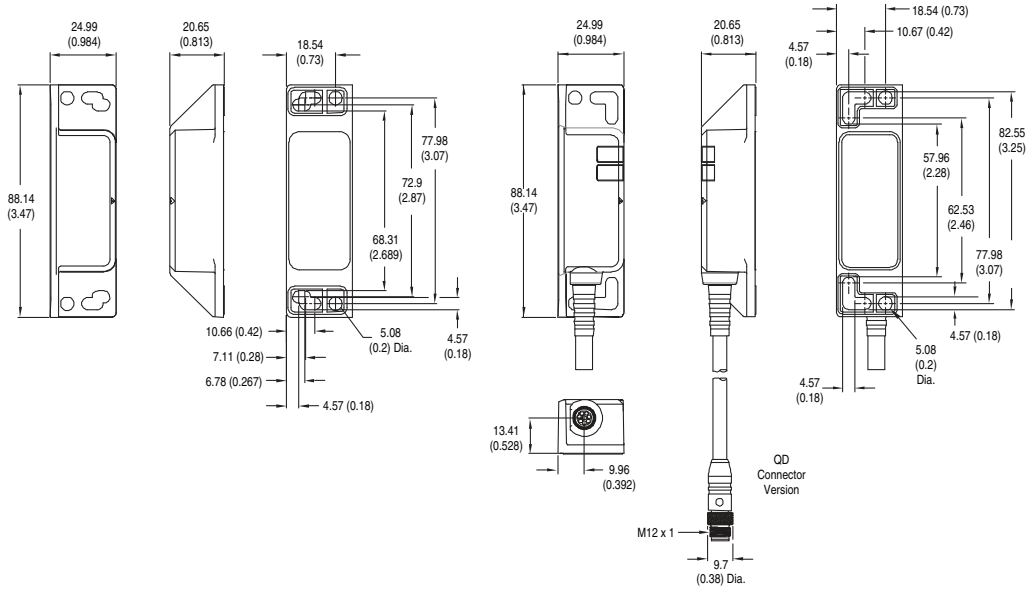
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

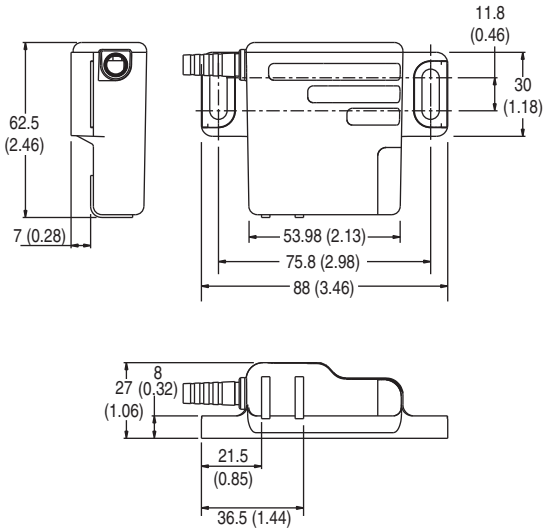
18 mm Barrel



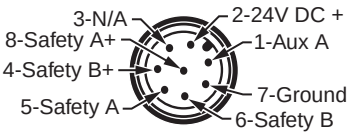
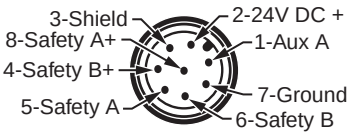
Large Rectangular Flat Pack



Integrated Latch



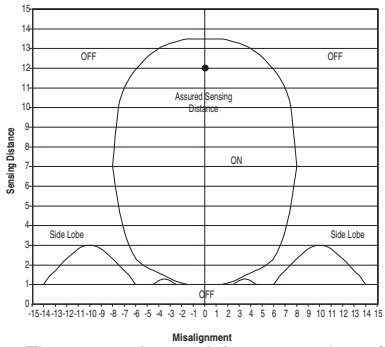
Typical Wiring Diagrams

Description		Plastic	Stainless Steel
8-Pin Micro (M12)			
8-Pin Cordset 889D-F8AB-∗ or cable version	Grey	Safety A	Safety A
	Red	Safety A+	Safety A+
	Pink	Safety B	Safety B
	Yellow	Safety B+	Safety B+
	White	Aux A	Aux A
	Brown	24V DC +	24V DC +
	Blue	Gnd	Gnd
	Green	NA	Shield

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

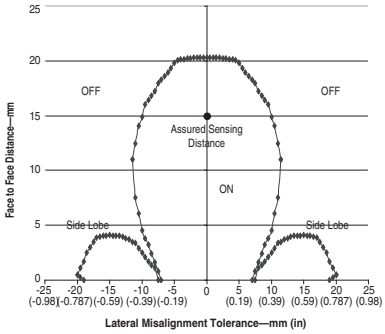
Misalignment Curves

18 mm Stainless Steel Barrel



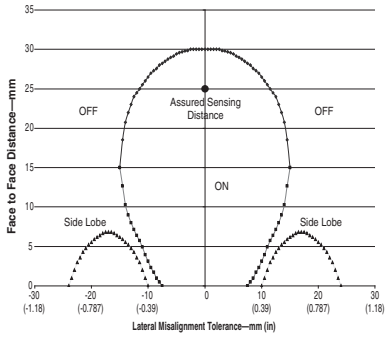
Note: There must be a minimum spacing of 4 mm (0.157 in.) if actuator and sensor face approaches laterally. This will prevent false triggering due to the side lobe areas.

18 mm Plastic Barrel



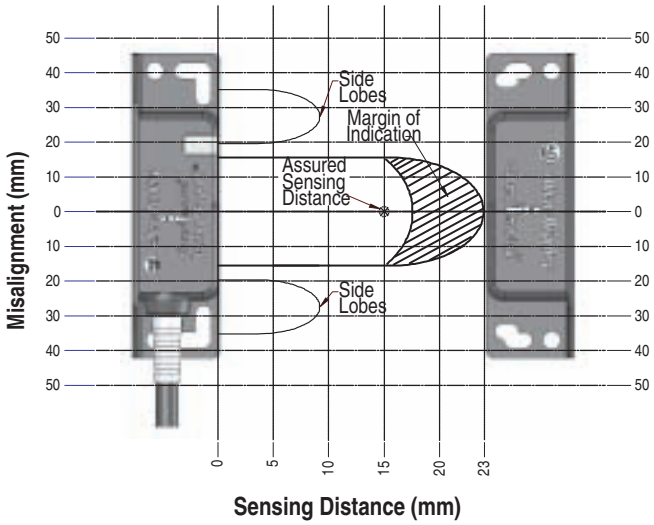
Note: There must be a minimum spacing of 4 mm (0.157 in.) if actuator and sensor face approaches laterally. This will prevent false triggering due to the side lobe areas.

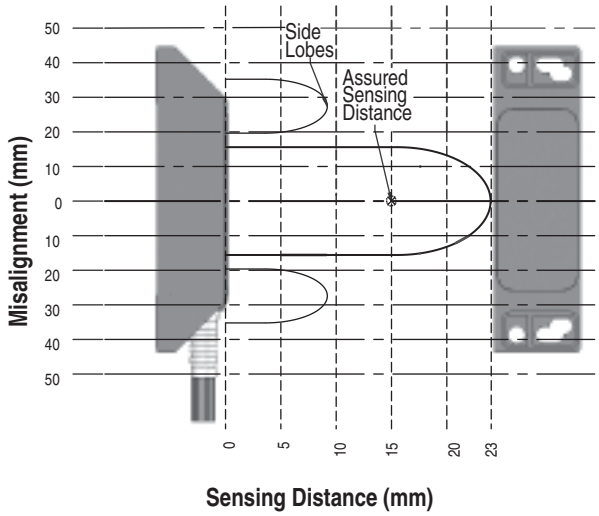
30 mm Plastic Barrel



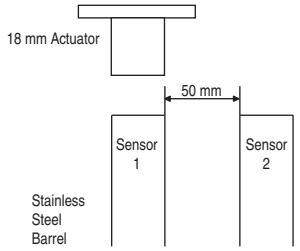
Note: There must be a minimum spacing of 7 mm (0.275 in.) if actuator and sensor face approaches laterally. This will prevent false triggering due to the side lobe areas.

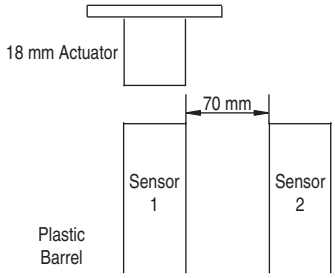
Large Rectangular Flat Pack

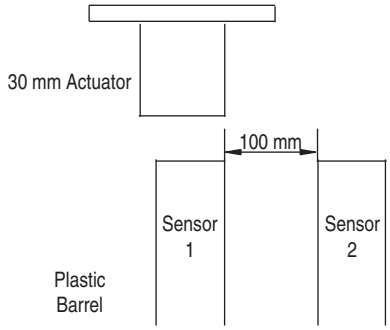


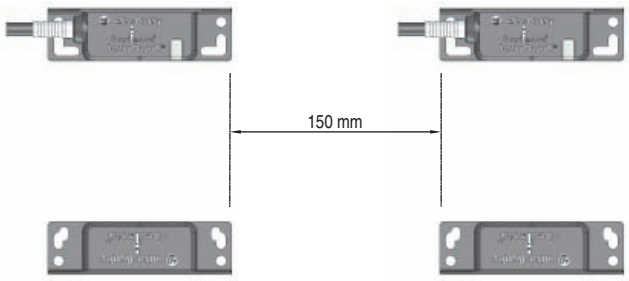


Minimum Distance Between Sensors

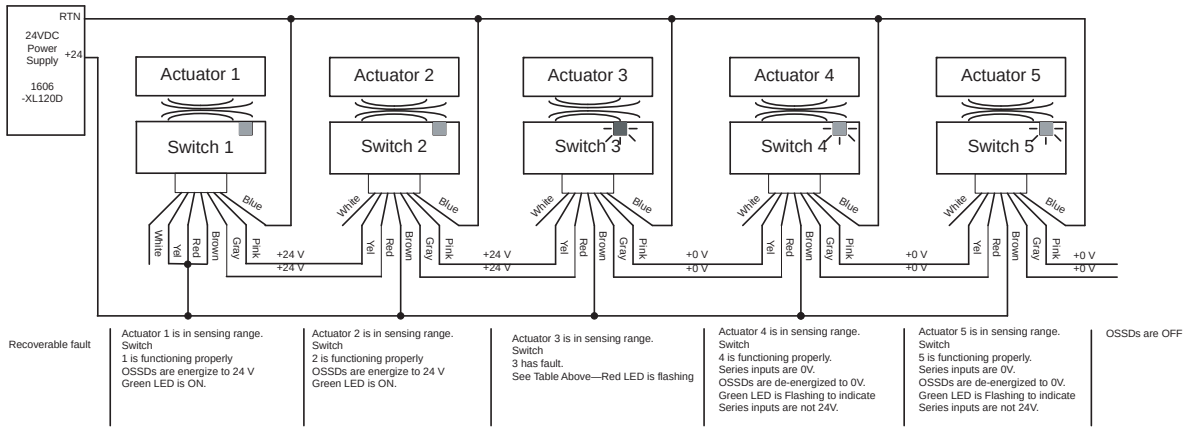








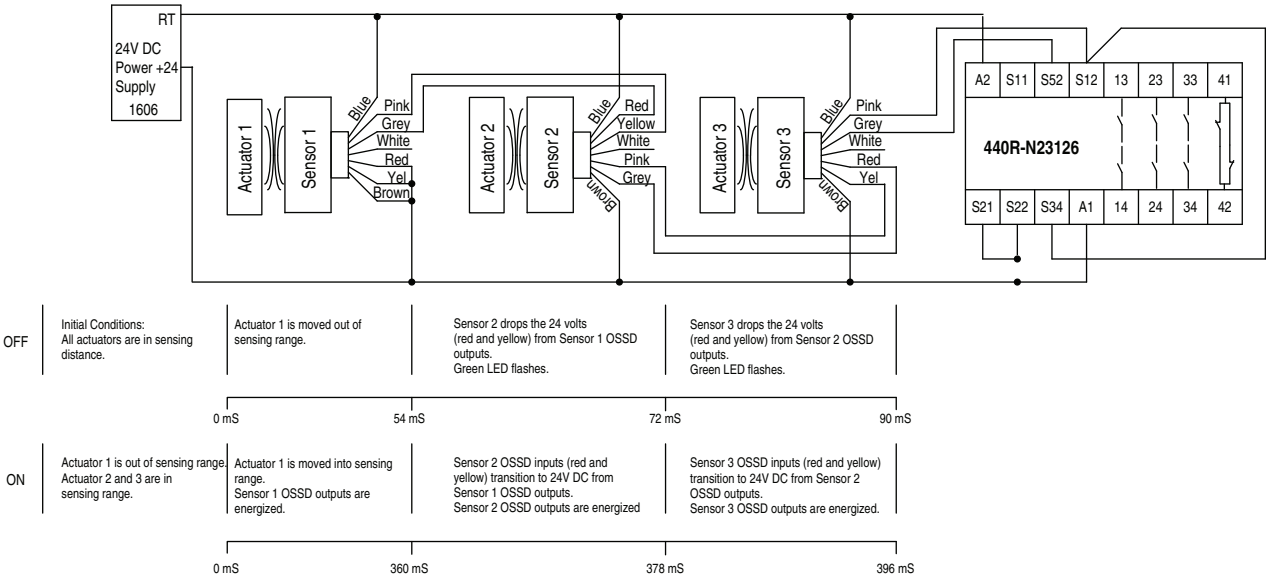
Diagnostic



Unit Indicators (per IEC 60073)

	State	Status	Troubleshooting
Device Output LED	Off	Not Powered	NA
	Red	Not Safe, Output Off	NA
	Green	Safe, Output On	NA
	Green Flash	Power Up Test	Check 24V DC on Safety + Outputs (yellow and red wire)
	Red Flash	1 Hz Flash Recoverable Fault 4 Hz Flash Nonrecoverable Fault	Recoverable Fault: Check Safety Outputs Are Not Shorted to GND, 24V DC or Each Other. Cycle Power.
	Amber Flash	Safe, Output On, Sensor Is Reaching Max. Sensing Distance	Re-adjust Distance Between Actuator and Sensor until Output LED Is Green

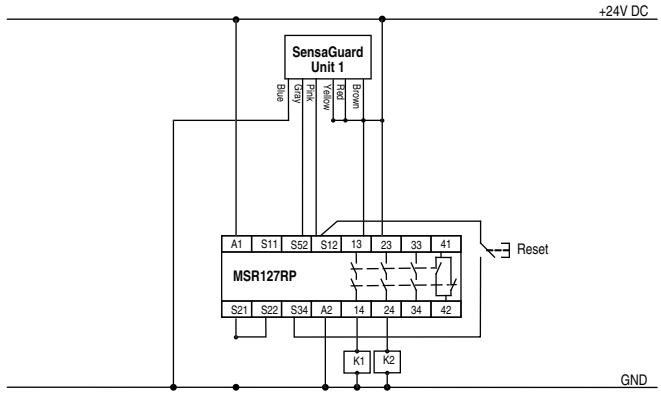
Unit Response Time



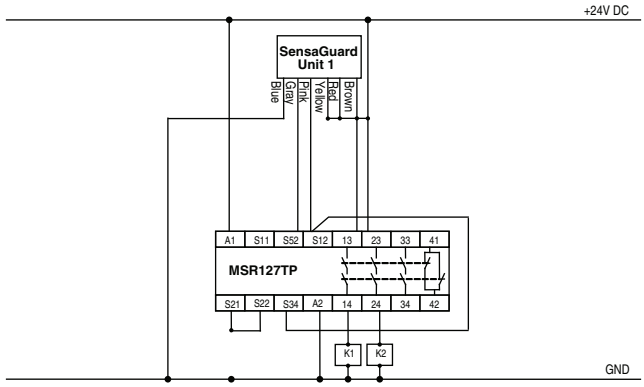
Application Wiring Examples

MSR127RP with One Sensor

Monitored Reset

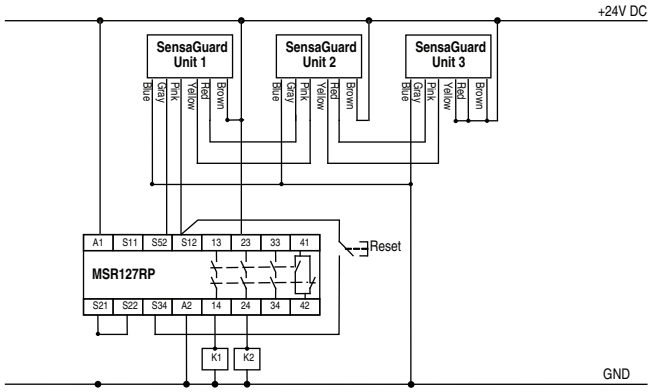


Automatic Reset

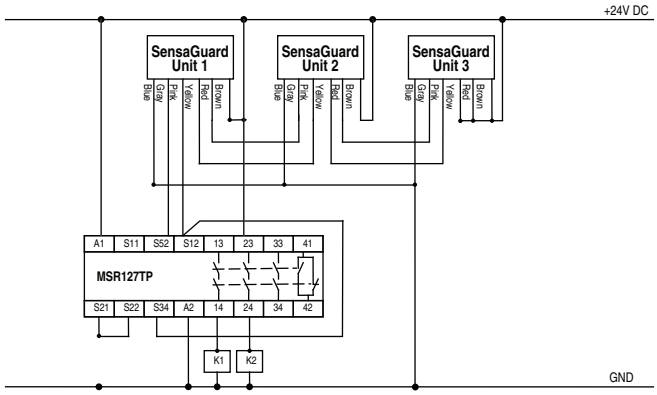


MSR127RP with Three Sensors

Monitored Reset

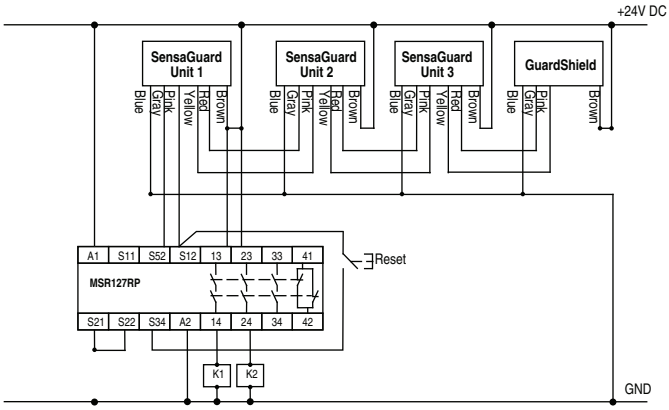


Automatic Reset



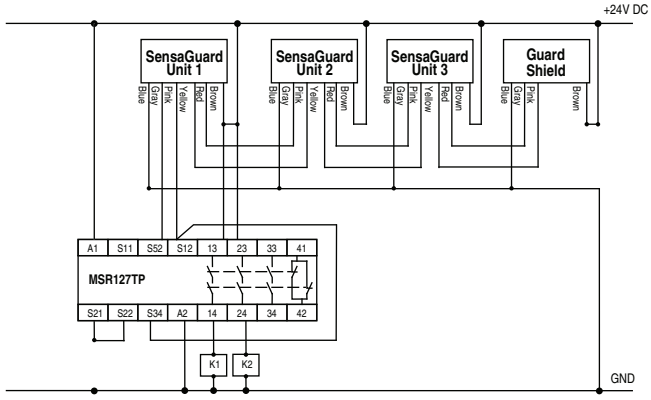
MSR127RP with Two Sensors and One Light Curtain

Monitored Reset



Note: Light curtain must be last (farthest from MSR127).

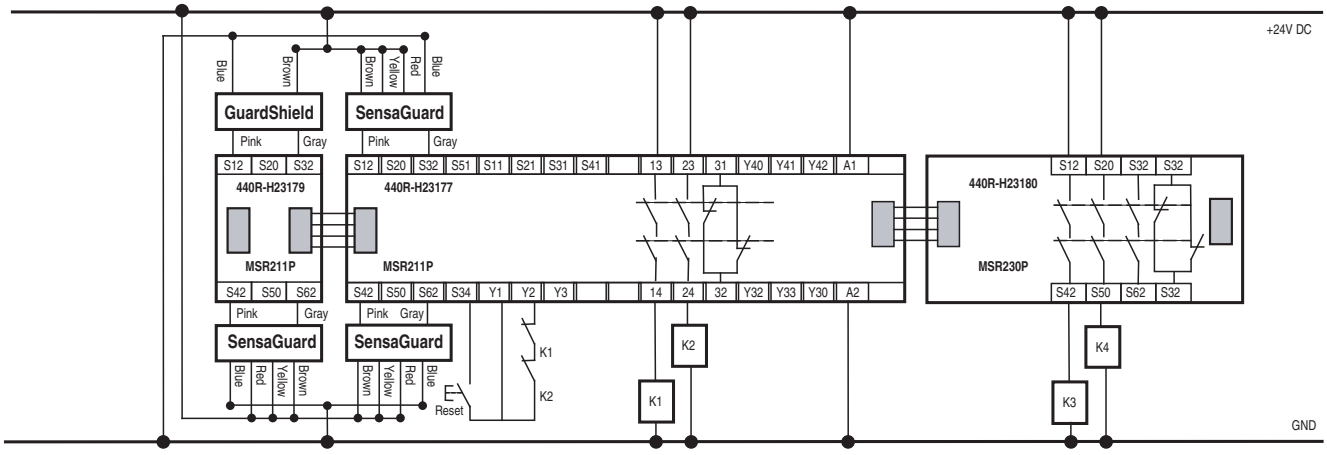
Automatic Reset



Note: Light curtain must be last (farthest from MSR127).

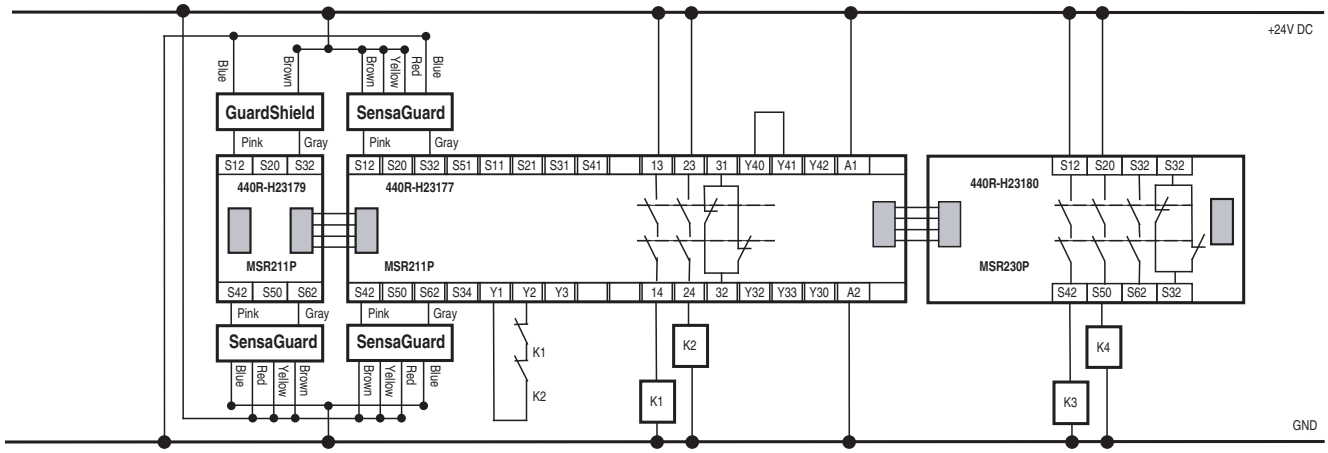
MSR200 Series with Three Sensors and One Light Curtain

Manual Reset



Note: Light curtain can be attached to any input.

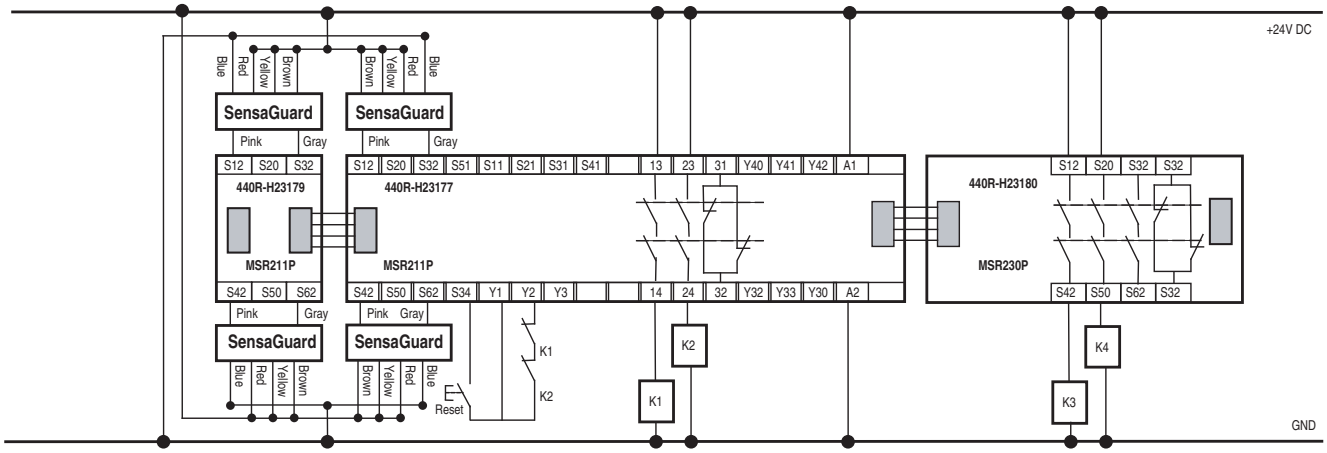
Automatic Reset



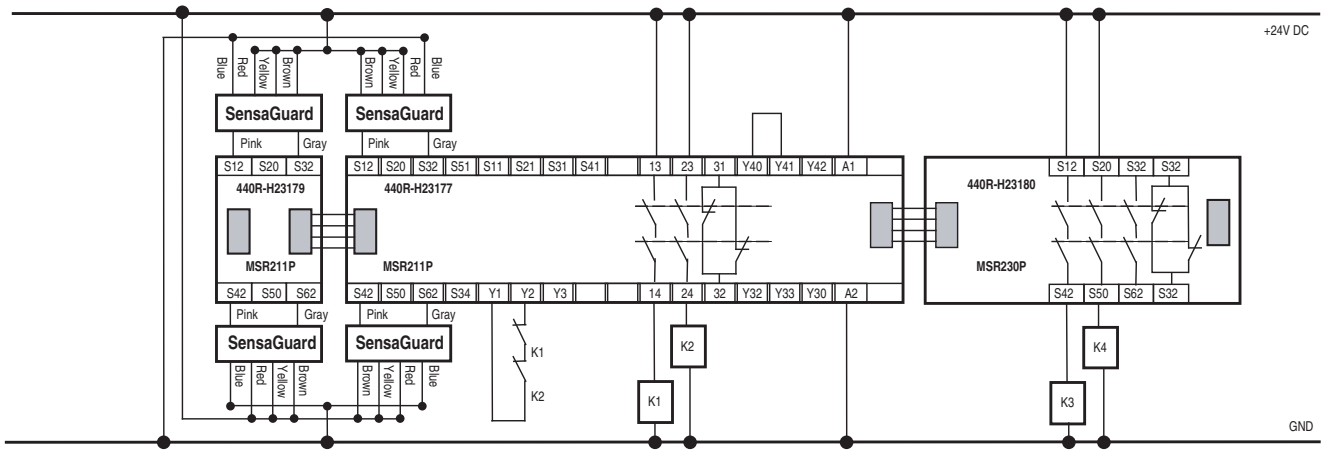
Note: Light curtain can be attached to any input

MSR200 Series with Four Sensors

Manual Reset



Automatic Reset



Non-Contact Switches

Magnetically Coded



Description

With the increasing speed and complexity of applications a simple magnetic switch may be insufficient to meet the increased risks, therefore the design incorporates several magnetically sensitive elements which must be triggered in a particular sequence to operate correctly.

The sensor with its molded-in brackets and diminutive size, is extremely versatile and simple to install. For high-risk applications the control unit is used with a single sensor to give a high-integrity system. For other applications, multiple sensors (including mechanical switches) can be connected.

Features

- Non-contact actuation
- Magnetic coded sensing
- High tolerance to misalignment
- Designed for use with specified controllers

Specifications

	MC1	MC2
Safety Ratings		
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC60947-5-1, IEC/EN60947-5-3, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 1 Device per EN 954-1; Dual channel interlocks suitable for Cat. 3 or 4 systems	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics	
Certifications	CE Marked for all applicable directives, cULus, and TÜV	
Outputs (Guard Door Closed, Actuator in Place)		
Safety Outputs	2 N.C. REEDS	2 N.C. Solid-State Relays
Auxiliary Outputs	—	1 x PNP, 0.2 A max.; Status: OFF (0V DC)
Operating Characteristics		
Operating Distance, Make [mm (in.)]	8 (0.3)	10 (0.39)
Operating Distance, Break [mm (in.)]	15 (0.59)	25 (0.98)
Misalignment Tolerance, Min	See Misalignment Wire	
Repeat Accuracy	10% of Sensing Range	
Output Current, Max.	200 mA	200 mA
Switching Current @ Voltage, Max.	24V DC @ 200 mA	24V DC @ 200 mA +10%/-15%
Operating Voltage/Power Supply	—	24V DC, +10%/-15%/50 mA max./Class 2 SELV
Frequency of Operating Cycle	1 Hz	1 Hz
Environmental		
Enclosure Type Rating	IP67 (NEMA 6P)	IP 69K
Operating Temperature [C (F)]	-10…+55° (+14…+131°)	
Relative Humidity	5…95%	
Shock	IEC 68-2, 27, 30 g, 11 ms	
Vibration	IEC 68-2-6, 10…55 Hz	
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6	
Physical Characteristics		
Housing Material	Molded ABS	Ultrador
Actuator Material	Molded ABS	Ultrador
Color	Red	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

Product Selection

Type	Operating Voltage/Input Current	Safety Outputs	Auxiliary Outputs	Status Indicator	Connection	Cat. No.
MC1	—	2 N.C. REEDS	—	No	—	**440N-Z2NRS1C**
					—	**440N-Z2NRS1A**
					10 m Cable	440N-Z2NRS1B
MC2	24V DC, +10%/-15%/50 mA max.	2 N.C. Solid-State Relays	1 x PNP, 0.2 A max.; Status: OFF (0V DC)	Yes	8-Pin Micro (M12)	440N-Z21W1PH
					—	440N-Z21W1PA
					—	440N-Z21W1PB

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	Connection to Distribution Box 4-Pin Micro (M12)	8-Pin Micro (M12)
	2 N.C.	2 N.C. & 1 N.O.
Cordset	889D-F4AC-✶	889D-F8AB-✶
Patchcord	889D-F4ACDM-❄	889D-F8ABDM-❄
Distribution Box	898D-4‡LT-DM4	—
Shorting Plug	898D-41LU-DM	—
T-Port	898D-43LY-D4	—

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the page 7-1.

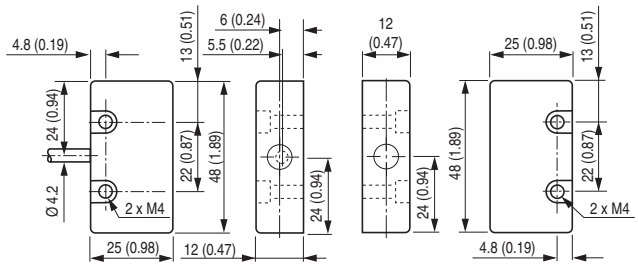
Accessories

Description	Cat. No.
MC1 Spare Actuator	440N-A17233
MC2 Spare Actuator	440N-A32114

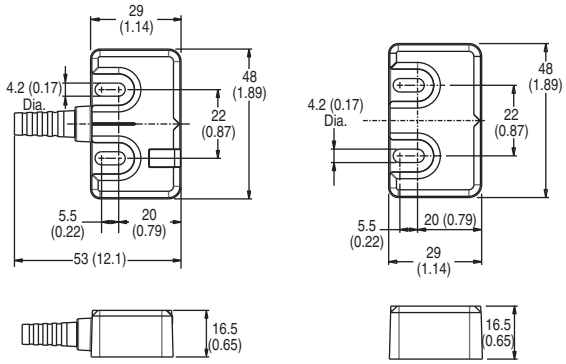
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

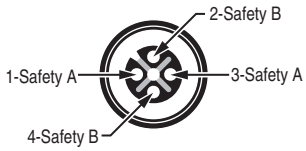
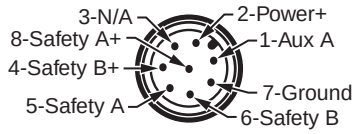
MC1



MC2



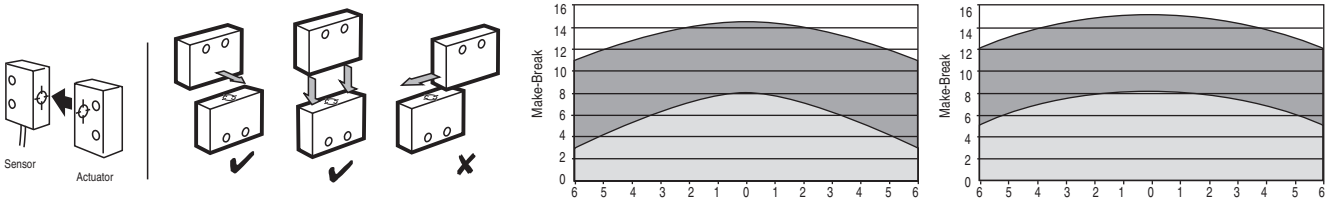
Typical Wiring Diagrams

Description		MC1 2 N.C.	MC2 2 N.C. + 1 N.O.
4-Pin Micro (M12)			—
8-Pin Micro (M12)		—	
Cordset 889D-F4AC-∗ or Cable Version	Brown	Safety A	—
	Blue		
	White	Safety B	—
	Black		
8-Pin Cordset 889D-F8AB-∗ or Cable Version	Grey	—	Safety A
	Red		Safety A
	Pink		Safety B
	Yellow		Safety B
	White		Aux
	Brown		24V DC +
	Blue		Gnd
	Green		NA

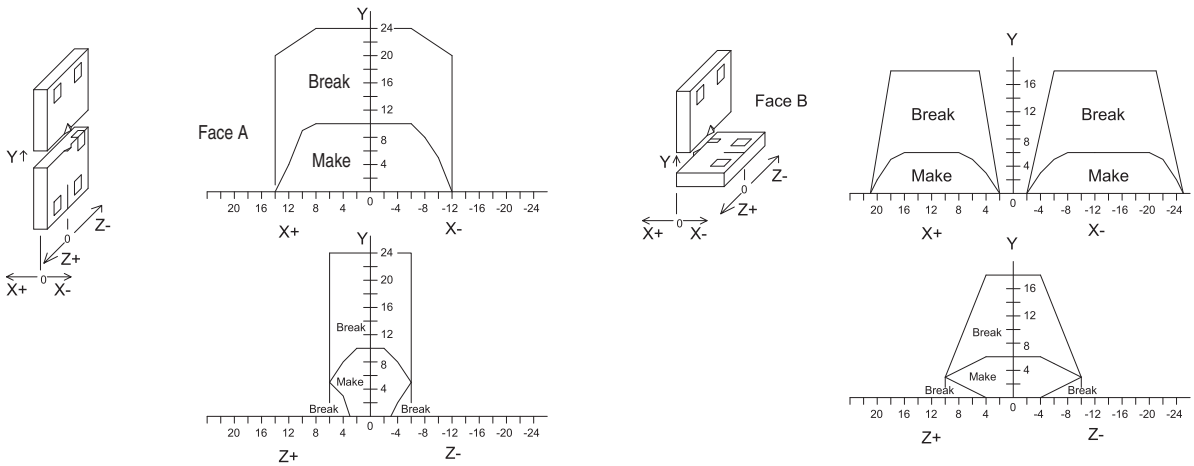
∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Sensing & Misalignment Curve

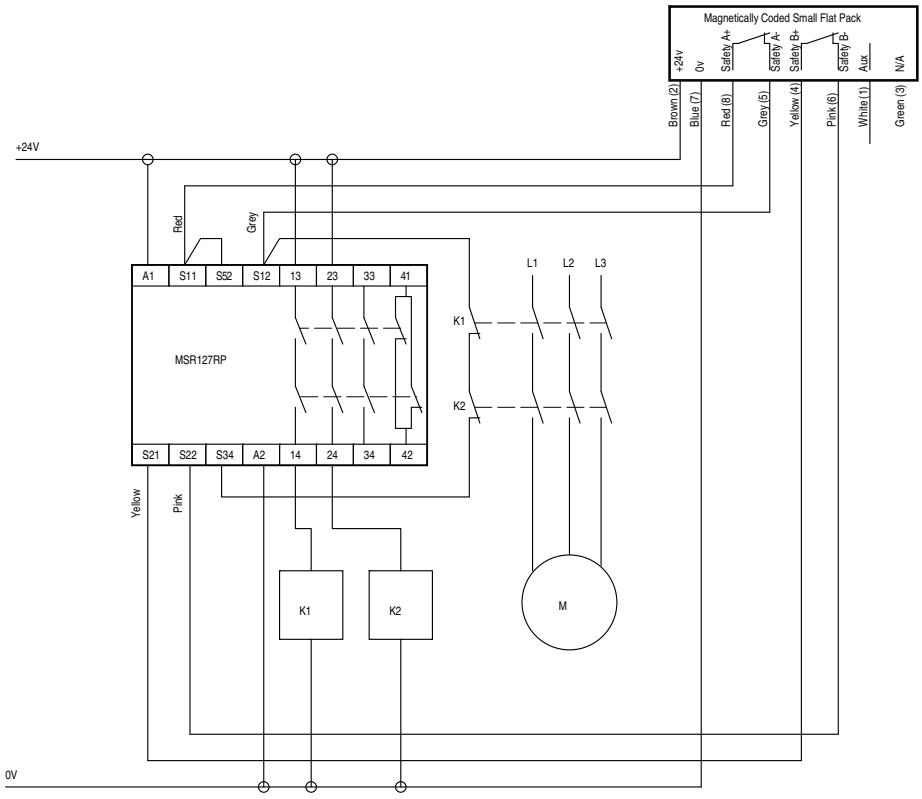
MC1



MC2



MC2 Application Wiring Example



Non-Contact Switches

Ferrogard™ 1, 2, 20 & 21



Description

The Ferrogard range of magnetically actuated safety switches offers non-contact reliability together with tolerance to misalignment. They are designed to be installed so that when a guard door is opened, the action of the magnetic actuator being removed from the switch opens the N.C. safety contacts which are intended for the isolation of control power to a machine primary control element.

The FRS1, FRS2, FRS20, FRS21 are rectangular housings. Sealed to IP67 (NEMA 6P), these Ferrogards are ideal for wet environments.

Unlike some magnetic switches the Ferrogards have protected safety contacts to help ensure that they do not fail to danger. In addition, some versions have independent auxiliary signal contacts to indicate the guard condition.

All Ferrogards have internal non-resettable overload protection on the safety contact. They should be protected by an external fuse rated as shown in the Specifications table.

Features

- Non-contact actuation
- High tolerance to misalignment
- High switching current (up to 2 A AC, 1 A DC)
- Plastic rectangular housing (IP67)
- Cable or quick-disconnect (QD) connections

Specifications

Safety Ratings	
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, ANSI B11.19, AS4024.1
Safety Classification	Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems
Functional Safety Data **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics
Certifications	CE Marked for all applicable directives and cULus
Outputs (Guard Door Closed, Actuator in Place)	
Safety Outputs	FRS1: 1 N.C., FRS2: 1 N.C., FRS20: 2 N.C., FRS21: 2 N.C.
Auxiliary Outputs	FRS1: None, FRS2: 1 N.O., FRS20: None, FRS21: 1 N.O.
Operating Characteristics	
Operating Distance, Make [mm (in.)]	Safety: 12 (0.47); Auxiliary: 15 (0.59)
Operating Distance, Break [mm (in.)]	Safety: 23 (0.91); Auxiliary: 26 (1.02)
Fuses, External	FRS1, 2 & 21: 1.6 A (Bussmann BK/60 A-1.6 A) max. FRS20: 0.4 A (Bussmann BK/60 A-400 mA) max.
Environmental	
Enclosure Type Rating	IP67 (NEMA 6P)
Operating Temperature [C (F)]	-10…+55° (+14…+131°)
Relative Humidity	5…95%
Shock	50 g
Vibration	7 g; 50…200 Hz
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6
Physical Characteristics	
Actuator/Housing Material	Molded ABS plastic
Weight [g (lbs)]	FRS 1—Sensor: 35 (0.08)/Actuator: 85 (0.19) FRS 2—Sensor: 40 (0.09)/Actuator: 85 (0.19) FRS 20—Sensor: 43 (0.09)/Actuator: 85 (0.19) FRS 21—Sensor: 43 (0.09)/Actuator: 85 (0.19)
Color	Red

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

Product Selection

Safety Contact Switching Capability	Safety Contacts	Auxiliary Contacts	Connection	Type	Cat. No.
250V AC, 2 A max	1 N.C.	—	2 m Cable	FRS 1	440N-G02001
			4 m Cable		440N-G02004
			6 m Cable		440N-G02022
			8 m Cable		440N-G02041
			10 m Cable		440N-G02015
		1 N.O.	2 m Cable	FRS 2	440N-G02002
			4 m Cable		440N-G02014
			6 m Cable		440N-G02038
			8 m Cable		440N-G02033
			10 m Cable		440N-G02019
			15 m Cable		440N-G02043
			20 m Cable		440N-G02040
			4-Pin Micro QD		440N-G02093
	2 N.C.	—	4-Pin Micro QD	FRS 20	440N-G02097
	2 N.C.	1 N.O.	2 m Cable	FRS 21	440N-G02055
			4 m Cable		440N-G02061
			6 m Cable		440N-G02060
			10 m Cable		440N-G02059
			6-Pin AC Micro QD§		440N-G02098
24V DC, 1 A	1 N.C.	1 N.O.	2 m Cable	FRS 2	440N-G02092
			4-Pin Micro QD		**440N-G02094**
	2 N.C.	—	4 m Cable	FRS 20	440N-G02085
			4-Pin Micro QD		**440N-G02090**
		1 N.O.	2 m Cable	FRS 21	440N-G02058
			4 m Cable		440N-G02077
			6 m Cable		440N-G02083
			6-Pin Micro QD		**440N-G02099**

Note: Contacts are described with the guard door closed, that is, actuator in place. Switch is shipped complete with actuator.
§ For connector ratings see 3-9.

Non-Contact Switches

Ferrogard™ 1, 2, 20 & 21

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR30T	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Single-Function Safety Relays for 1 N.C. & 1 N.O. Contact Switch							
MSR9T	2 N.O.	1 N.C.	Fixed	Auto./Manual	24V AC/DC	5-14	440R-F23027
MSR33RT	2 N.O. Solid State	1 N.O.	Removable	Auto. or Monitored Manual	24V DC SELV	5-18	440R-F23200
Modular Safety Relays							
MSR211P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-84	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	Connection to Distribution Box 4-Pin Micro (M12) 1 N.C. & 1 N. O.	6-Pin Micro (M12) 2 N.C. & 1 N.O.
Cordset	889D-F4AC-∗	889R-F6ECA-∗
Patchcord	889D-F4ACDM-❄	889R-F6ECRM-❄
Distribution Box	898D-P4‡KT-DM4	898R-F68MT-A5
Shorting Plug	898D-41KU-DM	898R-P61MU-RM
T-Port	898D-43KY-D4	—

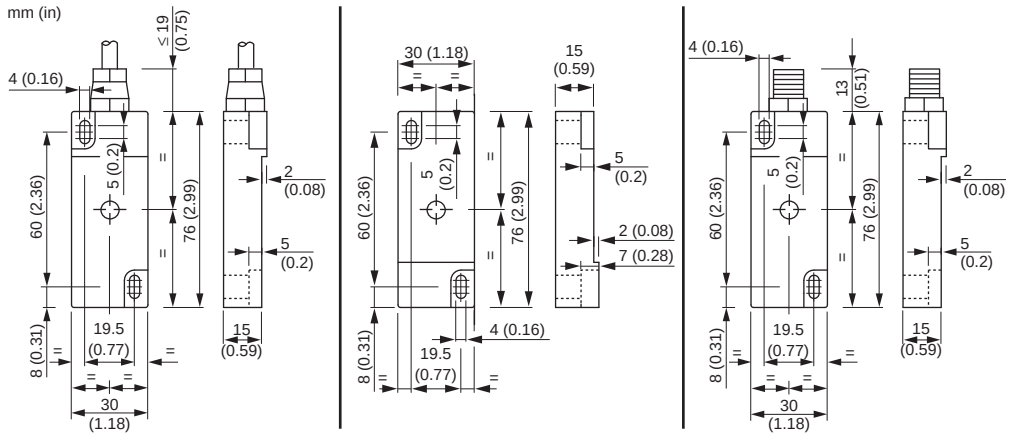
∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

Accessories

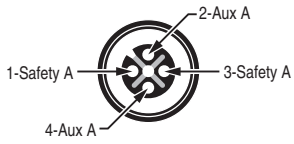
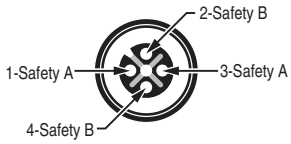
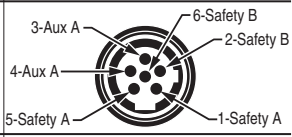
Description	Cat. No.
Replacement Actuator	440N-A02005

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



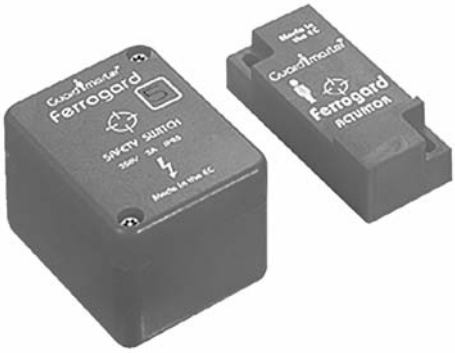
Typical Wiring Diagrams

		FRS1	FRS2	FRS20	FRS21
		1 N.C.	1 N.C. + 1 N.O.	2 N.C.	2 N.C. + 1 N.O.
4-Pin Micro (M12)		—			—
6-Pin Micro (M12)		—	—	—	
Cordset 889D-F4AC-∗ or Cable Versions	Brown	—	Safety A	Safety A	—
	Blue				
	Black	—	Aux A	Safety B	—
	White				
Cordset 889R-F6ECA-∗	Red/White	—	—	—	Safety A
	Red/Black				
	Red				Safety B
	Red/Blue				
	Green				Aux A
	Red/Yellow				
Cable Versions	Safety A	Brown	Blue	Brown	Black
		Blue	White	Blue	White
	Safety B	—	Yellow	Black	Red
			Green	White	Blue
	Aux A	—	—	—	Yellow
					Green

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Non-Contact Switches

Ferrogard™ 3, 4 & 5



Description

The Ferrogard range of magnetically actuated switches offers non-contact reliability together with tolerance to misalignment. They are designed to be installed so that when a guard door is opened, the action of the magnetic actuator being removed from the switches opens the N.C. safety contacts which are intended for the isolation of control power to a machine primary control element.

The FRS 3, 4 and 5 have terminal connections. The user must drill a hole in the housing at a convenient location to allow the wiring to enter the housing. The cover is secured with anti-tamper security screws.

Unlike some magnetic switches the Ferrogards have protected safety contacts to help ensure that they do not fail to danger. In addition, some versions have independent auxiliary signal contacts to indicate the guard condition.

All Ferrogards have internal non-resettable overload protection on the safety contact. They should be protected by an external fuse rated as shown in the Specifications table.

Features

- Non-contact actuation
- High tolerance to misalignment
- High switching current (up to 2 A)
- Various contact arrangements
- Terminal connections

Specifications

Safety Ratings	
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, ANSI B11.19, AS4024.1
Safety Classification	Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics
Certifications	CE Marked for all applicable directives and cULus
Outputs (Guard Door Closed, Actuator in Place)	
Safety Outputs	FRS3: 1 N.C., FRS4: 1 N.C., FRS5: 1 N.C.
Auxiliary Outputs	FRS3: 1 N.C., FRS4: 1 N.O., FRS5: None
Operating Characteristics	
Operating Distance, Make [mm (in.)]	Safety/Auxiliary: FRS 3—12 (0.47); FRS 4—12 (0.47); FRS 5—12 (0.47)
Operating Distance, Break [mm (in.)]	Safety/Auxiliary: FRS 3—24 (0.94); FRS 4—10 (0.39); FRS 5—12 (0.47)
Auxiliary Contact Switching Capability, Min	300V DC, 250V AC 0.5 A including inrush
Safety Contact External Fusing	≤1.6 A quick blow
Environmental	
Enclosure Type Rating	IP65 (NEMA 13)
Operating Temperature [C (F)]	-10…+65° (+14…+149°)
Relative Humidity	5…95%
Shock	IEC 68-2-27, 30 g, 11 ms
Vibration	IEC 68-2-6, 10…200 Hz
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6
Physical Characteristics	
Housing Material	Molded ABS plastic
Actuator Material	Molded ABS plastic
Color	Red

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

Product Selection

Safety Contact Switching Capability	Connection Type	Housing Material	Safety Contacts	Auxiliary Contacts	Type	Cat. No.
250V AC 2 A max	Terminals	Red Molded ABS Plastic	1 N.C.	1 N.C.	FRS 3	440N-G02003
				1 N.O.	FRS 4	440N-G02008
				—	FRS 5	440N-G02009

Note: Contacts are described with the guard door closed, that is, actuator in place.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30T	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

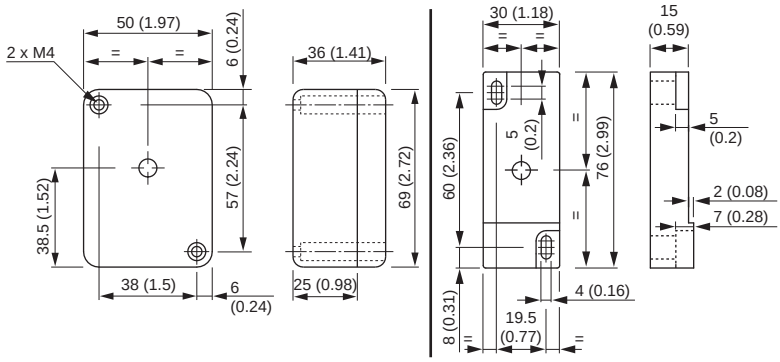
Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Accessories

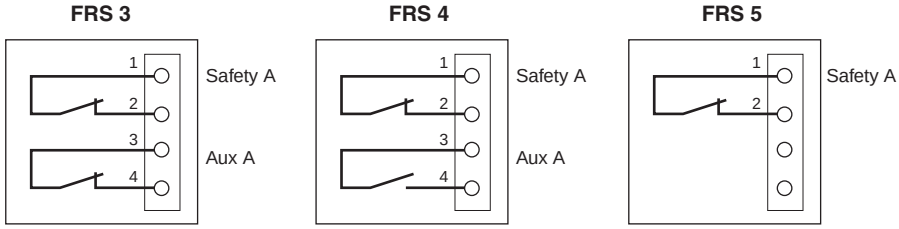
Description	Cat. No.
Replacement Actuator	440N-A02005

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



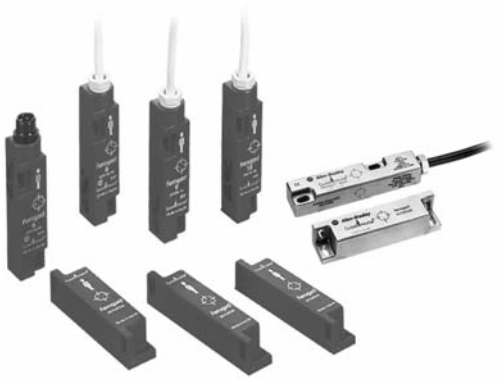
Typical Wiring Diagrams



3-Interlock Switches

Non-Contact Switches

Ferrogard™ 6, 9,10, 13 & 14



Description

The Ferrogard range of magnetically actuated safety switches offers non-contact reliability together with tolerance to misalignment. They are designed to be installed so that when a guard door is opened, the action of the magnetic actuator being removed from the switch opens the N.C. safety contact which is intended for the isolation of control power to a machine primary control element.

The FRS 6, 9, 10, 13, and 14 sensors and actuators incorporate slim housings to accommodate narrow mounting areas. They are environmentally sealed to IP67 (NEMA 6P), which makes them ideal for wet environments. These Ferrogard switches have two active sensing faces allowing more flexible mounting options.

Unlike some magnetic switches the Ferrogards have protected safety contacts to help ensure that they do not fail to danger.

All Ferrogards have internal non-resettable overload protection on the safety contact. They should be protected by an external fuse rated as shown in the Specifications table.

Features

- Non-contact actuation
- High tolerance to misalignment
- High switching current (up to 3 A)
- Two sensing faces
- IP67 (NEMA 6P) Rating
- Slim housings
- Stainless steel models available

Specifications

Safety Ratings		
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems	
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics	
Certifications	CE Marked for all applicable directives and cULus	
Outputs (Guard Door Closed, Actuator in Place)		
Safety Outputs	1 N.C.	1 N.C.
Auxiliary Outputs	—	1 N.C.
Operating Characteristics		
Operating Distance, Make [mm (in.)]	12 (0.47)	
Operating Distance, Break [mm (in.)]	23 (0.91)	
Environmental		
Enclosure Type Rating	IP67 (NEMA 6P)	
Operating Temperature [C (F)]	-10…+65° (+14…+149°)	
Relative Humidity	5…95%	
Shock	IEC 68-2-27, 30 g, 11 ms	
Vibration	IEC 68-2-6, 10…55 Hz	
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6	
Physical Characteristics		
Actuator/Housing Material	Molded ABS plastic	
Weight [g (lb)]	Sensor/Actuator FRS 6—28 (0.06)/70 (0.15) FRS 9—28 (0.06)/70 (0.15) FRS 10—28 (0.06)/70 (0.15)	
Color	Red	

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

Product Selection

Safety Contact Switching Capability	Safety Contacts	Auxiliary Contacts	Housing Material	Type	Connection	Cat. No.
250V AC, 2 A	1 N.C.	—	Red Molded ABS Plastic	FRS 6	2 m Cable	**440N-G02023**
					4 m Cable	440N-G02028
					6 m Cable	440N-G02032
					10 m Cable	440N-G02013
					4-Pin Micro QD	440N-G02095
24V DC, 1 A				FRS 9	2 m Cable	**440N-G02044**
					4 m Cable	440N-G02075
					6 m Cable	440N-G02082
					10 m Cable	440N-G02089
					4-Pin Micro QD	440N-G02096
110V AC, 3 A				FRS 10	2 m Cable	440N-G02045
					4 m Cable	440N-G02088
250V AC, 2 A		1 N.C.	Stainless Steel	FRS 13	2 m Cable	440N-G02154
					4 m Cable	440N-G02155
					4-Pin Micro QD	440N-G02160
24V DC, 1 A				FRS 14	2 m Cable	440N-G02156
					4 m Cable	440N-G02157
					4-Pin Micro QD	440N-G02161

Note: Contacts are described with the guard door closed, that is, actuator in place.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30T	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	4-Pin Micro (M12)
Cordset	889D-F4AC-∗
Patchcord	889D-F4ACDM-❄

∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
Note: For additional information, see page 7-1.

Accessories

Description	Cat. No.
FRS 6, 9, 10 Plastic Replacement Actuator	440N-A02025
FRS 13, 14 Stainless Steel Replacement Actuator	440N-A02165

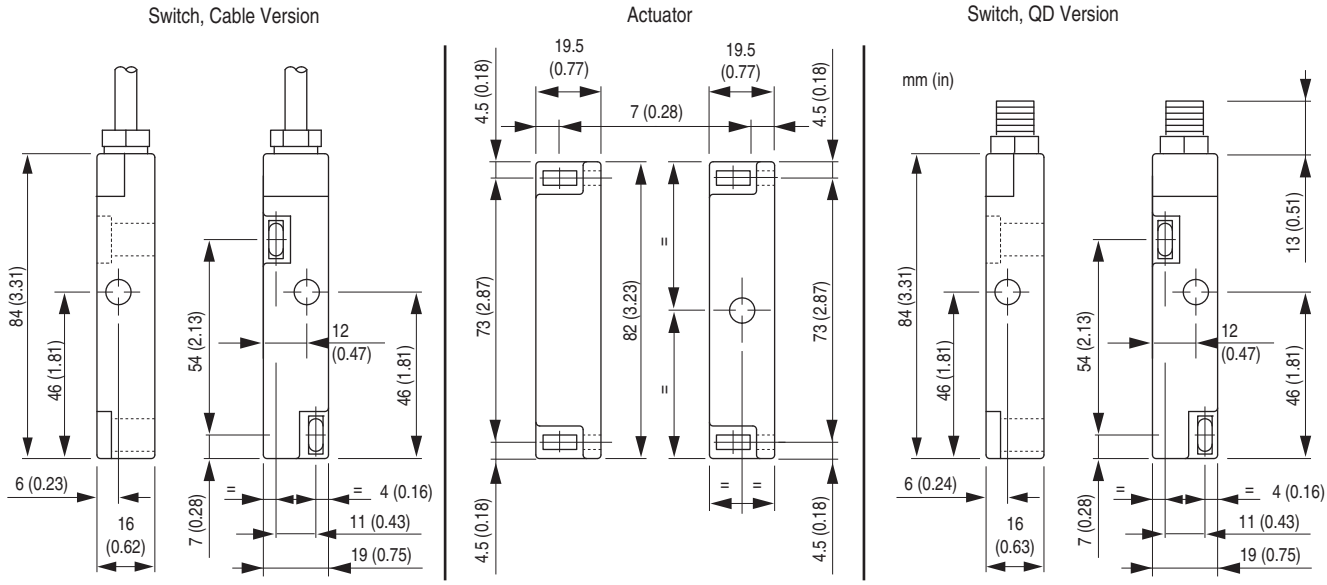
Non-Contact Switches

Ferrogard™ 6, 9,10, 13 & 14

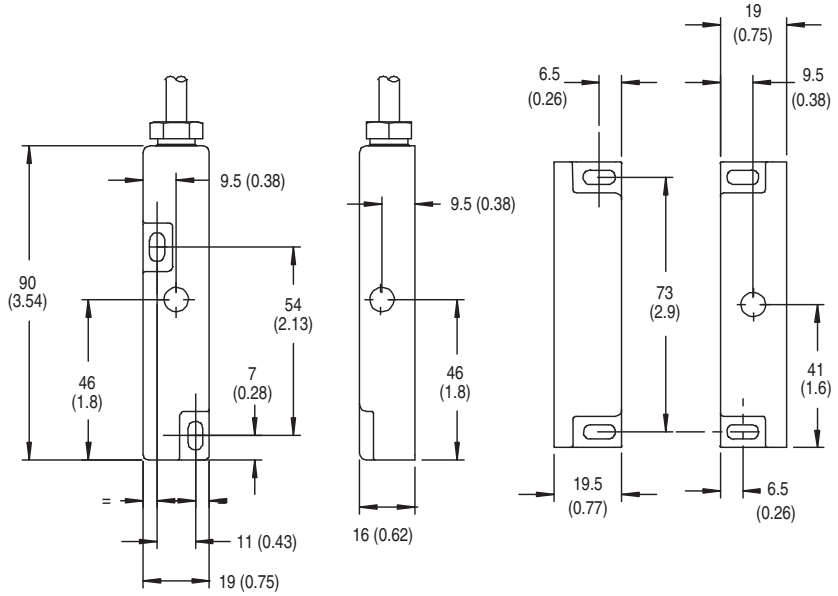
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

FRS 6, 9, 10



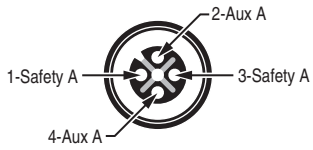
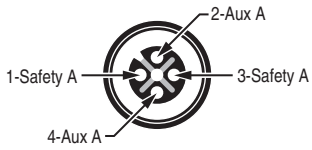
FRS 13, 14



Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

Allen-Bradley
Guardmaster®

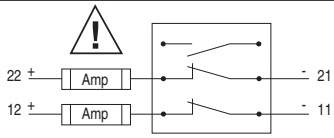
Typical Wiring Diagrams

		FRS 6, 9, 10	FRS 13, 14
		1 N.C.	1 N.C. + 1 N.O.
4-Pin Micro (M12)			
Cordset 889D-F4AC-∗	Brown	Safety A	Safety A
	Blue		
	White	—	Aux A
	Black		
Cable Version	Safety A	Brown	Brown
		Blue	Blue
	Aux A	—	Black
			Grey

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

External Fuse Safety Contacts

WARNING: All safety contacts fitted with internal non-resettable fuse and must be fused externally as detailed.



	Recommended: *Bussman BK/GDA-1.6 A ** Bussman BK/GDA-400 mA ***Bussman BK/GDA-2.5 A
FRS 1, 2, 3, 4, 5, 6, 13, 21 AC	AC ≤ 1.6 A* (F) IEC 60127-2
FRS 9, 14, 2 DC, 20 DC, 21 DC	DC ≤ 0.4 A** (F) IEC 60127-2
FRS 10	AC ≤ 2.5 A*** (F) IEC 60127-2

Non-Contact Switches

Ferrogard™ GD2



Description

The Ferrogard range of magnetically actuated safety switches offers non-contact reliability together with tolerance to misalignment. They are designed to be installed so that when a guard door is opened, the action of the magnetic actuator being removed from the switch opens the N.C. safety contacts which are intended for the isolation of control power to a machine primary control element.

The GD2 version has a stainless steel housing for added protection against inadvertent impacts to the housing. The contacts are completely sealed to meet IP68 (NEMA 6P) requirements, making them ideal for wet environments. The GD2 also has a wider temperature range than the plastic Ferrogard switches, making them useful in a wider range of applications.

Unlike some magnetic switches, the Ferrogards have protected safety contacts to help ensure that they do not fail to danger. In addition, some versions have independent auxiliary signal contacts to indicate the machine and guard condition.

All Ferrogards have internal non-resettable overload protection on the safety contact. They should be protected by an external fuse rated as shown in the Specifications table.

Features

- Non-contact actuation
- High tolerance to misalignment
- High switching current (up to 2 A AC, 1 A DC)
- Wide temperature range (-25…+125°C (-13…+257°F))
- Stainless steel housing
- Various contact arrangements

Specifications

Safety Ratings			
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, ANSI B11.19, AS4024.1		
Safety Classification	Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems		
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics		
Certifications	CE Marked for all applicable directives and cULus		
Outputs (Guard Door Closed, Actuator in Place)			
Safety Outputs	1 N.C.	2 N.C.	2 N.C.
Auxiliary Outputs	1 N.O.	—	1 N.O.
Operating Characteristics			
Operating Distance, Make [mm (in.)]	Safety: 12 (0.47); Auxiliary: 15 (0.59)		
Operating Distance, Break [mm (in.)]	Safety: 23 (0.91); Auxiliary: 26 (1.02)		
Environmental			
Enclosure Type Rating	IP68 (NEMA 6P)		
Operating Temperature [C (F)]	-25…+125° (-13…+257°)		
Relative Humidity	5…95%		
Shock	IEC 68-2-27, 30 g, 11 ms		
Vibration	IEC 68-2-6, 10…200 Hz		
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6		
Physical Characteristics			
Housing Material	Stainless Steel; BS3146 ANC4B (316L)		
Actuator Material	Stainless Steel; BS3146 ANC4B (316L)		
Weight [g (lbs)]	Sensor: 156 (0.34); Actuator: 168 (0.37)		

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

Product Selection

Safety Contact Switching Capability	Safety Contacts	Auxiliary Contacts	Connection	Type	Cat. No.
250V AC, 2 A max.	2 N.C.	—	3 m Cable	FRS 20 GD2	440N-G02113
	1 N.C.	1 N.O.	3 m Cable	FRS 2 GD2	440N-G02112
	2 N.C.		3 m Cable	FRS 21 GD2	440N-G02117
24V DC, 1 A max.	1 N.C.	1 N.O.	3 m Cable	FRS 2 GD2	440N-G02118
			10 m Cable	FRS 2 GD2	440N-G02147
	2 N.C.	—	3 m Cable	FRS 20 GD2	440N-G02119
	2 N.C.	1 N.O.	3 m Cable	FRS 21 GD2	**440N-G02123**
			6 m Cable	FRS 21 GD2	440N-G02143
			10 m Cable	FRS 21 GD2	440N-G02137
			8-Pin Micro (M12)	FRS 21 GD2	**440N-G02149**

Note: Contacts are described with the guard door closed, that is, actuator in place. Switch is shipped with complete actuator.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30T	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	8-Pin Micro (M12)
Cordset	889D-F8AB-✶
Patchcord	889D-F8ABDM-❄

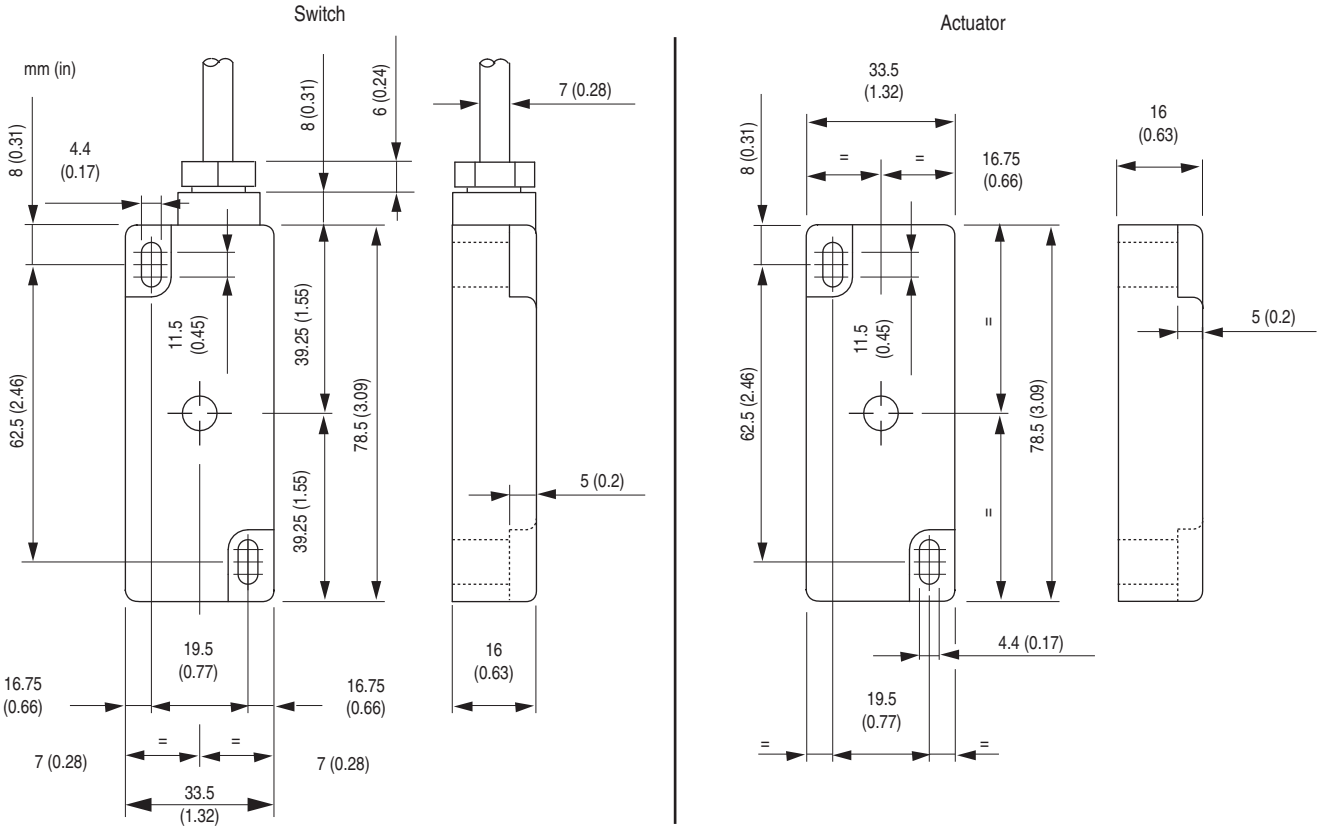
Accessories

Description	Cat. No.
Actuator	440N-A02128

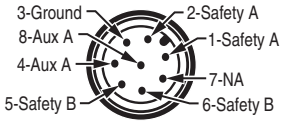
✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
Note: For additional information, see page 7-1.

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



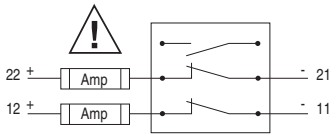
Typical Wiring Diagrams

Description		FRS21 2 N.C. + 1 N.O.	FRS2 1 N.C. + 1 N.O.	FRS20 2 N.C.
Cable Versions	Safety A	Black	Blue	Brown
		White	Red	Blue
	Safety B	Red	—	Black
		Blue		White
	Aux A	Yellow	Yellow	—
		Green	Green	
	Shield Gnd	—	Green/Yellow	Green/Yellow
8-Pin Micro (M12)			—	—
Cordset 889D-F8AB-∗	Brown White	Safety A	—	—
	Grey Pink	Safety B	—	—
	Yellow Red	Safety B	—	—
	Green Blue	NA	—	—

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

External Fuse Safety Contacts

WARNING: All safety contacts fitted with internal non-resettable fuse and must be fused externally as detailed.

	FRS 2 GD2 FRS20 GD2 FRS21 GD2	AC ≤ 1.6 A* (F) IEC 60127-2
	FRS 2 GD2 FRS 20 GD2 FRS21 GD2	DC ≤ 0.4 A** (F) IEC 60127-2

Recommended:
*Bussman BK/GDA-1.6 A
** Bussman BK/GDA-400 mA

Non-Contact Switches

Ferrogard™ GS1 & GS2



Description

The Ferrogard range of magnetically actuated safety switches offers non-contact reliability together with tolerance to misalignment. They are designed to be installed so that when a guard door is opened, the action of the magnetic actuator being removed from the switch opens the N.C. safety contacts which are intended for the isolation of control power to a machine primary control element.

The GS1 and GS2 are designed for heavy duty applications. The GS1 is housed in a stainless steel or brass housing. The GS2 offers the same characteristic as the GS1, but in an Ex Range housing for hazardous locations.

Unlike some magnetic switches the Ferrogards have protected safety contacts to help ensure that they do not fail to danger.

All Ferrogards have internal non-resettable overload protection on the safety contact. They should be protected by an external fuse rated as shown in the Specifications table.

See **Other Safety Products** section on page **9-1** for more information on the Ex Range version of the Ferrogard GS2.

Features

- Non-contact actuation
- High tolerance to misalignment
- High switching current (2 A AC)
- Metal housings (IP68)
- Ex Range version available

Specifications

Safety Ratings	
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, ANSI B11.19, AS4024.1
Safety Classification	Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics
Certifications	GS1 & GS2 - CE Marked for all applicable directives and cULus GS2 Ex - EExd IIC T6 Baseefa
Outputs (Guard Door Closed, Actuator in Place)	
Safety Outputs	1 N.C.
Auxiliary Outputs	—
Operating Characteristics	
Operating Distance, Make [mm (in.)]	GS1: 12 (0.47); GS2: 15 (0.59)
Operating Distance, Break [mm (in.)]	GS1: 23 (0.91); GS2: 26 (1.02)
Environmental	
Enclosure Type Rating	IP68 (NEMA 6P)
Operating Temperature [C (F)]	GS1: -25…+125° (-13…+257°) GS2: -40…+60° (-40…146°)
Relative Humidity	5…95%
Shock	IEC 68-2-27, 30 g, 11 ms
Vibration	IEC 68-2-6, 10…55 Hz
Radio Frequency	IEC 61000-4-3, IEC 61000-4-6
Physical Characteristics	
Housing Material	Stainless Steel or Brass
Weight [g (lbs)]	GS1 Brass: 381 (0.84) GS1 Steel: 388 (0.86) Actuator: 116 (0.26)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

Product Selection

Safety Contact Switching Capability	Safety Contacts	Auxiliary Contacts	Connection	Housing Material	Type	Cat. No.
250V AC, 2 A	1 N.C.	None	2 m Cable	Brass	GS 1	440N-G02048
				Stainless Steel		440N-G02049
			3 m Cable	Brass	GS2-Ex (brass)	440N-H02046
				Stainless Steel	GS2-Ex (stainless steel)	440N-H02047

Note: Contacts are described with the guard door closed, that is, actuator in place. Switch is shipped with complete actuator.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30T	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

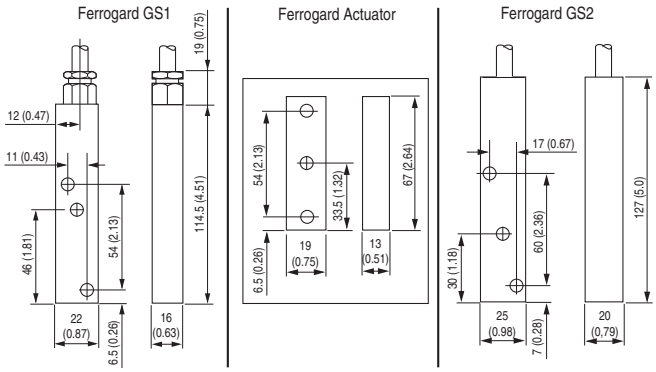
Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Accessories

Description	Used with	Cat. No.
Actuator, Alnico	Brass Switch	440N-A02056
Actuator, Epoxy-painted	Stainless Steel	440N-A02057

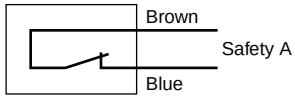
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Typical Wiring Diagrams

Cable



External Fuse Safety Contacts

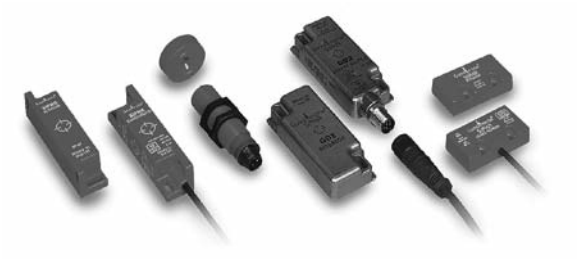
WARNING: All safety contacts fitted with internal non-resettable fuse and must be fused externally as detailed.

GS1 GS2	AC ≤ 1.6 A* (F) IEC 60127-2

Recommended:
*Bussman BK/GDA-1.6 A

Non-Contact Switches

Sipha™ Sensors



Description

With the increasing speed and complexity of applications a simple magnetic switch may be insufficient to meet the increased risks, therefore Sipha's design incorporates several magnetically sensitive elements which must be triggered in a particular sequence to operate correctly. The Sipha sensor, designed to operate with its own actuator, helps prevent defeatability by a simple magnet.

The Sipha with its molded-in brackets and diminutive size, is extremely versatile and simple to install. The Sipha sensor must be connected to the Sipha control unit giving a monitored circuit. For high-risk applications the control unit is used with a single sensor to give a high-integrity system. For other applications, multiple sensors (including mechanical switches) can be connected to one Sipha control unit. Sipha has facilities for connecting a manual reset button and for monitoring external devices such as contactors.

Four types of sensors and actuators are available incorporating different operating distances and physical sizes.

Features

- Non-contact actuation
- Magnetic coded sensing
- Four housing styles
- Must be operated with its own safety control unit

Specifications

Safety Ratings	
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC60947-5-1, IEC/EN60947-5-3, ANSI B11.19, AS4024.1
Safety Classification	Rating dependent on control unit and application.
Functional Safety Data **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	B10d: > 2 x 10^6 operations at min. PFH_D: > 3 x 10^{-7} MTTFd: > 385 years Dual channel interlock may be suitable for performance levels PLe or PLd (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Outputs (Guard Door Closed, Actuator in Place)	
Auxiliary Output Switching	300V DC, 250V AC, 0.5 A including inrush. 15V A/10 W suitable for AC/DC circuits
Operating Characteristics	
Sensing Distance, Make [mm (in.)]	Style S1: 5 (0.20) Style S2: 9 (0.35) Style S3: 5 (0.20) Style S4: 10 (0.39)
Sensing Distance, Break [mm (in.)]	Style S1: 11 (0.43) Style S2: 12 (0.47) Style S3: 12 (0.47) Style S4: 13 (0.51)
Environmental	
Enclosure Type Rating	IP67 (NEMA 6P)
Operating Temperature [C (F)]	S1, S2, S3: -10…+55° (+14…+131°) S4 (GD2): -25…+125° (-13…+257°)
Vibration	1 mm, 10…55 Hz
Shock	30 g, 11 ms half-sine
Physical Characteristics	
Cable Size	0.54 mm^2 (20 AWG) 4-wire PVC Jacket OD—4 mm (0.16 in.)
Material	S1, S2: Molded ABS S30 (Actuator): Polyester S31 (Sensor): Nylon (Trogamid) S4 (GD2): Stainless Steel
Mounting	Any position
Weight [g (lbs)]	S1: Sensor: 18 (0.04); Actuator: 15 (0.03) S2: Sensor: 20 (0.04); Actuator: 30 (0.07) S3: Sensor: 18 (0.04) Actuator: 6 (0.01) S4: Sensor: 150 (0.33); Actuator: 170 (0.37)

Product Selection

Housing Style	Housing Material	Safety Contacts	Auxiliary Contacts	Type	Connection	Cat. No.
 S1	ABS plastic	1 N.C. & 1 N.O.	None	S11	3 m Cable	**440N-S32014**
					10 m Cable	440N-S32016
			1 N.C.	S12	3 m Cable	440N-S32022
					10 m Cable	440N-S32032
			1 N.O.	S13	3 m Cable	440N-S32037
					10 m Cable	440N-S32036
 S2			None	S21	3 m Cable	440N-S32015
					10 m Cable	440N-S32017
			1 N.C.	S22	3 m Cable	440N-S32023
					10 m Cable	440N-S32033
			1 N.O.	S23	3 m Cable	440N-S32038
					10 m Cable	440N-S32039
 S3	Actuator: Polyester Sensor: Nylon [Trogamid]		None	S31	3 m Cable	440N-S32101
					4-Pin Micro (M12)	440N-S32024
 S4	Stainless Steel		1 N.C.	S42	8-Pin Micro (M12)	**440N-S32047**
					3 m Cable	440N-S32055
					10 m Cable	440N-S32056
			1 N.O.	S43	8-Pin Micro (M12)	440N-S32046
					3 m Cable	440N-S32053
					10 m Cable	440N-S32054

Recommended Logic Interfaces

Housing	Supply Voltage	Safety Contacts	Auxiliary Contacts	Housing Width	Type	Cat. Page No.	Cat. No.
	24V AC/DC	1 N.O.	1 N.C. Solid State	22.5 mm	Control Unit 1	5-74	440N-S32013
	24V AC/DC; 115/230V AC	2 N.O.	1 N.C.	45 mm	Control Unit 2		440N-S32021
	24V AC/DC; 115/230V AC	2 N.O. + 1 N.O. delayed	1 N.C.	90 mm	Sipha 6		440N-S32052

Connection Systems

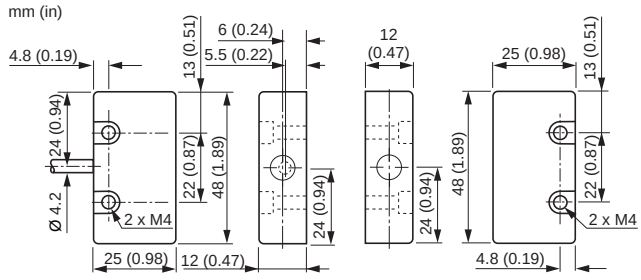
Description	4-Pin Micro (M12)	8-Pin Micro (M12)
Cordset	889D-F4ECA-✶	889D-F8AB-✶
Patchcord	889D-F4ECRM-❄	889D-F8ABDM-❄

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
Note: For additional information, see page 7-1.

Approximate Dimensions

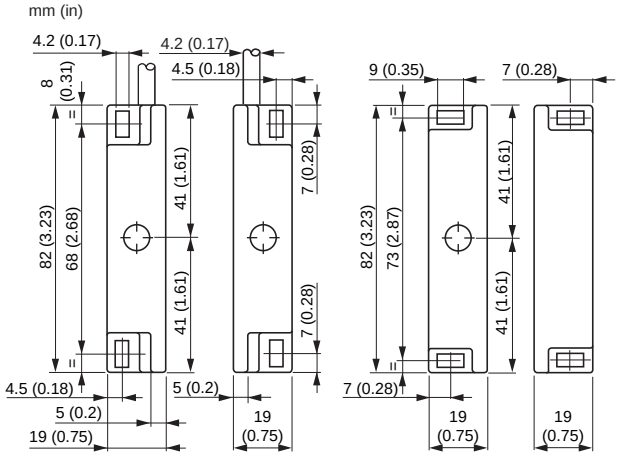
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Sipha S1



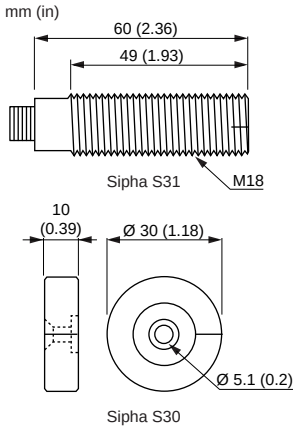
Sipha S11, S12, S13 Sipha S10

Sipha S2



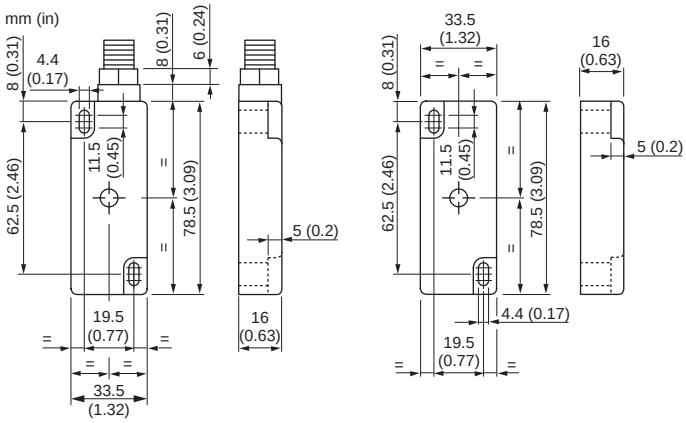
Sipha S21, S22, S23 Sipha S20

Sipha S3



Sipha S31 Sipha S30

Sipha S4



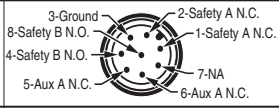
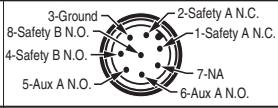
Sipha S42, S43 Sipha S40

Accessories

Description	Cat. No.
Actuator S10	440N-A32019
Actuator S20	440N-A32020
Actuator S30	440N-A32025
Actuator S40 (GD2)	440N-A32041
Bag of 40 washers for S2 models	440N-A17127

Typical Wiring Diagrams

Description		S11, S21 1 N.O. + 1 N.C.	S42, S12, S22 2 N.C. + 1 N.O.	S43, S13, S23 1 N.C. + 2 N.O.
Cable Versions	Red	Safety A_N.C.	Safety A_N.C.	Safety A_N.C.
	Blue			
	Yellow	Safety B_N.O.	Safety B_N.O.	Safety B_N.O.
	Green			
	Black	—	Aux A_N.C.	Aux A_N.O.
	White			
	Green/Yellow	—	External Ground	External Ground

Description		S31	S42	S43
4-Pin Micro (M12)			—	—
8-Pin Micro (M12)		—		
4-Pin Cordset 889D-F4AC-∗	Brown	Safety A_N.C.	—	—
	Blue			
	White	Safety B_N.O.	—	—
	Black			
8-Pin Cordset 889D-F8AB-∗	White Brown	Safety A	Safety A_N.C.	Safety A_N.C.
	Red Yellow	Safety B	Safety B_N.O.	Safety B_N.O.
	Grey Pink	Aux A	Aux A_N.C.	Aux A_N.O.
	Green Blue	NA	Gnd	Gnd

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Hinge Switches

Sprite™



Description

The Sprite is a hinge-actuated safety interlock switch in a compact housing—only 75 x 25 x 29 mm (2.95 x 0.98 x 1.14 in.)—making it the smallest interlock currently available. The Sprite has been designed for smaller machines such as printing machines, copiers and domestic machinery, which until now, have been able to use standard safety interlocks due to space restrictions. Despite its small size, the Sprite includes the necessary safety-related functions, such as forced-guided contacts and a tamper-resistant mechanism allowing machinery to be safeguarded in compliance with the machinery directive.

The shaft of the Sprite is connected to the existing hinge pin and the degree of operation can be adjusted to suit the application via the adjustable cam in the switch head.

IMPORTANT: After adjustment, the cam must be secured in position with the supplied cam locking pin to ensure optimal performance.

Features

- Ideal for small, light-weight guards
- The smallest hinge interlock switch available, 75 x 25 mm case
- Degree of operation can customized with adjustable cam
- Contacts, 2 N.C. or 1 N.C. & 1 N.O.
- Four possible shaft positions, easy to install

Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 device per EN 954-1 May be suitable for use in Cat 3 or Cat 4 systems depending on the architecture and application characteristics			
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus NRTL/C and TÜV			
Outputs					
Safety Contacts ❄		2 N.C. direct-opening action		1 N.C. direct-opening action	
Auxiliary Contacts		—		1 N.O.	
Shaft Rotation for Contact Operation		Maximum 11°; Minimum 3° (adjustable)			
Thermal Current I_{lth}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Break Contact Force, Min.		8 cNm (torque on shaft)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		1 cycle/s			
Operating Life @ 100 mA load		1,000,000 operations			
Environmental					
Enclosure Type Rating		IP67			
Operating Temperature [C (F)]		-20…+80° (-4…176°)			
Physical Characteristics					
Housing Material		UL Approved glass-filled PBT			
Shaft Material		Stainless Steel			
Weight [g (lb)]		80 (0.176)			
Color		Red			

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Contact			Shaft Type	Actuator Shaft Dimensions—mm (in)	Cat. No.			
					M16 Conduit		Connector§	
Safety	Auxiliary	Action			M16	1/2 inch NPT Adaptor	4-Pin Micro (M12)	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)
2 N.C.	—	—	Solid	80 x Ø10 (3.14 x 0.39)	440H-S34019	440H-S34023	440H-S34027	—
				60 x Ø8 (2.36 x 0.31)	440H-S34020	440H-S34024	440H-S34028	—
				50 x Ø10(1.96 x 0.39)	440H-S34010	440H-S34017	440H-S34014	440H-S2NNPPS
			Pre-Bored	30 x Ø16 (1.18 x 0.63) bore Ø9.5 (0.37)	440H-S34033	440H-S34034	440H-S34035	440H-S2NNHPS
1 N.C.	1 N.O.	BBM	Solid	80 x Ø10 (3.14 x 0.39)	440H-S34021	440H-S34025	440H-S34029	—
				60 x Ø8 (2.36 x 0.31)	440H-S34022	440H-S34026	440H-S34030	—
				50 x Ø10(1.96 x 0.39)	440H-S34012	440H-S34018	440H-S34015	—
			Pre-Bored	30 x Ø16 (1.18 x 0.63) bore Ø9.5 (0.37)	440H-S34036	—	—	—

§ For connector ratings, see page 3-9.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR9T	2 N.O.	1 N.C.	Fixed	Auto./Manual	24V AC/DC	5-14	440R-F23027
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
MSR33RT	2 N.O. Solid State	1 N.O.	Removable	Auto. or Monitored Manual	24V DC SELV	5-18	440R-F23200
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

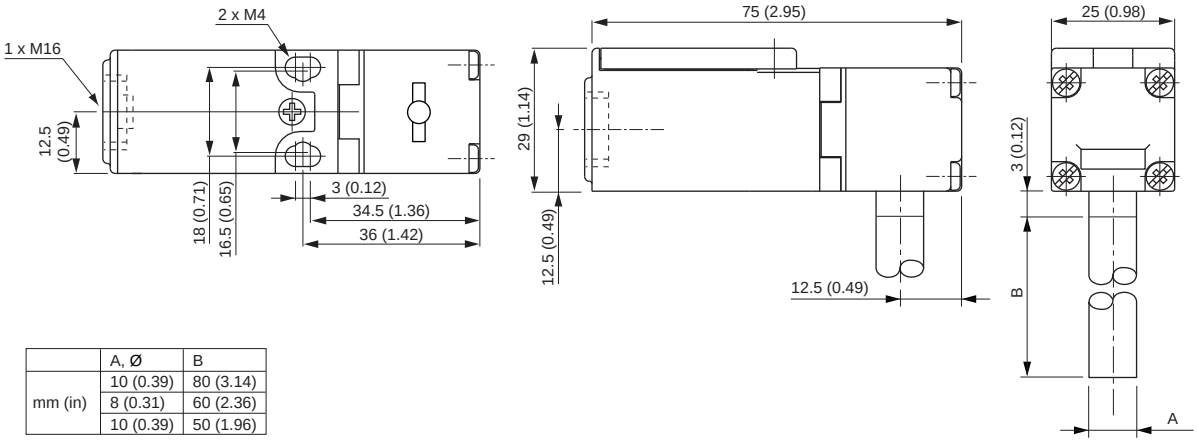
Description	4-Pin Micro (M12)		5-Pin Micro (M12) for ArmorBlock Guard I/O
	2 N.C.	1 N.C. & 1 N.O.	2 N.C.
Cordset	889D-F4AC-✶	889D-F4AC-✶	—
Patchcord	889D-F4ACDM-❄	889D-F4ACDM-❄	889D-F5ACDM-✶
Distribution Box	889D-4‡LT-DM4	898D-F4‡KT-DM4	—
Shorting Plug	889D-41LU-DM	898D-41KU-DM	—
T-Port	889D-43LY-D4	898D-43KY-D4	—

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ Replace symbol with 4 or 8 for number of ports.
Note: For additional information, see the Safety Connection System section (page 7-1) of this catalog.

Approximate Dimensions

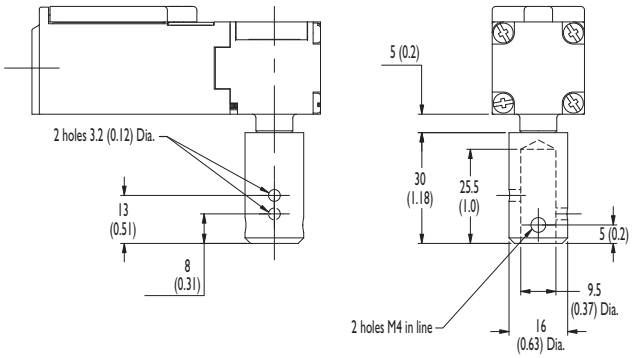
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

= mm (in)



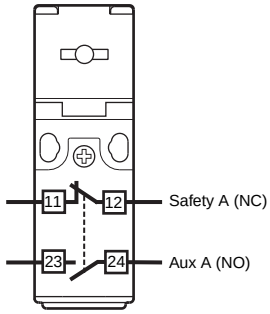
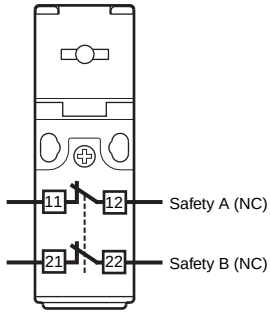
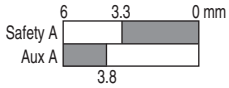
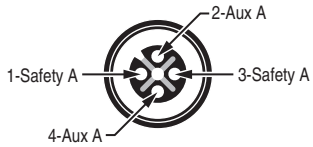
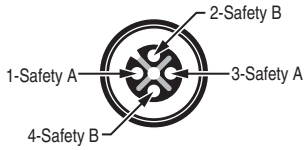
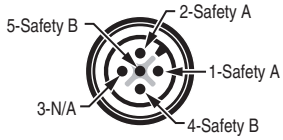
	A, Ø	B
mm (in)	10 (0.39)	80 (3.14)
	8 (0.31)	60 (2.36)
	10 (0.39)	50 (1.96)

Hollow Shaft



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Typical Wiring Diagrams

Description		1 N.C. & 1 N.O.	2 N.C.
Contact Configuration			
Contact Action □Open ■Closed			
4-Pin Micro (M12)			
5-Pin Micro (M12) For ArmorBlock Guard I/O		—	
Cordset 889D-F4AC-∗	Brown	Safety A	Safety A
	Blue		
	White	Aux A	Safety B
	Black		

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Hinge Switches

Ensign™ 3



Description

The Ensign 3 is a hinge-actuated safety-interlock switch designed to fit at the hinge point of guards. With its rotatable head, the versatile Ensign 3 offers up to four different mounting options.

Operation of the unit is achieved by the hinging action of the guard. The actuation shaft is connected to the existing hinge pin and the degree of operation can be adjusted to suit the application via the adjustable cam in the switch head.

IMPORTANT: After adjustment, the cam must be secured in position with the supplied cam locking pin to ensure safety function performance.

The switch includes the necessary safety-related functions, such as forced-guided contacts and a tamper-resistant mechanism, allowing machinery to be safeguarded in compliance with the machinery directive. It is sealed to IP67 and has one conduit entry, M16 or connector style.

Features

- Compact size—90.5 x 31 x 30.4 mm (3.56 x 1.22 x 1.2 in) housing
- Ideal for small, lightweight guards
- Degree of operation can be customized with adjustable cam
- Contacts, 2 N.C. & 1 N.O. or 3 N.C. (sealed to IP67)
- Four possible shaft positions, easy to install
- Solid and hollow shafts available

Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 device per EN 954-1 dual channel interlocks suitable for Cat. 3 or 4 systems			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus, and TÜV			
Outputs					
Safety Contacts ❄		3 N.C. direct-opening action		2 N.C. direct-opening action	
Auxiliary Contacts		—		1 N.O.	
Shaft Rotation for Contact Operation		3 N.C. Adjustable 12° max.: 3° min. 2 N.C. 1 N.O. (BBM) Adjustable 14° max.: 5° min. 2 N.C. 1 N.O. (MBB) Adjustable 12° max.: 3° min.			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Break Contact Force, Min.		8 cNm (torque on shaft)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		1 cycle/s			
Operating Life @ 100 mA load		1,000,000 operations			
Environmental					
Enclosure Type Rating		IP67			
Operating Temperature [C (F)]		-20…+80° (-4…176°)			
Physical Characteristics					
Housing Material		UL Approved glass-filled PBT			
Shaft Material		Stainless Steel			
Weight [g (lb)]		100 (0.22)			
Color		Red			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Contact			Actuator Shaft Dimensions— mm (in)	Shaft Type	Cat. No.			
					M16 Conduit		Connector❄	
Safety	Auxiliary	Action			M16	1/2 inch NPT Adaptor	6-Pin Micro (M12)	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12) ✶
3 N.C.	—	—	80 x Ø10 (3.14 x 0.39)	Solid	440H-E22025	440H-E22050	440H-E22059	—
			60 x Ø8 (2.36 x 0.31)		440H-E22031	440H-E22051	440H-E22060	—
			50 x Ø10 (1.96 x 0.39)		440H-E22047	440H-E22052	440H-E22061	440H-E2NNPPS
			30 x Ø16 (1.18 x 0.63) bore Ø9.5 (0.37)	Pre-bored	440H-E22067	440H-E22068	440H-E22069	440H-E2NNHPS
2 N.C.	1 N.O.	BBM	80 x Ø10 (3.14 x 0.39)	Solid	440H-E22027	440H-E22053	440H-E22037	—
			60 x Ø8 (2.36 x 0.31)		440H-E22033	440H-E22054	440H-E22039	—
			50 x Ø10 (1.96 x 0.39)		440H-E22048	440H-E22055	440H-E22062	—
			30 x Ø16 (1.18 x 0.63) bore Ø9.5 (0.37)	Pre-bored	440H-E22064	440H-E22065	440H-E22066	—
		MBB	80 x Ø10 (3.14 x 0.39)	Solid	440H-E22029	440H-E22056	440H-E22038	—
			60 x Ø8 (2.36 x 0.31)		440H-E22035	440H-E22057	440H-E22040	—
			50 x Ø10 (1.96 x 0.39)		440H-E22049	440H-E22058	440H-E22063	—
			30 x Ø16 (1.18 x 0.63) bore Ø9.5 (0.37)	Pre-bored	440H-E22070	440H-E22071	440H-E22072	—

✶ With a 5-pin micro (M12) connector, not all contacts are connected. See page 3-97 for wiring details.
❄ For connector ratings, see 3-9.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

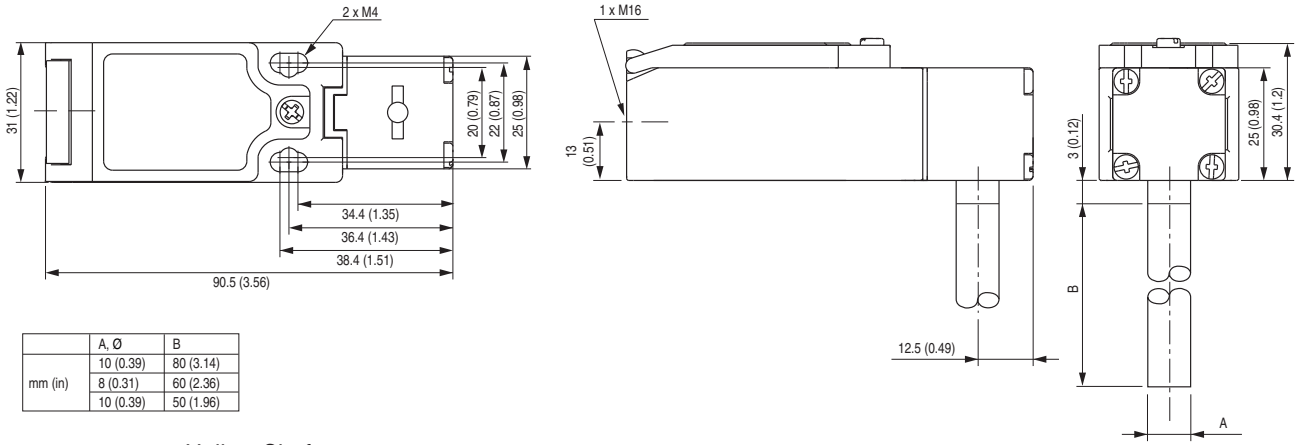
Connection Systems

Description	6-Pin Micro 3 N.C.-2 N.C. & 1 N.O.	Connections to ArmorBlock Guard I/O 5-Pin Micro (M12) 3 N.C.
Cordset	889R-F6ECA-‡	—
Patchcord	889R-F6ECRM-§	889D-F5ACDM-‡
Distribution Box	898R-P68MT-A5	—
Shorting Plug	898R-P61MU-RM	—

‡ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
§ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
Note: For additional information, see page 7-1.

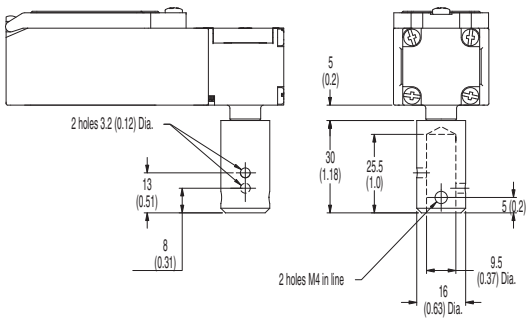
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



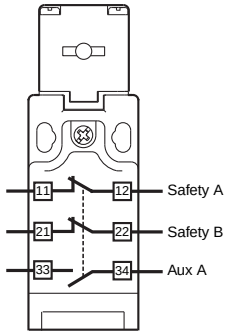
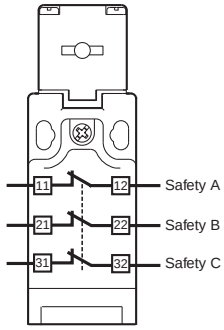
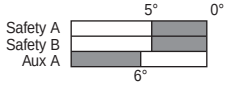
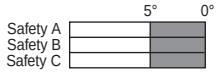
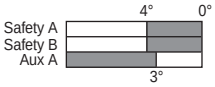
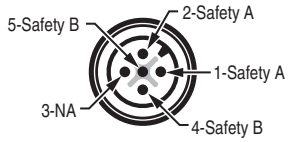
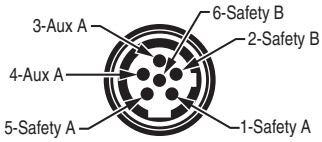
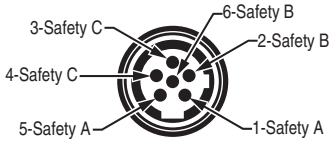
	A, Ø	B
mm (in)	10 (0.39)	80 (3.14)
	8 (0.31)	60 (2.36)
	10 (0.39)	50 (1.96)

Hollow Shaft



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Typical Wiring Diagrams

Description		2 N.C. & 1 N.O.	3 N.C.
Contact Configuration			
Contact Action □Open ■Closed			
		BBM	
			
		MBB	
5-Pin Micro (M12) For ArmorBlock Guard I/O		—	
6-Pin Micro (M12)			
Cordset 889R-F6ECA-∗	1 Red/White	Safety A	Safety A
	5 Red/Black		
	2 Red	Safety B	Safety B
	6 Red/Blue		
	3 Green	Aux A	Safety C
	4 Red/Yellow		

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Hinge Switches

Rotacam™



Description

The Rotacam is heavy-duty, hinge-actuated safety-interlock switch. It can be used as, or connected to, the existing hinge pin for direct operation of the switch. Machine power is isolated when the guard has been opened just 5°. For applications requiring a larger degree of operation, the internal cam can be adjusted from 5…11°.

IMPORTANT: After adjustment, the cam must be secured in position with the supplied cam locking pin to ensure optimal performance.

The Rotacam is available with two N.C. safety contacts and one N.O. auxiliary contact. The switch includes the necessary safety-related functions, such as forced-guided contacts and a tamper-resistant mechanism, allowing machinery to be safeguarded in compliance with the machinery directive.

The die-cast housing is sealed to IP66 and features one M20 conduit entry (1/2 inch NPT and connector style also available). Two different shaft lengths of 30 mm and 85 mm can also be specified.

EX and Pneumatic styles of Rotacam are also available; see page 9-10 for more information.

Features

- Can be used as a hinge pin on light- and medium-weight guard doors
- Isolates power within 5° of door movement
- Degree of operation can be customized with adjustable cam
- Robust die-cast case, ideal for heavy-duty applications
- Contacts, 2 N.C. & 1 N.O.

Specifications

Safety Ratings					
Standards		EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1			
Safety Classification		Cat. 1 Device per EN954-1 Dual channel interlocks suitable for Cat. 3 or 4 systems			
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus, SUVA, and TÜV			
Outputs					
Safety Contacts ❄		2 N.C. direct opening action			
Auxiliary Contacts		1 N.O.			
Shaft Rotation for Contact Operation		11° maximum; 5° minimum, (adjustable)			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Break Contact Force, Min.		12 cNm (torque on shaft)			
Actuation Speed, Max.		160 mm (6.29 in.)/s			
Actuation Frequency, Max.		1 cycle/s			
Operating Life @ 100 mA load		>1,000,000 operations			
Environmental					
Enclosure Type Rating		IP66			
Operating Temperature [C (F)]		-20…+80° (-4…176°)			
Physical Characteristics					
Housing Material		Heavy-duty die-cast alloy			
Shaft Material		Stainless Steel			
Weight [g (lb)]		420 (0.926)			
Color		Red			

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

Allen-Bradley
Guardmaster®

Product Selection

Safety Contacts	Auxiliary Contacts	Contact Action	Shaft Dimensions	Operating Shaft Type	Cat. No.		
					M20 Conduit		Connector§
					M20	1/2 inch NPT Adaptor	8-Pin Micro (M12)
2 N.C.	1 N.O.	BBM	L = 30 (1.18) D = 16 (0.63)	Pre-Bored	440H-R03074	440H-R03078	440H-R03111
			L = 85 (3.35) D = 12.7 (0.5)	Solid	440H-R03079	440H-R03088	440H-R03112

§ For connector ratings, see 3-9.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-12.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

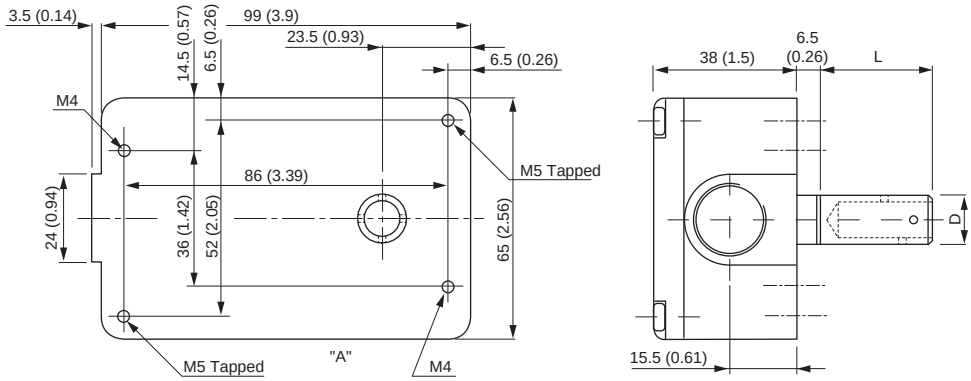
Connection Systems

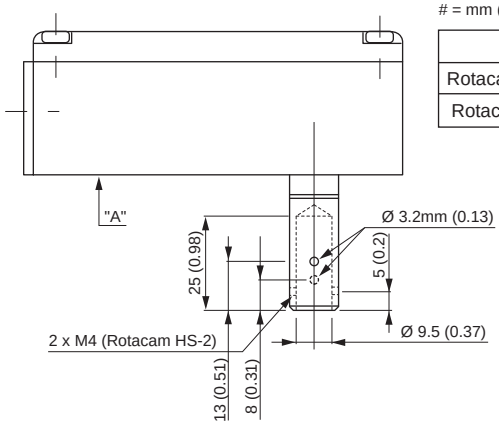
Description	8-Pin Micro (M12)
	2 N.C. & 1 N.O.
Cordset	889D-F8AB-∗
Patchcord	889D-F8ABDM-❄
Distribution Box	—
Shorting Plug	—
T-Port	—

∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
Note: For additional information, see page 7-1.

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



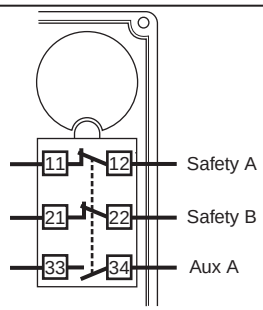
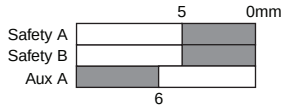
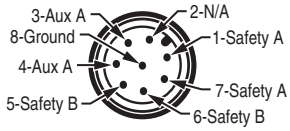


= mm (in)

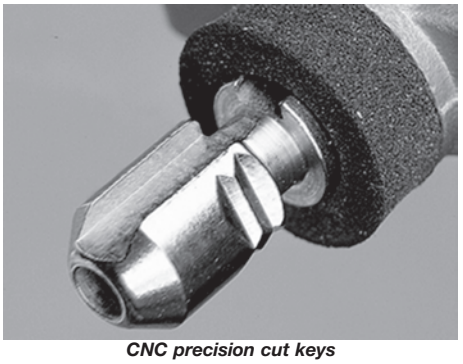
	L	D
Rotacam HS-2	30mm (1.18)	16mm (0.63)
Rotacam P85	85mm (3.35)	12.7mm (0.5)

Note: Holes only on pre-bored models.
Note: 2D, 3D and electrical drawings are available on www.ab.com.

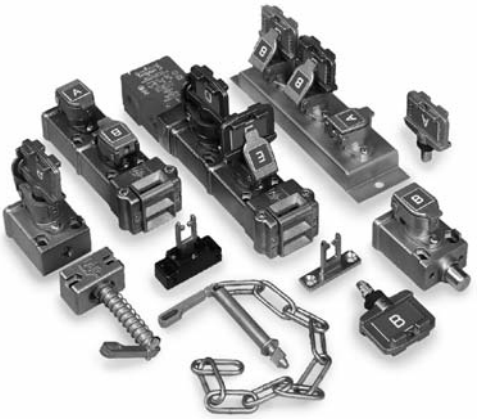
Typical Wiring Diagrams

Description		2 N.C. & 1 N.O.
Contact Configuration		
Contact Action □Open ■Closed		
8-Pin Micro (M12) Pin 2 Not Connected		
8-Pin Cordset 889D-F8AB-∗	White Blue	Safety A
	Grey Pink	Safety B
	Green Yellow	Aux A
	Red	Ground
	Brown	Not Connected

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.



CNC precision cut keys



Interlocking and Control Solutions

Trapped Key Interlocks—Why Use Them?

Based upon the premise that no one key can be in two places at once, key interlock systems can be configured to provide that a predetermined sequence of events takes place or that hazards have been reduced before operators can become exposed to them.

It is a mechanical system and is therefore widely used in applications including those where the location of plant, environment or explosive atmospheres make the use of electrical interlock systems unsuitable or expensive to install. In addition, unique coding can be provided, leading to a greater degree of security and tamper-resistance.

Why Prosafe?

In order to derive the full benefits from a trapped key interlocking system its components must be totally practical, easily maintainable and readily available. Prosafe's unique key and code barrel gives the ability for even complicated interlocking systems and spare parts to be ordered from our worldwide network of distributors—fast! A first for trapped key interlocks.

Five Unique Prosafe Benefits

Compare the following to other trapped key manufacturers:

1. All stainless interlocking and coded parts—including the code barrel and internal components at no extra cost.
2. Weather cap as standard—no extra charge for dust caps and seals.
3. Standard red color-coded key and ID tags—at no extra charge.
4. Custom color/text keys and ID tags—nominal extra charge.
5. A complete range of isolators, key exchange, miniature valve interlocks and gate interlocks—all using the same key principle.

CE Marking—Tested and Approved

Only Prosafe products carry the prestigious BG mark. A sign of safety, independently tested by the German Berufsgenossen-schaftliches Institut für Arbeitssicherheit, "BIA." Additional tests for valve interlocks include Lloyds Certificate for fire test and salt-mist resistance.

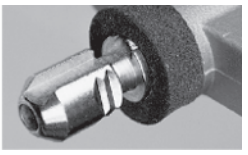
Over 100,000 Operations

Prosafe products have been subjected to independent, exhaustive testing. With only a small amount of lubricant added infrequently, keys were inserted, rotated and removed at a rate of 12 times per minute. After 100,000 operations (at 10 operations a day this is equivalent to 27 years) the unit was functioning satisfactorily and most importantly would "pass" only the original or equivalent new key. No incorrect keys could operate the lock, underlining the unit's integrity as well as longevity.

The Prosafe Advantage

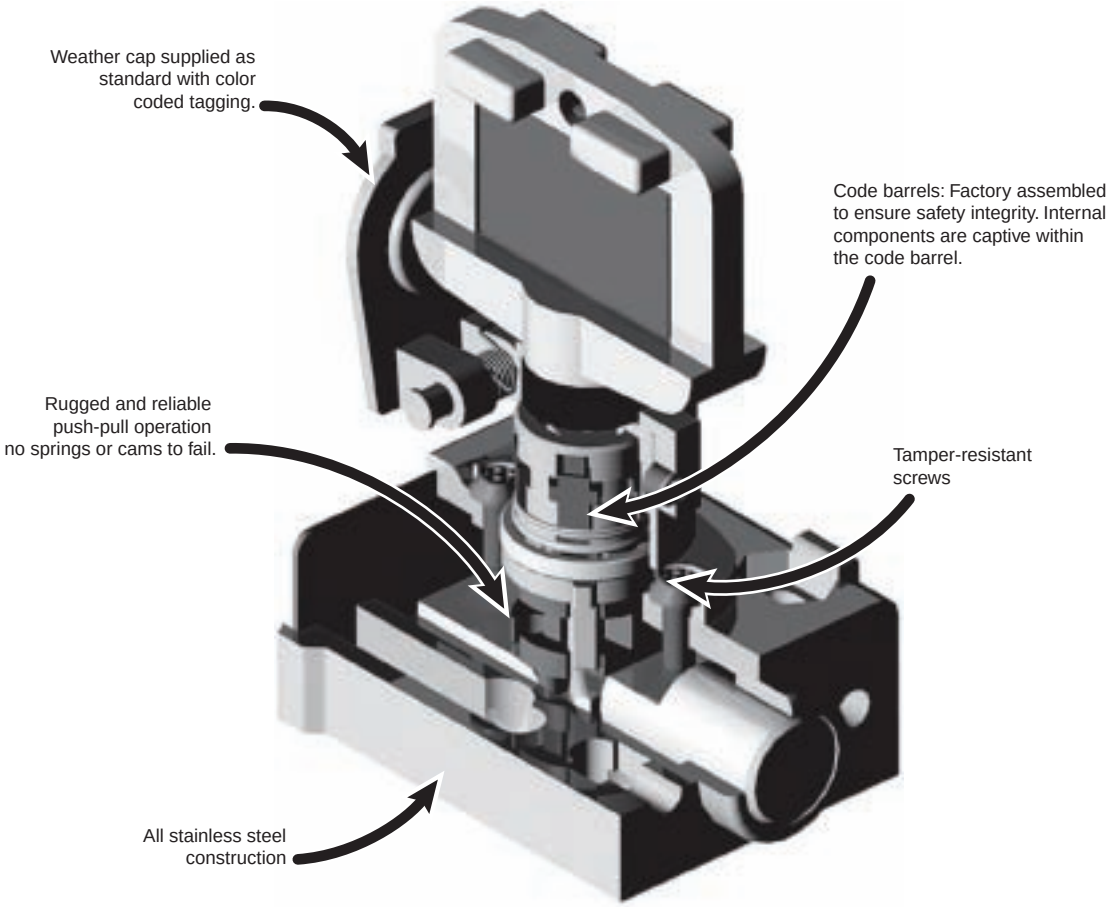






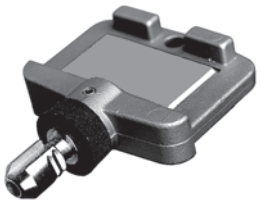
Stainless steel construction.

The Advantage



Prosafe Keys

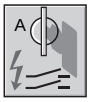
Compact, solid and sturdy keys supplied with dust seals and coded tagging. Optional colors/text are available.



Design Suggestions for an Interlocking System

Plant and Machinery Interlocking

Primary hazards
(Power isolation)



Rotary key switch

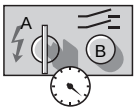


3 Port spool valve

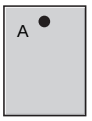
Consider removal of all power providing kinetic energy to the system i.e., electrical motors, pressurized air, etc.

Comments
Consider factors such as run down and environmental factors such as hazardous (explosive) atmospheres. Use EEX isolator and timed delay units where necessary.

Auxiliary hazards



Timed delay unit



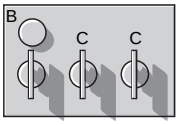
Solenoid key release unit coupled to temperature or pressure switch sensors



Bolt lock off device for grounding and capacitive discharge

Consider if the hazard is removed immediately i.e.,
a) Machine run on due to momentum.
b) Pressurization of hydraulic or pneumatic systems.
c) Stored energy such as capacitance or static electricity.
d) Temperature, either hot or cold, creating a hazard.

Key control element



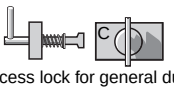
Required when more than one hazard element needs isolation or more than one exposure/access point interlocking.

Comments
Consider sequentially interlocking all primary sources of hazard so all are eliminated. In turn, releasing a single key to input in key control element. Additional monitoring, isolation or control functions such as switches or solenoid locks may be incorporated at this stage to eliminate other elements.

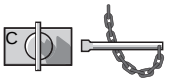
Guarded area access



Bolt lock for sliding guards

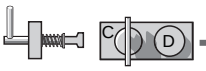


Access lock for general duty sliding, hinge and lift off guards



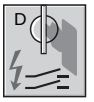
Chain interlock for large or poorly aligned sliding, hinge and lift off guards

To gain access to the danger zone.



Comments
Consider 2 key versions to provide
a) Personnel key exchange types to prevent operator lock-in (whole body access applications only).
b) Lock out devices requiring 2 keys in from different sources to enable controlled access.

Ancillary functions



Rotary key switch



3 Port spool valve

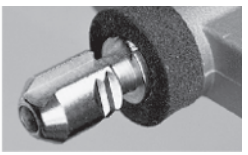
Required when additional functions such as programming/machine resetting are necessary.

Comments
Two key versions required at access points to facilitate this feature.

The Prosafe Advantage

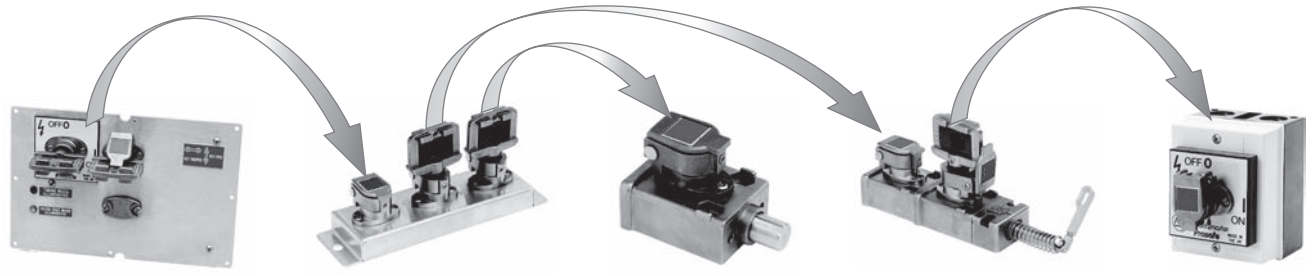






Stainless steel construction.

Illustrated Principles of Trapped Key Interlocking



AA
ETU
Isolator with timed delay key release

AA AB AB
KEX
Trapped key 'AA' Locking off ETU, Release access door lock, key 'AB'.

AB
SBL
'AB' key in to retract bolt from guard door.

AB AC
DAL
'AB' key in then 'AC' key out to open guard door.

AC
RKS
To energize robot teach mode.

Sequence of Operation

1. The ETU isolator has two keys. One is a nonremovable key. The other key (a "AA" coded key) can be removed after a timed duration, which is set by a potentiometer inside the ETU isolator. Turn the nonremovable key to turn the hazardous machine motion off and start the timer. When the time expires, the Key Free LED turns ON. Remove the "AA" key.
2. Insert the "AA" key into the Key Exchange Unit (KEX) and turn it 90°.
3. Turn one of the "AB" keys 90° and remove it from the KEX. This traps the "AA" key in the KEX and prevents the restarting of the machine.
4. Insert the "AB" key into the Single-key Bolt Lock (SBL) and turn it 90° to gain partial body access to the machine.
5. Turn the second "AB" key 90° and remove it from the KEX. Removal of this key also traps the "A" key in the KEX and prevents the restarting of the machine.
6. Insert the "AB" key into the Dual-key Access Lock (DAL) and turn it 90°.
7. Turn the "AC" key 90° and remove the "C" key. Rotate the access handle to allow full body entry into the hazard zone.
8. Take the "AC" key into the hazard zone, insert it into the rotary key switch (RKSE) and turn it 90° to send a signal to the machine control system, to allow the machine to operate in a slow or teach mode.
9. Reverse the process to return the machine to full operational mode.

Bill of Materials

Item	Quantity	Description	Cat. No.
1	1	Single Key Time Delayed with an AA Primary Key	**440T-MSTUE11AA**
2	1	Key Exchange Unit, AB Primary Key, Two B Secondary Keys Trapped (included)	**440T-MKEXE11AAABAB**
3	1	Single Bolt Lock, AB Primary Key	**440T-MSBLE10AB**
4	1	Dual Access Lock, AB Primary Key, C Secondary Key Trapped (included)	**440T-MDALE10ABAC**
5	1	Rotary Key Switch, AC Primary Code Barrel	**440T-MRKSE10AC**
6	1	AA Key	**440T-AKEYE10AA**

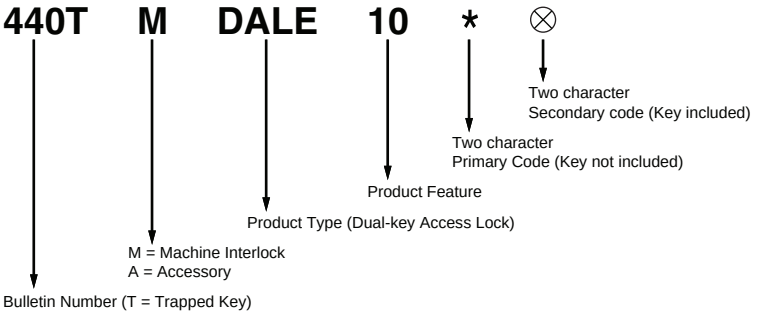
Note: Primary keys must be ordered separately, when not provided for by a previous sequential trapped key. In the example above, only one primary key must be ordered separately. The remaining primary keys are provided by a previous sequential secondary (trapped) key.

Code Selection

Ordering Prosafe trapped key products requires codes to be included in the cat. no.

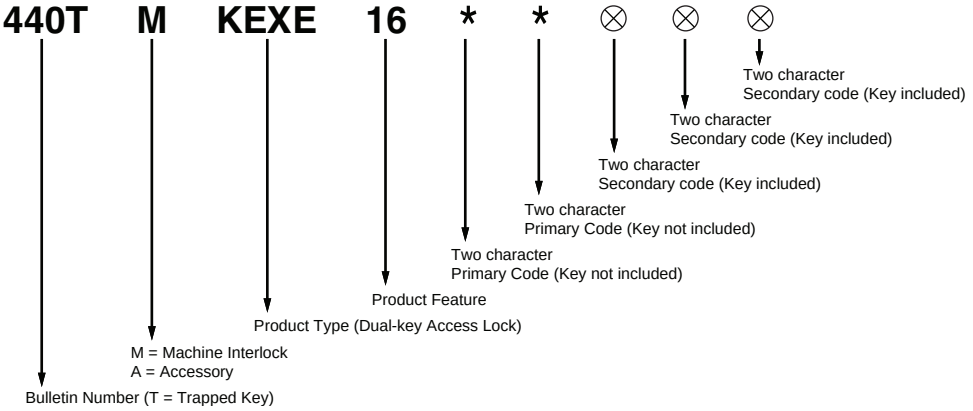
- The codes are added to the end of the cat. no.
- Each code must be two characters in length.
- The first code(s) is the primary code and the last code(s), if necessary, are the secondary code(s).
- Primary codes do not include the key. The key must be ordered separately or must come from a previous operation.
- Secondary codes come complete with a key, as the key is trapped in the code barrel.
- Use the tables on page 3-107 to select and track codes.

Ordering Example 1



Order Cat. No. 440TMDALE100AAAB to get a Dual key Access Lock with an "AA" primary code and a "AB" secondary code, with a "AB" key included.

Ordering Example 2

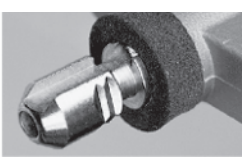


Order Cat. No. 440TMKEXE16AAABACACAC to get a key exchange unit with "AA" and "AB" primary codes and three "AC" secondary codes. The "AA" and "AB" keys are not included. The three "AC" keys, which are trapped in the secondary code barrels, are included.

The Prosafe Advantage







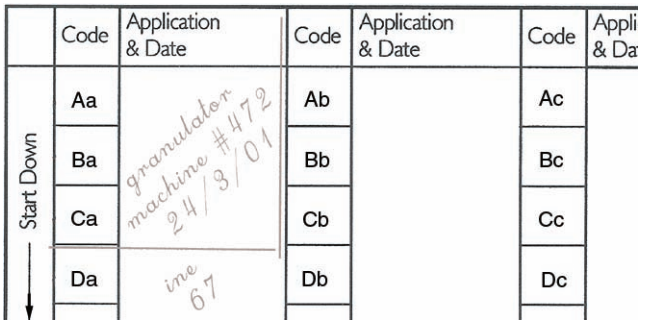
Stainless steel construction.

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Key Coding

Below is an example reference guide that is useful in selecting and tracking codes. Start down the Aa column as the lower codes (typically Aa to Za) are stocked. The chart continues on to Zz. Note that there are only 24 letters used—O & Q are not used.

Codes are ordered with upper case letters. Labels with two letter codes will show the first letter in the upper case and the second letter in lower case.



Code	Application & Date	Code	Application & Date	Code	Application & Date	Code	Application & Date	Code	Application & Date	Code	Application & Date
Aa		Ab		Ac		Ad		Ae		Af	
Ba		Bb		Bc		Bd		Be		Bf	
Ca		Cb		Cc		Cd		Ce		Cf	
Da		Db		Dc		Dd		De		Df	
Ea		Eb		Ec		Ed		Ee		Ef	
Fa		Fb		Fc		Fd		Fe		Ff	
Ga		Gb		Gc		Gd		Ge		Gf	
Ha		Hb		Hc		Hd		He		Hf	
Ia		Ib		Ic		Id		Ie		If	
Ja		Jb		Jc		Jd		Je		Jf	
Ka		Kb		Kc		Kd		Ke		Kf	
La		Lb		Lc		Ld		Le		Lf	
Ma		Mb		Mc		Md		Me		Mf	
Na		Nb		Nc		Nd		Ne		Nf	
Pa		Pb		Pc		Pd		Pe		Pf	
Ra		Rb		Rc		Rd		Re		Rf	
Sa		Sb		Sc		Sd		Se		Sf	
Ta		Tb		Tc		Td		Te		Tf	
Ua		Ub		Uc		Ud		Ue		Uf	
Va		Vb		Vc		Vd		Ve		Vf	
Wa		Wb		Wc		Wd		We		Wf	
Xa		Xb		Xc		Xd		Xe		Xf	
Ya		Yb		Yc		Yd		Ye		Yf	
Za		Zb		Zc		Zd		Ze		Zf	

Rotary Switches



Description

The rotary switches are used for electrical isolation of machinery to improve safe access and also as teach boxes in robot cells. Once the power has been turned off, the key can then be withdrawn and used in the next sequence of operation such as unlocking an access hatch or allowing valves to be operated.

The rotary switch can either be mounted in a panel or purchased in an enclosure. The rotary switch is available with 4 poles, either 4 N.O. or 2 N.C. and 2 N.O. The 100 A 4 N.O. switch has 3 contacts rated at 100 A and 1 contact rated at 20 A.

Features

- 316L stainless steel keys
- Direct drive operation—positively opens contacts
- Stainless steel dust cap included
- Up to 400 A isolation
- 4 N.O., 2 N.O. and 2 N.C., 3 N.O./1 N.C., 3 N.O., or 3 N.C. and neutral contacts
- Replaceable code barrel assembly

Specifications

Safety Ratings	
Standards	EN1088, IEC/EN60204-1, IEC/EN60947-5-1, ISO12100-1&2, ISO14119, GS-ET-19, AS4024.1, UL508, CSA 22.2
Category	Cat. 1 per EN 954-1 (ISO 13849-1) Suitable for Cat. 2, 3, and 4 systems
Certifications	CE Marked for all applicable directives, BG, cULus on contact block; C-Tick not required
Operating Characteristics	
Conduit Entry	4 x M20 (RKS only)
Mechanical Life	100,000 operations
Finger Protection	DIN 57106/VDE 0106 T.100
Environmental Characteristics	
Operating Temperature [C (F)]	-10…+40 ° (14…104 °)
Relative Humidity	95%
Physical Characteristics	
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.

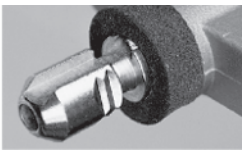
Specifications (continued)

Weight [g (lbs)]	RPSE	10, 11, 12, 13, 20:	500 (1.1)	14, 16:	1000 (2.2)
	RKSE	10, 11, 12, 13:	850 (1.9)	14, 16:	1250 (2.8)
Electrical Life		100,000 operations			
Climatic Test		Constant to DIN IEC 68 Part 2-3 Variable to DIN IEC 68 Part 2-30			
Ambient Temperature, Operation		Encased -25…40 °C (10…104 °F)			
(Ui) Rated Insulation Voltage		690V			
(Uimp) Rated Impulse withstand Voltage		6 kV			
S3 Intermittent Rating Duty Factor (VDE 0530, Part 1)		60/40/25% = 1, 3/1, 6/2 xlu			
Last two digits of Cat. No. (See Product Selection table)		10 11 16	12	13	14
Rated Uninterrupted Current (Iu)	IEC/EN/VDE	20A	32A	63A	100A
	UL/CSA	16A	30A	60A	100A
Rated Operational Voltage (Ue)	IEC/EN/VDE	690V	690V	690V	1000V
	UL/CSA	600V	600V	600V	600V
	Main Switch Isolation Voltage, Max.	750V	750V	750V	1000V
Rated Operational Current (Ie)	AC-21A IEC/EN/VDE	20A	32A	63A	100A
	AC-1 SEV	20A	32A	63A	100A
Rated Operational Power at 50/60 Hz (AC-23A IEC/EN/VDE)	3-phase 220…240V	4 kW	5.5 kW	15 kW	22 kW
	3-pole 380…440V	7.5 kW	11 kW	22 kW	37 kW
	500…690V	7.5 kW	11 kW	22 kW	37 kW
Rated Operational Power at 50/60 Hz (AC-3A IEC/EN/VDE)	3-phase 220…240V	3 kW	4 kW	11 kW	22 kW
	3-pole 380…440V	5.5 kW	7.5 kW	18.5 kW	30 kW
	500…690V	5.5 kW	7.5 kW	18.5 kW	30 kW
DOL Rating (UL/CSA)	3-phase 140V	1 HP	2 HP	5 HP	10 HP
	3-pole 240V	2 HP	5 HP	15 HP	25 HP
	480V	5 HP	10 HP	30 HP	30 HP
	600V	5 HP	10 HP	40 HP	30 HP
Rated Breaking Capacity	AC-23/AC-3 220…240V	250A	330A	500A	600A
	Motor Switch 380…440V	250A	330A	500A	600A
	500…690V	150A	220A	270A	300A
Fuse Rating (GI)		25 A, max.	35 A, max.	63/50 A, max.	100 A, max.
Rated Fuse Short Circuit Current		15 kA	15 kA	15/20 kA	25 kA
Terminal Cross Section		1…10		4…16	2.5…3.5
		mm^2 single/multiple wire			
Conductor Size, mm^2 min…max		0.75 …6		2.5…10	1.5…2.5
		(stranded) with sleeve			
		8 AWG		6 AWG	2 AWG

The Prosafe Advantage







Stainless steel construction.

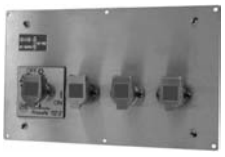
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Allen-Bradley
GuardMaster®

Product Selection

Type	Contact Type	Current Accuracy	Cat. No.
 Enclosure Mounted (RKS only)	4 N.O.	20 A	440T-MRKSE10✶
	2 N.O. & 2 N.C.	20 A	440T-MRKSE11✶
	4 N.O.	32 A	440T-MRKSE12✶
	4 N.O.	63 A	440T-MRKSE13✶
	3 N.O. & 1 N.O.	3 N.O. 100 A and 1 N.O. 20 A	440T-MRKSE14✶
	8 N.O.	20 A	440T-MRKSE16✶
Mild Steel Enclosure Mounted (RKS only)	3 N.O. + Neutral	200 A	440T-MRKSE21✶
	3 N.O.	400 A	440T-MRKSE22✶
 Panel Mounted	4 N.O.	20 A	440T-MRPSE10✶
	2 N.O. & 2 N.C.	20 A	440T-MRPSE11✶
	4 N.O.	32 A	440T-MRPSE12✶
	4 N.O.	63 A	440T-MRPSE13✶
	3 N.O. & 1 N.O.	3 N.O. 100 A and 1 N.O. 20 A	440T-MRPSE14✶
	8 N.O.	20 A	440T-MRPSE16✶
	3 N.O. & 3 N.C.	20 A	440T-MRPSE18✶
	4 N.O.	40 A	440T-MRPSE20✶

✶ Substitute the desired primary code for this symbol (key not included). See page 3-107.

	Type	Number of Keys	Contact Type	Current Accuracy	Cat. No.
Isolator on First Key Out					
	Dual key isolator	2 keys out	4 N.O.	20 A	440T-MMRSE10✶✶
			2 N.O. & 2 N.C.	20 A	440T-MMRSE11✶✶
			4 N.O.	32 A	440T-MMRSE12✶✶
			4 N.O.	63 A	440T-MMRSE13✶✶
	Triple key isolator	3 keys out	4 N.O.	20 A	440T-MMRSE20✶✶✶
			2 N.O. & 2 N.C.	20 A	440T-MMRSE21✶✶✶
			4 N.O.	32 A	440T-MMRSE22✶✶✶
			4 N.O.	63 A	440T-MMRSE23✶✶✶
	Quad key isolator	4 keys out	4 N.O.	20 A	440T-MMRSE30✶✶✶✶
			2 N.O. & 2 N.C.	20 A	440T-MMRSE31✶✶✶✶
			4 N.O.	32 A	440T-MMRSE32✶✶✶✶
			4 N.O.	63 A	440T-MMRSE33✶✶✶✶
	Dual key exchange isolator	1 key in/ 1 key out	4 N.O.	20 A	440T-MMRXE10✶⊗
			2 N.O. & 2 N.C.	20 A	440T-MMRXE11✶⊗
			4 N.O.	32 A	440T-MMRXE12✶⊗
			4 N.O.	63 A	440T-MMRXE13✶⊗
	Triple key exchange isolator	1 key in/ 2 key out	4 N.O.	20 A	440T-MMRXE20✶⊗⊗
			2 N.O. & 2 N.C.	20 A	440T-MMRXE21✶⊗⊗
			4 N.O.	32 A	440T-MMRXE22✶⊗⊗
			4 N.O.	63 A	440T-MMRXE23✶⊗⊗
	Quad key exchange isolator	1 key in/ 3 key out	4 N.O.	20 A	440T-MMRXE30✶⊗⊗⊗
			2 N.O. & 2 N.C.	20 A	440T-MMRXE31✶⊗⊗⊗
			4 N.O.	32 A	440T-MMRXE32✶⊗⊗⊗
			4 N.O.	63 A	440T-MMRXE33✶⊗⊗⊗

✶ Substitute the desired primary code for this symbol (key not included). See page 3-107.
⊗ Substitute the desired secondary code for this symbol (key included). See page 3-107.

Accessories

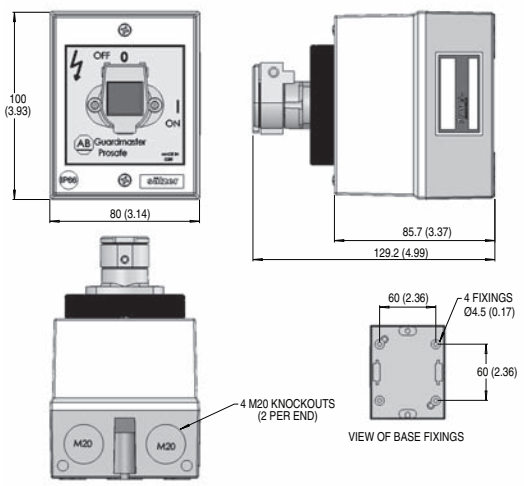
Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10∗
Stainless steel replacement code barrel for products other than 100 A RPS/RKS units with dust cap		440T-ASCBE14∗
Stainless steel replacement code barrel for 100 A unit rotary switch		440T-ASCBE11∗
Stainless steel weatherproof replacement dust cap		440T-ASFC10∗
Cable grip, M20 conduit, accommodates cable diameter 7…10.5 mm (0.27…0.41 in.)	3-53	440A-A09028
Adaptor, conduit, M20 to 1/2 inch NPT, plastic		440A-A09042
Supplemental Contact Block, 20 A, 1 N.O. Late Make, Early Break 1 N.C. Auxiliary	For use with RPSE12, RPSE20 (maximum 1 per switch)	440T-AACA10
Supplemental Contact Block, 20 A, 2 N.O. Late Make, Early Break	For use with RPSE12, RPSE20 (maximum 1 per switch)	440T-AACA11
Supplemental Contact Block, 20 A, 1 N.O., 1 N.C.	For use with RPSE13 & 14	440T-AACA20
Supplemental Contact Block, 20 A, 2 N.O.	For use with RPSE13 & 14	440T-AACA21
ABS plastic enclosure	For use with dual key, and dual key exchange, isolators	440T-AIPB10
Stainless steel enclosure (240x180x150 mm)	For use with >20 A RPSE units (not including RPSE21 or 22)	440T-AIPB25
Stainless steel enclosure (150x150x80 mm)	For use with RPSE10 & 11	440T-AIPB26
ABS plastic enclosure	For use with triple/quad key, and triple/quad key exchange, isolators	440T-AIPB50
Stainless steel enclosure	For use with triple/quad key, and triple/quad key exchange, isolators	440T-AIPB55

∗ Substitute the desired primary code for this symbol (key not included). See page 3-107.

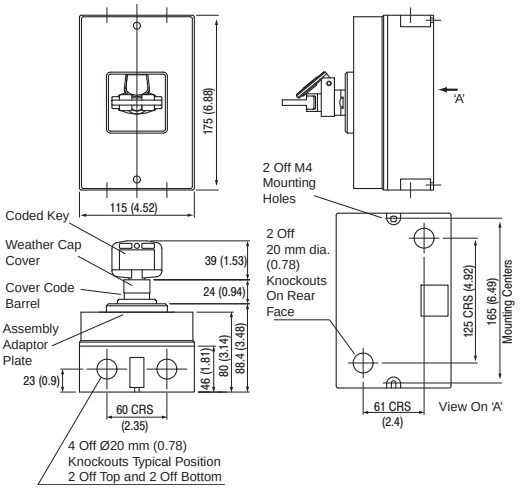
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

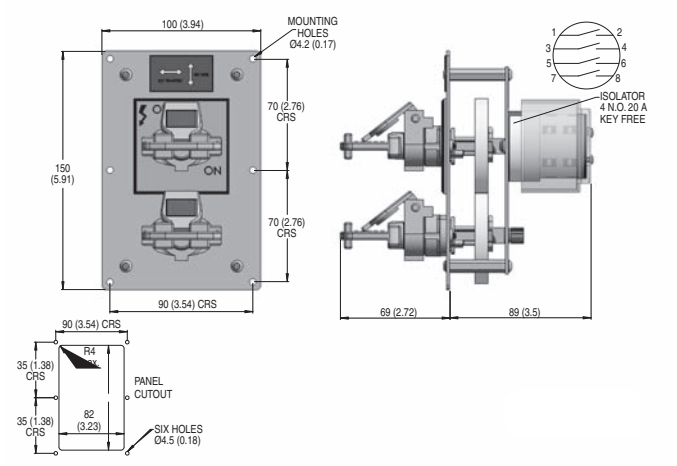
MRKSE10 and MRKSE11



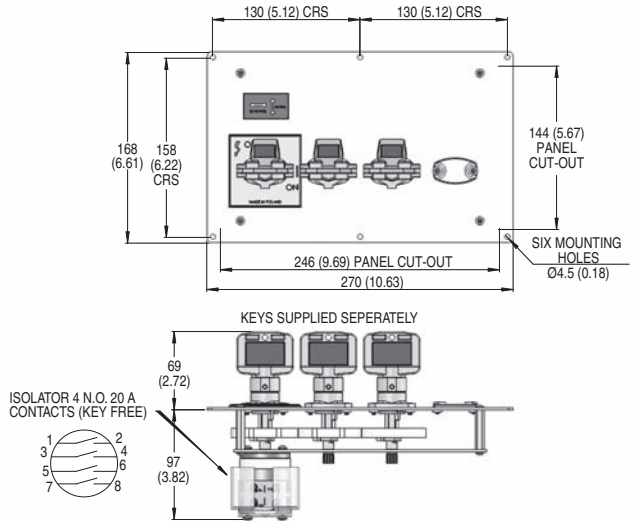
MRKSE12 and MRKSE13



MMRSE10



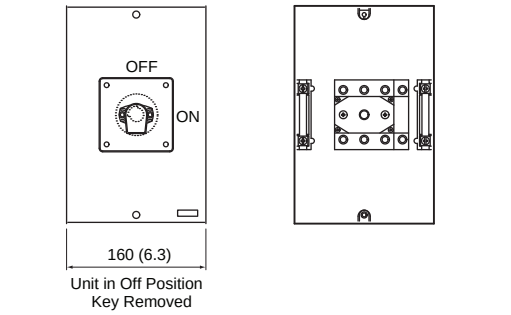
MMRSE20

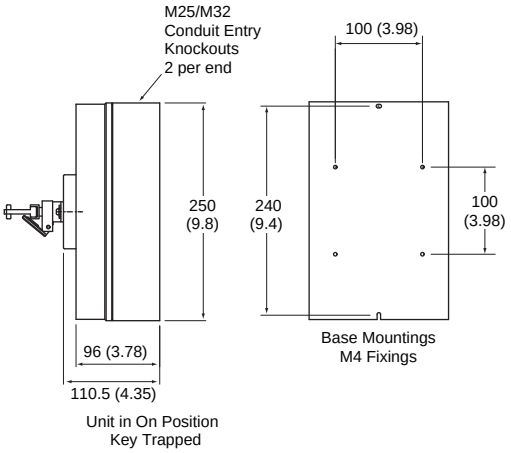


Approximate Dimensions [mm (in.)] (continued)

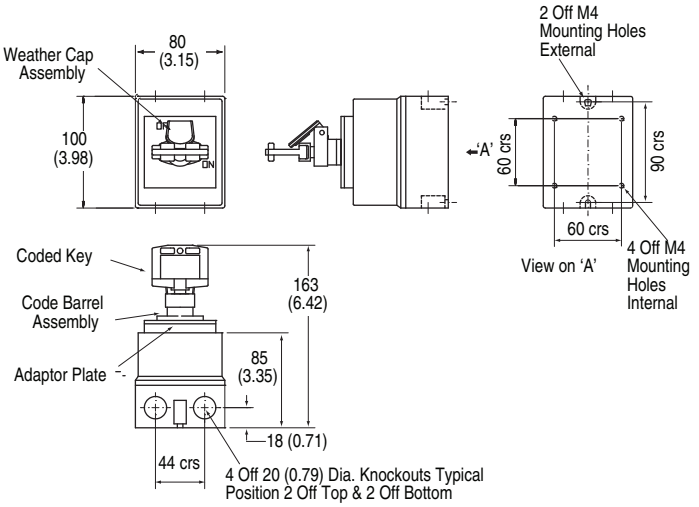
Dimensions are not intended to be used for installation purposes.

MRKSE14

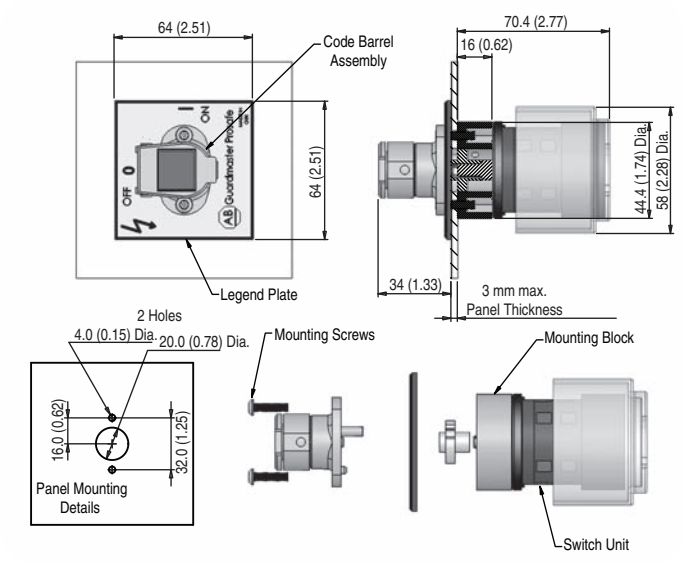




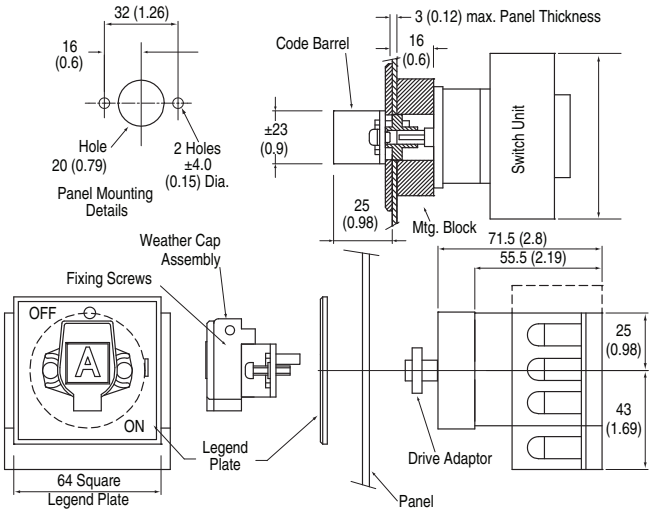
MRKSE16



MRPSE10 and 11

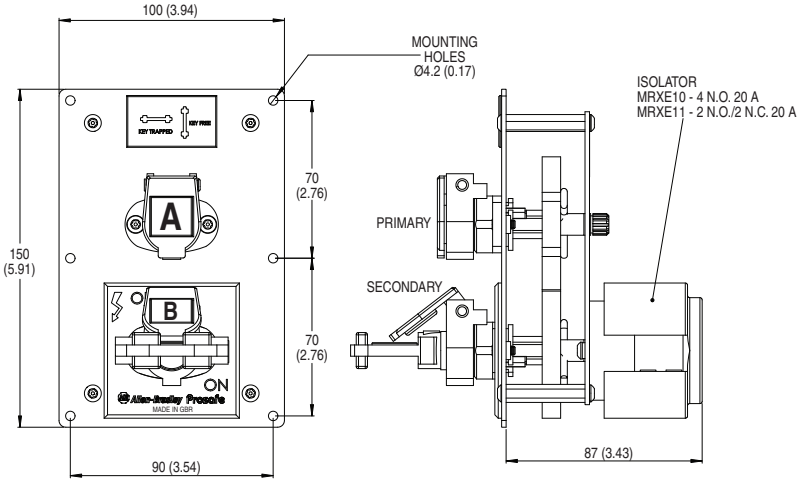


MRPSE 12, 13, 14 and 20

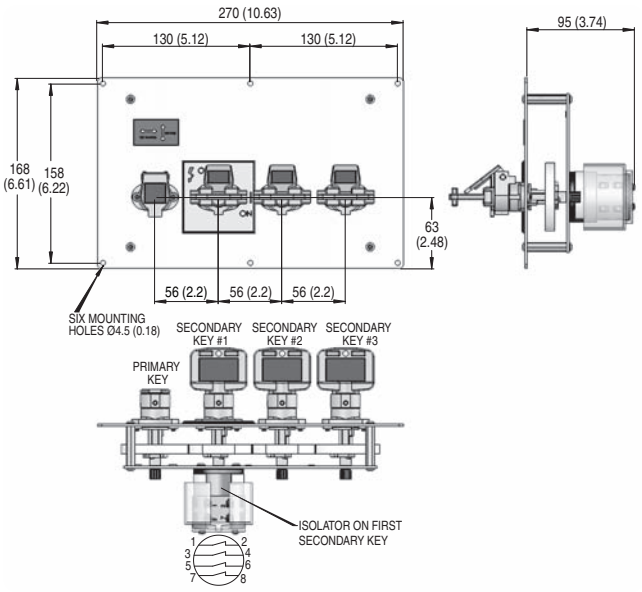


Approximate Dimensions [mm (in.)] (continued)

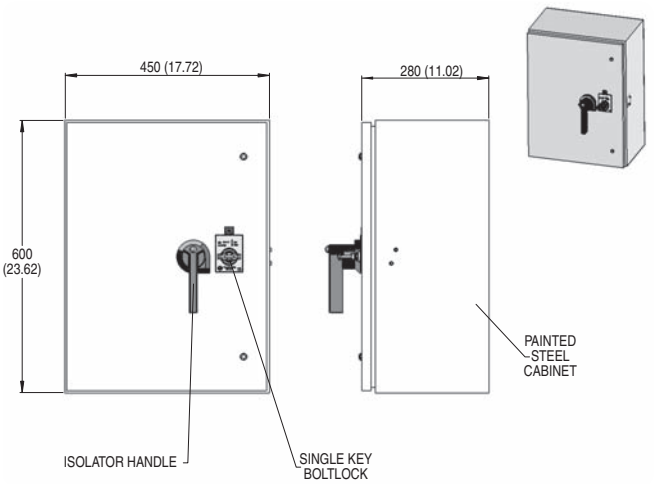
MMRXE10 and MMRXE11



MMRXE30

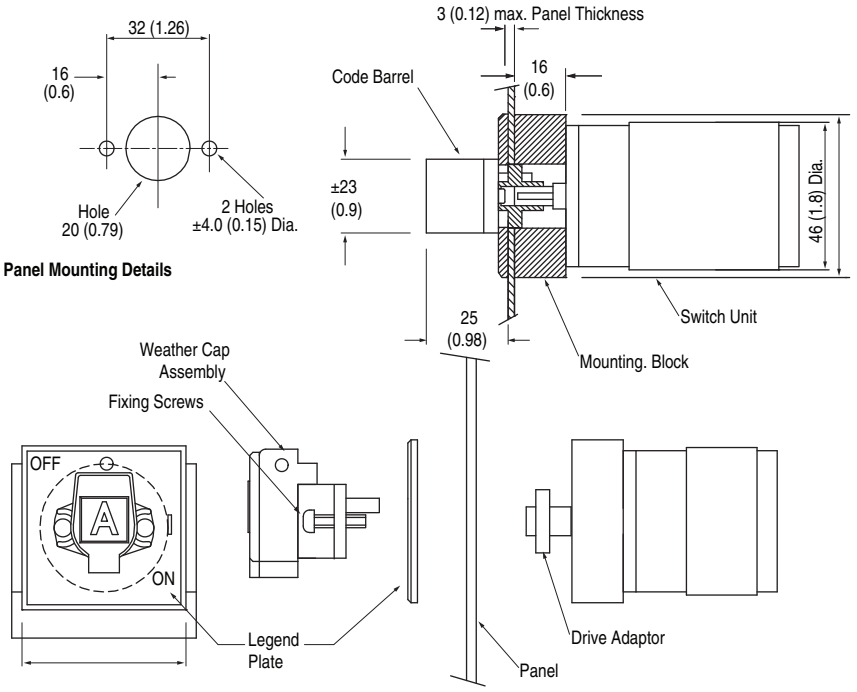


MRKSE22



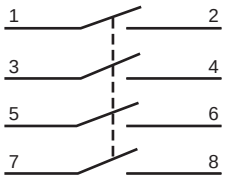
Approximate Dimensions [mm (in.)] (continued)

MRPSE16

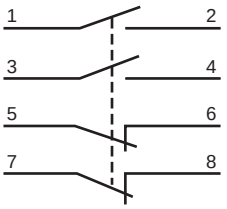


Typical Wiring

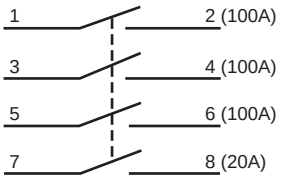
Diagrams Shown with Key Free



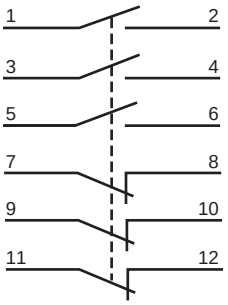
MRKSE10 and MRPSE10
MRKSE12 and MRPSE12
MRKSE13 and MRPSE13
---------- and MRPSE20
MMRSE10 and MMRXE10
MMRSE12 and MMRXE12
MMRSE13 and MMRXE13
MMRSE20 and MMRXE20
MMRSE22 and MMRXE22
MMRSE23 and MMRXE23
MMRSE30 and MMRXE30
MMRSE32 and MMRXE32
MMRSE33 and MMRXE33



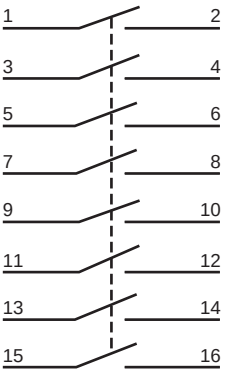
MRKSE11 and MRPSE11
MMRSE11 and MMRXE11
MMRSE21 and MMRXE21
MMRSE31 and MMRXE31



MRKSE14 and MRPSE14



MRKSE18 and MRPSE18



MRKSE16 and MRPSE16

Solenoid Release Units



Description

The solenoid release unit is used for electrical isolation of machinery to improve safe access. It consists of a rotary power switch and a solenoid. The trapped key can be removed once an external signal is given to its internal solenoid locking mechanism. An indicator light on the solenoid release unit indicates when the trapped key can be removed; that is, when power is applied to the solenoid. The solenoid signal only needs to be present when key removal is necessary. The solenoid is rated for 100% duty cycle. Power to the solenoid can be removed after the trapped key is removed.

Rotating the trapped key causes the isolating power switch to change state; the normally open contacts open and the normally closed contacts (if applicable) will close.

The trapped key can then be used in the next sequence of the operation.

Features

- Direct drive operation—positively opens contacts
- Integral solenoid monitoring
- Key trapped until release signal is applied
- LED or NEON "key free" indication
- 316L stainless steel construction
- 24V DC, 110V AC or 230V AC solenoid options
- Weatherproof stainless steel dust cap as standard
- UL and CSA Approval on switches
- Single or multiple key units available (contact factory)
- Replaceable code barrel assembly

Specifications

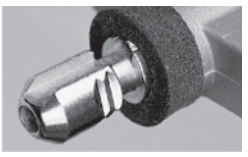
Safety Ratings

Standards	EN1954-1, IEC/EN60204-1,EN1088, IEC/EN60947-5-1, ISO13849-1, ISO12100-1&2, ISO14119, GS-ET-19, AS4024.1
Certifications	CE Marked for all applicable directives and BG
Operating Characteristics	
Solenoid Voltage	24V DC, 110V AC, 230V AC
Solenoid Power	DC Types: 6.5 W continuous AC Types: 6V A continuous
Electrical Life	100,000 operations
Mechanical Life	100,000 operations
Utilization Category	
Electrical Characteristics	See rotary power switches.
Environmental & Physical Characteristics	
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Material	Trapped Key Components: 316L stainless steel Steel Face Plate: 316L stainless steel Optional Box: ABS plastic
Operating Temperature [C (F)]	0…40 ° (32…104 °)
Relative Humidity	95%

The Prosafe Advantage







Stainless steel construction.

Product Selection

Type	Solenoid Voltage	Contacts	Current, Nom	Cat. No.
Single key out	24V DC	2 N.O. & 2 N.C.	20 A	440T-MSRUE11✶
		4 N.O.		440T-MSRUE10✶
			32 A	440T-MSRUE12✶
		3 N.O. & 3 N.C.	20 A	440T-MSRUE13✶
	110V AC	2 N.O. & 2 N.C.	20 A	440T-MSRUE22✶
		4 N.O.		440T-MSRUE20✶
			32 A	440T-MSRUE23✶
		3 N.O. & 3 N.C.	20 A	440T-MSRUE14✶
		4 N.O.	63 A	440T-MSRUE24✶
	230V AC	2 N.O. & 2 N.C.	20 A	440T-MSRUE33✶
		4 N.O.		440T-MSRUE30✶
			32 A	440T-MSRUE34✶
			63 A	440T-MSRUE35✶
	110V DC	2 N.O. & 2 N.C.	20 A	440T-MSRUE44✶
		4 N.O.		440T-MSRUE40✶
		3 N.O. & 3 N.C.		440T-MSRUE46✶
Dual key out	24V DC	4 N.O.	20 A	440T-MS2097D✶✶
		2 N.O. & 2 N.C.		440T-MS2097A✶✶
		4 N.O.	32 A	440T-MS2097G✶✶
			63 A	440T-MS2097J✶✶
Triple key out	24V DC	4 N.O.	20 A	440T-MS3417D✶✶✶
		2 N.O. & 2 N.C.		440T-MS3417A✶✶✶
		4 N.O.	32 A	440T-MS3417G✶✶✶
			63 A	440T-MS3417J✶✶✶
Quad key out	24V DC	4 N.O.	20 A	440T-MS3418D✶✶✶✶
		2 N.O. & 2 N.C.		440T-MS3418A✶✶✶✶
		4 N.O.	32 A	440T-MS3418G✶✶✶✶
			63 A	440T-MS3418J✶✶✶✶

✶ Substitute the desired primary code for this symbol (key not included). See 3-107.

Accessories

Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10✶
Stainless steel replacement code barrel with dust cap		440T-ASCBE14✶
Stainless steel weatherproof replacement dust cap		440T-ASFC10✶
Optional plastic enclosure	For use with single key out 20 A units	440T-AIPB10
	For use with single key out 32 A units	440T-AIPB22
Optional ABS plastic enclosure	For use with triple/quad key out units	440T-AIPB50
Optional stainless steel enclosure	For use with triple/quad key out units	440T-AIPB55

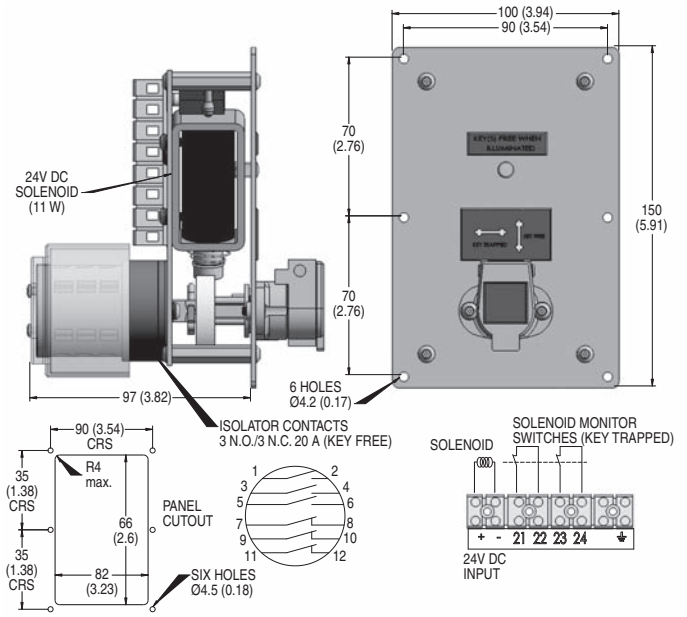
✶ Substitute the desired primary code for this symbol (key not included). See 3-107.

Solenoid Release Units

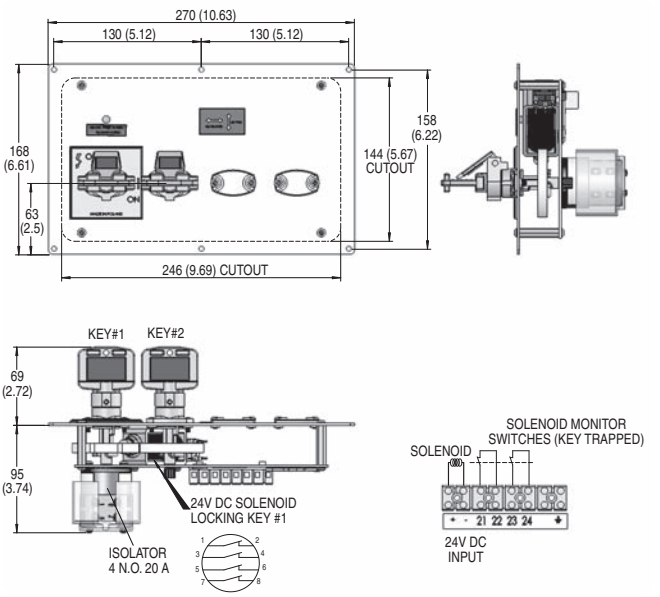
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

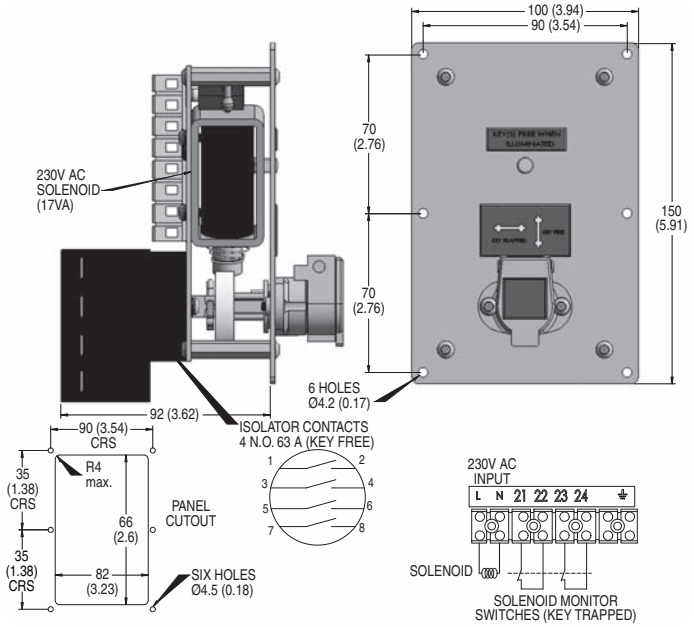
MSRUE13



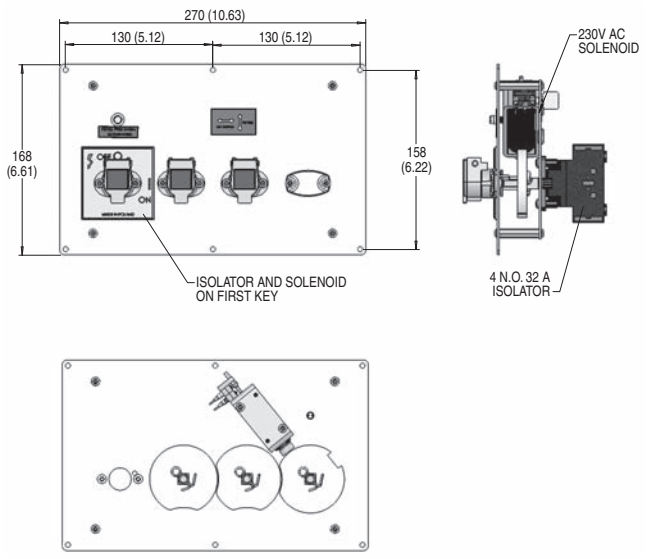
MS2097



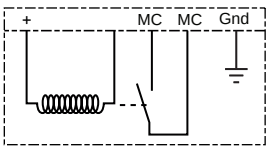
MSRUE35



MS3417



Typical Wiring



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Description

The Electronic Timed-delay Unit (ETU) is used in applications that require an elapsed time to occur before allowing access to a hazardous area. The ETU uses an CU1 control unit timer to execute the timing sequence. Turning a nonremovable key initiates the timer. When the CU1 times out, its output energizes an internal solenoid, which then allows the removal of either one or two trapped keys.

The Single-key Timed delay Unit (STU) has one trapped key. After the CU1 preset time has expired, the single trapped key can be removed and used to continue the next sequence in allowing access to the hazard. The single key must be returned to the STU and trapped to allow the nonremovable key to re-initiate the hazard.

The Dual-key Timed delay Unit (DTU) has two trapped keys. After the CU1 preset time has expired, both keys can be removed and used to continue the next sequences in allowing access to the hazard. Both keys must be returned to the DTU and trapped to allow the nonremovable key re-initiate the hazard.

Features

- Timed-delay output up to 40 minutes
- Single key or dual key
- 316L stainless steel keys
- Category 1 Stop
- Replaceable code barrel assembly

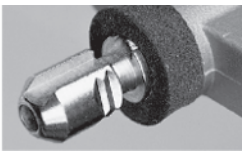
Specifications

Safety Ratings	
Standards	IEC/EN60204-1,EN1088, IEC/EN60947-5-1, ISO13849-1, ISO12100-1&2, ISO14119, GS-ET-19, AS4024.1
Category	Cat. 1 per EN 954-1 (ISO 13849-1)
Certifications	CE Marked for all applicable directives and BG
Operating Characteristics	
Electrical Life	100,000 operations
Mechanical Life	100,000 operations
Solenoid Voltage	24V DC, 110V AC, and 230V AC
Time Delay	0.1 s…30 min
Environmental & Physical Characteristics	
Operating Temperature [C (F)]	0…40 ° (32…104 °)
Relative Humidity	95%
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Material	Trapped key components: 316L stainless steel Face plate: 316L stainless steel Optional box: ABS plastic or stainless steel

The Prosafe Advantage







Stainless steel construction.

Electronic Timed-Delay Units

Product Selection

Type	Solenoid Voltage	Contact Set 1	Contact Set 2	Cat. No.
Single key out Panel mounted	24V DC	3 N.O. 40 A	1 N.O. 20 A	440T-MSTUE10✶
		2 N.O. 20 A	1 N.C. 20 A	440T-MSTUE11✶
	110V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MSTUE20✶
		2 N.O. 20 A	1 N.C. 20 A	440T-MSTUE22✶
	230V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MSTUE30✶
		2 N.O. 20 A	1 N.C. 20 A	440T-MSTUE33✶
Dual key out Panel mounted	24V DC	3 N.O. 40 A	1 N.O. 20 A	440T-MDTUE10✶✶
		2 N.O. 20 A	1 N.C. 20 A	440T-MDTUE11✶✶
	110V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MDTUE20✶✶
		2 N.O. 20 A	1 N.C. 20 A	440T-MDTUE22✶✶
	230V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MDTUE30✶✶
		2 N.O. 20 A	1 N.C. 20 A	440T-MDTUE33✶✶

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

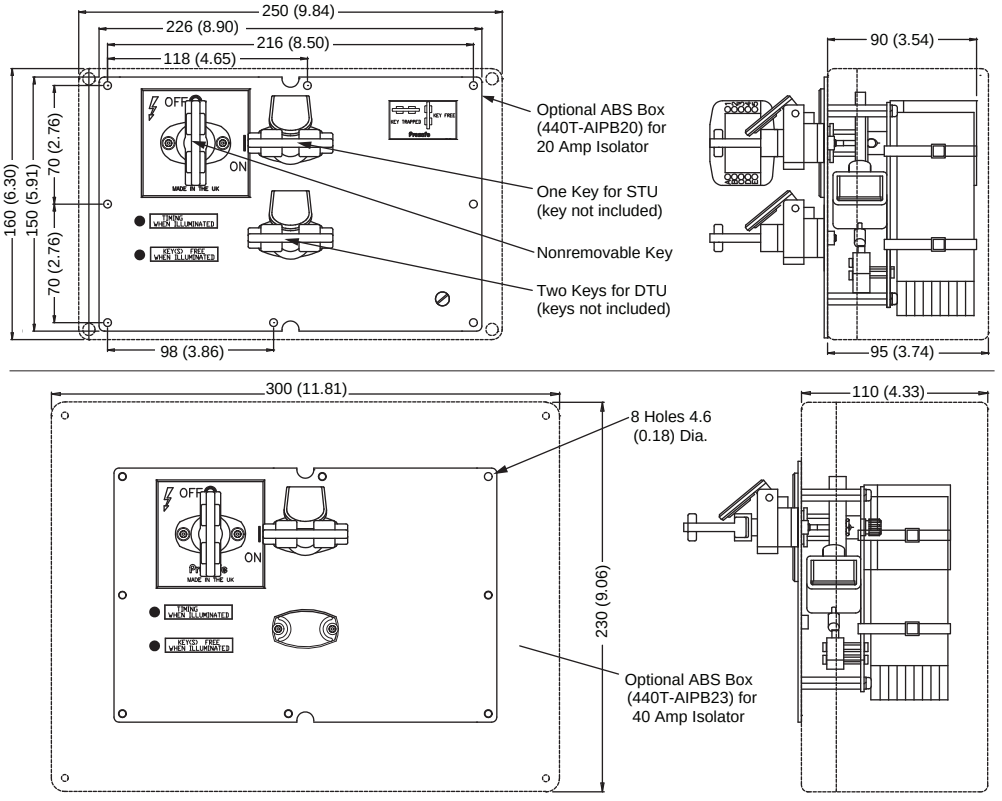
Accessories

Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10✶
Stainless steel replacement code barrel with dust cap		440T-ASCBE14✶
Stainless steel weatherproof replacement dust cap		440T-ASFC10✶
Optional plastic enclosure	For use with 20 A units	440T-AIPB20
	For use with 40 A units	440T-AIPB23
Optional stainless steel enclosure	For use with all units	440T-AIPB46

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



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Description

The Stopped Motion Unit (SMU) is used in applications that require the detection of stopped motion of mechanical parts of a machine. The SMU uses inductive proximity sensors to detect motion and the CU2 control unit to monitor the sensors.

The CU2 requires a PNP and an NPN output type proximity sensors. When the proximity sensors stop detecting movement, the CU2 activates its output, powering an internal solenoid. With the solenoid energized, one or two trapped keys can be removed from the SMU.

The removable trapped keys (one or two) can be used to continue the next sequence in allowing access to the hazardous area.

See the CU2 control unit for details on setting the delay time.

Additional proximity sensors can be found in the Sensors catalog.

Features

- Stopped motion detection
- NPN and PNP proximity sensors
- Timed-delay output up to 40 minutes
- Category 1 Stop
- Replaceable code barrel assembly

Specifications

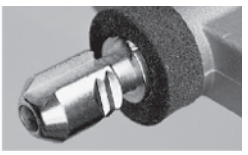
Safety Ratings

Standards	EN1954-1, IEC/EN60204-1, EN1088, IEC/EN60947-5-1, ISO13849-1, ISO12100-1&2, ISO14119, GS-ET-19, AS4024.1
Category	Cat. 3 per EN 954-1 (ISO 13849-1)
Certifications	CE Marked for all applicable directives and BG
Operating Characteristics	
Electrical Life	100,000 operations
Mechanical Life	100,000 operations
Solenoid Voltage	24V DC, 110V AC, and 230V AC
Time Delay	0.1 s…40 min
Zero Speed Sensors	2x inductive sensors
Environmental & Physical Characteristics	
Operating Temperature [C (F)]	0…40° (32…104°)
Relative Humidity	95%
Shear Force to Key	15.1 k•N (3398 lbs)
Torque to Key	14 N•m (124 lb•in)
Material	Trapped key components: 316L stainless steel Face plate: 316L stainless steel Optional box: ABS plastic or stainless steel Inductive sensors: stainless steel barrel, plastic face
Mounting	Tamper resistant screws
Weight	2.0 kg (4.4 lbs)

The Prosafe Advantage







Stainless steel construction.

Stopped Motion Units

Product Selection

Type	Solenoid Voltage	Contact Set 1	Contact Set 2	Cat. No.
Single key out Panel mounted	24V DC	3 N.O. 40 A	1 N.O. 20 A	440T-MSMSE10∗
		2 N.O. 20 A	1 N.C. 20 A	440T-MSMSE11∗
	110V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MSMSE20∗
		2 N.O. 20 A	1 N.C. 20 A	440T-MSMSE22∗
	230V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MSMSE30∗
		2 N.O. 20 A	1 N.C. 20 A	440T-MSMSE33∗
Dual key out Panel mounted	24V DC	3 N.O. 40 A	1 N.O. 20 A	440T-MDMSE10∗∗
		2 N.O. 20 A	1 N.C. 20 A	440T-MDMSE11∗∗
	110V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MDMSE20∗∗
		2 N.O. 20 A	1 N.C. 20 A	440T-MDMSE22∗∗
	230V AC	3 N.O. 40 A	1 N.O. 20 A	440T-MDMSE30∗∗
		2 N.O. 20 A	1 N.C. 20 A	440T-MDMSE33∗∗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

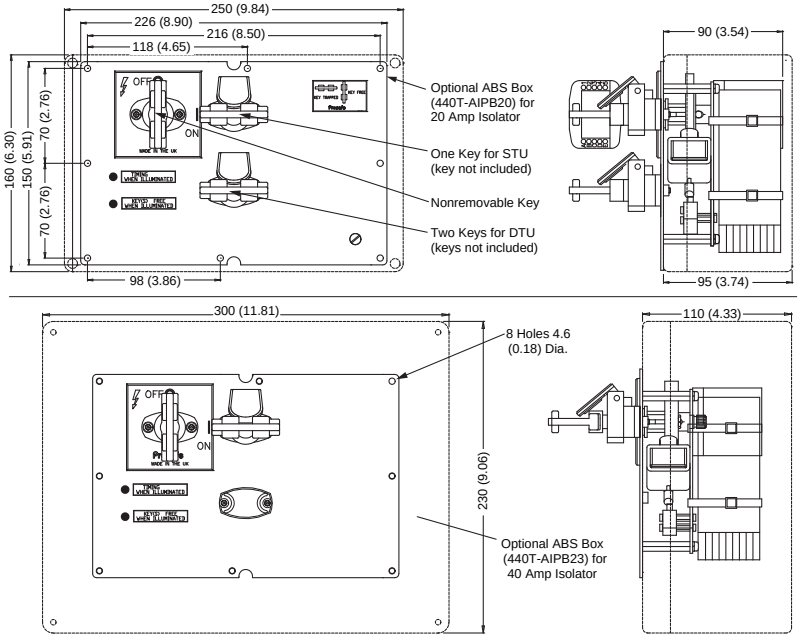
Accessories

Description	Size [mm]	Type	Additional Information	Cat. No.
Stainless steel key	—	—	3-140	440T-AKEYE10∗
Stainless steel replacement code barrel with dust cap				440T-ASCBE14∗
Stainless steel weatherproof replacement dust cap				440T-ASFC10∗
500 mA fuse—Bussmann Cat. No. ETF-500 mA		500 mA @ 250V	NA	440R-A31562
Optional plastic enclosure		—	For use with 20 A units	440T-AIPB20
			For use with 40 A units	440T-AIPB23
Optional stainless steel enclosure			For use with all units	440T-AIPB46
Inductive Proximity Sensor, Three-wire, DC	12	NPN	page 5-57	872C-D3NN12-E2
		PNP		872C-D3NP12-E2
	18	NPN		872C-D5NN18-E2
		PNP		872C-D5NP18-E2
	30	NPN		872C-D10NN30-E2
		PNP		**872C-D10NP30-E2**

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

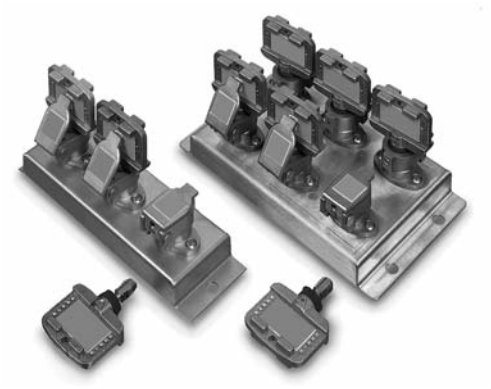
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



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Description

The key exchange unit (KEX) is used in an interlocking sequence to link together other devices in the Prosafe range and caters to more complex operating sequences.

The operating principle is such that no secondary keys can be removed from the unit until all primary keys have been inserted, rotated, and trapped. The primary keys remain trapped until all secondary keys have been re-inserted, rotated, and trapped.

It is typically used in applications where there is more than one access way to the hazardous area, and each access way must be open at the same time. The key exchange unit accomplishes this by allowing one or more keys to be inserted which then releases multiple keys out.

A typical process may require a rotary key switch to turn a motor off. The key from the rotary switch is removed and inserted into a KEX. The KEX then releases three keys which would allow simultaneous access to the hazard area through three different gates. This KEX is described as 1 key in 3 keys out. The keys in are considered primary codes, so the keys are not included in the KEX. The keys out are considered secondary codes, so the keys are included.

Features

- A range of off-the-shelf units in various combinations
- 316L stainless steel construction
- Primary key(s) in release secondary keys simultaneously on units up to six ways
- Weatherproof stainless steel dust cap as standard
- Replaceable code barrel assembly

Specifications

Safety Ratings

Standards	EN1088, ISO12100-1&2, ISO14119, AS4024.1
Category	Cat. 3 per EN 954-1 (ISO 13849-1) cULus and TÜV
Certifications	CE Marked for all applicable directives and BG; C-Tick not required
Operating Characteristics	
Operating Temperature [C (F)]	-40…+200 ° (-40…+392 °)
Mechanical Life	100,000 operations
Environmental & Physical Characteristics	
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Relative Humidity	95%
Material	316L stainless steel

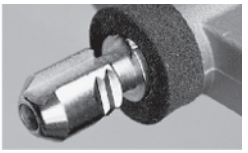
Optional Key Exchange Cabinets

Number of Keys	Length [mm (in.)]	Width [mm (in.)]	Depth [mm (in.)]	Cat. No.
Painted Mild Steel				
7…11 way (max)	400 (15.7)	300 (11.8)	200 (7.87)	440T-AIPB30
12…15 way (max)	400 (15.7)	400 (15.7)	210 (8.26)	440T-AIPB33
16…25 way (max)	600 (23.6)	600 (23.6)	210 (8.26)	440T-AIPB34
Stainless Steel				
12…15 way (max)	400 (15.7)	400 (15.7)	210 (8.26)	440T-AIPB40
16…25 way (max)	600 (23.6)	600 (23.6)	210 (8.26)	440T-AIPB44

The Prosafe Advantage







Stainless steel construction.

Exchange Units

Product Selection

Key Exchange Units		
Number of Keys	Keys In and Out	Cat. No.
2 way	1 key in 1 key out	440T-MKEXE10‡
3 way	1 key in 2 keys out	440T-MKEXE11‡
4 way	1 key in 3 keys out	440T-MKEXE12‡
5 way	1 key in 4 keys out	440T-MKEXE13‡
6 way	1 key in 5 keys out	440T-MKEXE14‡
4 way	2 key in 2 keys out	440T-MKEXE15‡
5 way	2 key in 3 keys out	440T-MKEXE16‡
6 way	2 key in 4 keys out	440T-MKEXE17‡
6 way	3 key in 3 keys out	440T-MKEXE18‡
7 way	1 key in 6 keys out	440T-MKEXE19‡
8 way	1 key in 7 keys out	440T-MKEXE20‡
9 way	1 key in 8 keys out	440T-MKEXE22‡
10 way	1 key in 9 keys out	440T-MKEXE23‡
11 way	1 key in 10 keys out	440T-MKEXE24‡
12 way	1 key in 11 keys out	440T-MKEXE25‡
13 way	1 key in 12 keys out	440T-MKEXE26‡
14 way	1 key in 13 keys out	440T-MKEXE27‡
15 way	1 key in 14 keys out	440T-MKEXE28‡
16 way	1 key in 15 keys out	440T-MKEXE29‡
17 way	1 key in 16 keys out	440T-MKEXE30‡
18 way	1 key in 17 keys out	440T-MKEXE33‡
19 way	1 key in 18 keys out	440T-MKEXE34‡
20 way	1 key in 19 keys out	440T-MKEXE35‡
21 way	1 key in 20 keys out	440T-MKEXE36‡
22 way	1 key in 21 keys out	440T-MKEXE37‡
23 way	1 key in 22 keys out	440T-MKEXE38‡
24 way	1 key in 23 keys out	440T-MKEXE39‡
25 way	1 key in 24 keys out	440T-MKEXE40‡

‡ Specify the codes individually for each primary key in (key not included) and for each secondary key (key included). See 3-107 for code selection.
Consult factory for other configurations of keys in and keys out.

Accessories

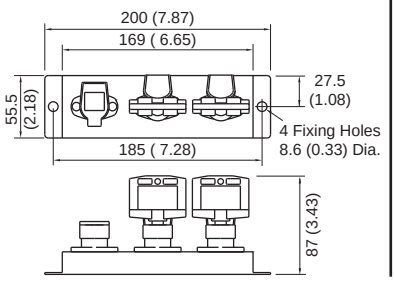
Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10✶
Stainless steel replacement code barrel with dust cap		440T-ASCBE14✶
Stainless steel weatherproof replacement dust cap		440T-ASFC10✶
Optional Key Exchange Cabinet	Mild steel cabinet for 7-…11-way units	440T-AIPB30
	Mild steel cabinet for 12-…15-way units	440T-AIPB33
	Mild steel cabinet for 16-…25-way units	440T-AIPB34
	Stainless steel cabinet for 12-…15-way units	440T-AIPB40
	Stainless steel cabinet for 16-…25-way units	440T-AIPB44

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

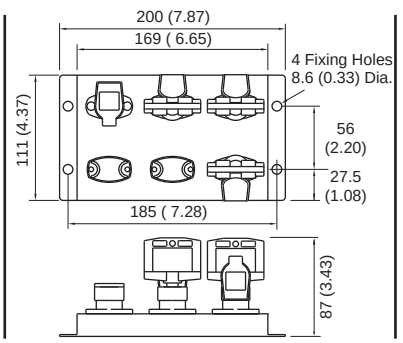
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

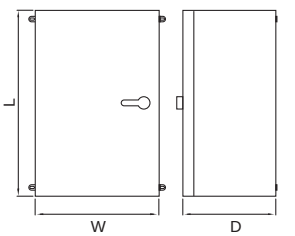
(2) 3 Way Key Exchange Unit



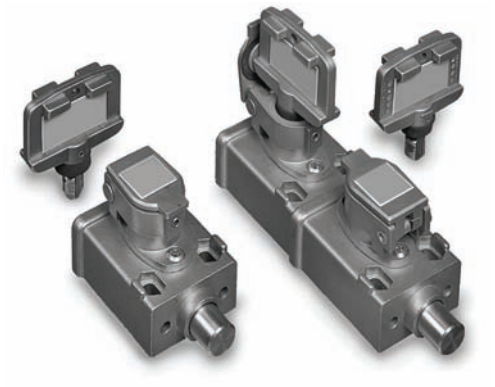
(4, 5 or) 6 Way Key Exchange Unit



Key Exchange Cabinets
(painted mild steel or stainless steel)



Allen-Bradley
GuardMaster®



Description

The bolt interlocks are designed to allow access to hazardous areas when an appropriate key is inserted into the interlock. These bolt interlocks are manufactured in 316L stainless steel to provide a rugged, industrial grade method of helping prevent access through gates.

One advantage of the bolt interlocks is that there is no need to run power wires to the gate. Power is disconnected by a trapped key rotary switch on a control panel and the key is then hand-carried to the gate by the operator.

The Single Bolt interlock (SBL) is designed to be used to access hazardous areas where partial body exposure is required. The SBL is not shipped with a key. If two keys are needed for partial body access, select the Dual Bolt interlock (DBL) that requires both keys to be trapped to operate. This version of the DBL does not include the keys.

When whole body access is needed, the DBL, with one primary key and one secondary trapped key (included) should be used. The secondary key serves the function of a personnel key. This DBL allows the operator to carry the personnel key into the hazardous area. When the operator returns from the hazardous area and returns the personnel key to the DBL, the locking sequence can be reversed and the process re-started.

Features

- 316L stainless steel construction
- Various extensions of bolt
- Direct drive push/pull operation
- Replaceable code barrel assembly
- Fitted with tamper resistant screws
- Weatherproof stainless steel dust cap as standard
- Solenoid and electric versions
- Multiple key options

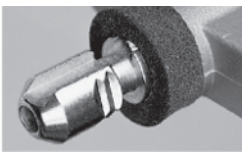
Specifications

Safety Ratings	
Standards	EN1088, ISO12100-1&2, ISO14119, AS4024.1
Category	Cat. 1 per EN 954-1 (ISO 13849-1) Suitable for Cat. 2, 3, or 4 systems
Certifications	CE Marked for all applicable directives and BG; C-Tick not required
Operating Characteristics	
Operating Temperature [C (F)]	Mechanical: -40…+200 ° (-40…+392°) Electrical: -20…+80 ° (-4…+176 °) Solenoid: -20…+60 ° (-4…+140°)
Mechanical Life	100,000 operations
Environmental & Physical Characteristics	
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Relative Humidity	95%
Weight [kg (lbs)]	SBL: 0.60 (1.32) DBL: 1.10 (2.43)
Material	316L stainless steel
Mounting	SBL: 2 x M5 counterbored from top or 2 x M5 from underside with M5 nuts DBL: 4 x M5 counterbored from top or 4 x M5 from underside with M5 nuts
Bolt Diameter	15 mm (0.59 in.)

The Prosafe Advantage







Stainless steel construction.

Bolt Interlocks

Product Selection - Mechanical

Type	Trapped Key Condition	Bolt Retracted [mm (in.)]	Bolt Extended [mm (in.)]	Cat. No.
Single key	Key trapped to retract bolt	0	14 (0.55)	440T-MSBLE10∗
		3 (0.11)	17 (0.66)	440T-MSBLE11∗
		6 (0.23)	20 (0.78)	440T-MSBLE12∗
		13 (0.51)	27 (1.06)	440T-MSBLE13∗
Dual key	Both keys trapped to retract bolt	0	14 (0.55)	440T-MDBLE10∗∗
		3 (0.11)	17 (0.66)	440T-MDBLE11∗∗
		6 (0.23)	20 (0.78)	440T-MDBLE12∗∗
		13 (0.51)	27 (1.06)	440T-MDBLE13∗∗
	Primary key trapped, secondary key free to retract bolt	0	14 (0.55)	440T-MDBLE14∗⊗
		3 (0.11)	17 (0.66)	440T-MDBLE15∗⊗
		6 (0.23)	20 (0.78)	440T-MDBLE16∗⊗
		13 (0.51)	27 (1.06)	440T-MDBLE17∗⊗
Dual Key with Secondary Ejector Key		0	14 (0.55)	440T-MDBLJ14∗⊗
		3 (0.11)	17 (0.66)	440T-MDBLJ15∗⊗
		6 (0.23)	20 (0.78)	440T-MDBLJ16∗⊗
		13 (0.51)	20 (0.78)	440T-MDBLJ17∗⊗
Triple key	Three keys trapped to retract bolt	0	14 (0.55)	440T-MTBLE10∗∗∗
		3 (0.11)	17 (0.66)	440T-MDBLE11∗∗∗
		6 (0.23)	20 (0.78)	440T-MTBLE12∗∗∗
		13 (0.51)	27 (1.06)	440T-MTBLE13∗∗∗
	Two primary trapped, one secondary key free to retract bolt	0	14 (0.55)	440T-MTBLE14∗∗⊗
		3 (0.11)	17 (0.66)	440T-MTBLE15∗∗⊗
		6 (0.23)	20 (0.78)	440T-MTBLE16∗∗⊗
		13 (0.51)	27 (1.06)	440T-MTBLE17∗∗⊗
	One primary trapped, two secondary keys free to retract bolt	0	14 (0.55)	440T-MTBLE18∗⊗⊗
		3 (0.11)	17 (0.66)	440T-MTBLE19∗⊗⊗
		6 (0.23)	20 (0.78)	440T-MTBLE20∗⊗⊗
		13 (0.51)	27 (1.06)	440T-MTBLE21∗⊗⊗
Quad key	Four keys trapped to retract bolt	0	14 (0.55)	440T-MQBLE10∗∗∗∗
		3 (0.11)	17 (0.66)	440T-MQBLE11∗∗∗∗
		6 (0.23)	20 (0.78)	440T-MQBLE12∗∗∗∗
		13 (0.51)	27 (1.06)	440T-MQBLE13∗∗∗∗
	Three primary trapped, one secondary key free to retract bolt	0	14 (0.55)	440T-MQBLE14∗∗∗⊗
		3 (0.11)	17 (0.66)	440T-MQBLE15∗∗∗⊗
		6 (0.23)	20 (0.78)	440T-MQBLE16∗∗∗⊗
		13 (0.51)	27 (1.06)	440T-MQBLE17∗∗∗⊗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

Product Selection - Electrical

Contact Type	Type	Trapped Key Condition	Bolt Retracted [mm (in.)]	Bolt Extended [mm (in.)]	Cat. No.
2 N.C. & 1 N.O. break before make	Single key	Free key to retract bolt	0	14 (0.55)	440T-MSBSE10∗
			3 (0.11)	17 (0.66)	440T-MSBSE11∗
			6 (0.23)	20 (0.78)	440T-MSBSE12∗
			13 (0.51)	27 (1.06)	440T-MSBSE13∗
		Key trapped to retract bolt	0	14 (0.55)	440T-MSBSE33∗
			3 (0.11)	17 (0.66)	440T-MSBSE34∗
			6 (0.23)	20 (0.78)	440T-MSBSE35∗
			13 (0.51)	27 (1.06)	440T-MSBSE36∗
	Dual key	Both keys trapped to retract bolt	0	14 (0.55)	440T-MDBSE10∗∗
			3 (0.11)	17 (0.66)	440T-MDBSE11∗∗
			6 (0.23)	20 (0.78)	440T-MDBSE12∗∗
			13 (0.51)	27 (1.06)	440T-MDBSE13∗∗
		Primary key trapped, secondary key free to retract bolt	0	14 (0.55)	440T-MDBSE14∗⊗
			3 (0.11)	17 (0.66)	440T-MDBSE15∗⊗
			6 (0.23)	20 (0.78)	440T-MDBSE16∗⊗
			13 (0.51)	27 (1.06)	440T-MDBSE17∗⊗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

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Product Selection - Solenoid

Solenoid Voltage	Contact Type	Type	Trapped Key Condition	Bolt Retracted [mm (in.)]	Bolt Extended [mm (in.)]	Cat. No.
24V DC	2 N.C. & 1 N.O. break before make	Single key	Free key to retract bolt	0	14 (0.55)	440T-MSBUE10∗
				3 (0.11)	17 (0.66)	440T-MSBUE11∗
				6 (0.23)	20 (0.78)	440T-MSBUE12∗
				13 (0.51)	27 (1.06)	440T-MSBUE13∗
			Key trapped to retract bolt	0	14 (0.55)	440T-MSBUE33∗
				3 (0.11)	17 (0.66)	440T-MSBUE34∗
				6 (0.23)	20 (0.78)	440T-MSBUE35∗
				13 (0.51)	27 (1.06)	440T-MSBUE36∗
		Dual key	Both keys trapped to retract bolt	0	14 (0.55)	440T-MDBUE10∗∗
				3 (0.11)	17 (0.66)	440T-MDBUE11∗∗
				6 (0.23)	20 (0.78)	440T-MDBUE12∗∗
				13 (0.51)	27 (1.06)	440T-MDBUE13∗∗
			Primary key trapped, secondary key free to retract bolt	0	14 (0.55)	440T-MDBUE14∗⊗
				3 (0.11)	17 (0.66)	440T-MDBUE15∗⊗
				6 (0.23)	20 (0.78)	440T-MDBUE16∗⊗
				13 (0.51)	27 (1.06)	440T-MDBUE17∗⊗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

Accessories

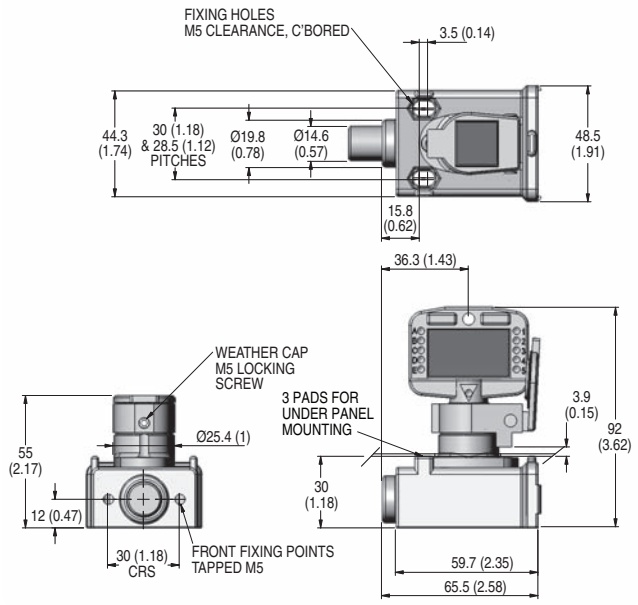
Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10∗
Stainless steel replacement code barrel with dust cap		440T-ASCBE14∗
Stainless steel weatherproof replacement dust cap		440T-ASFC10∗
Stainless steel ejector key		440T-AKEYE13∗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

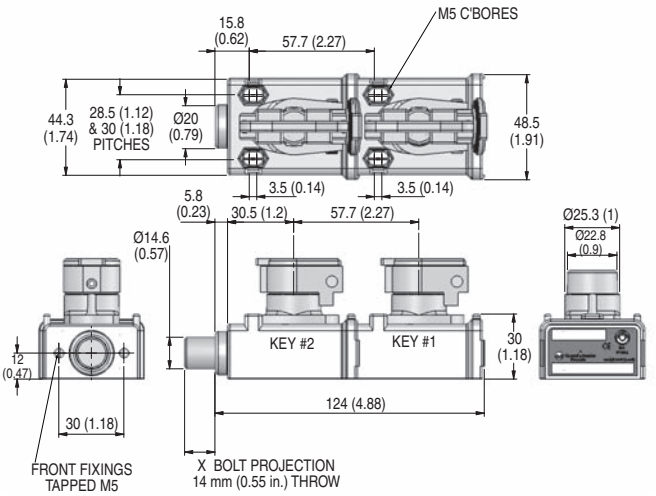
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

MSBLE10, 11, 12, and 13



MDBLE10, 11, 12, and 13

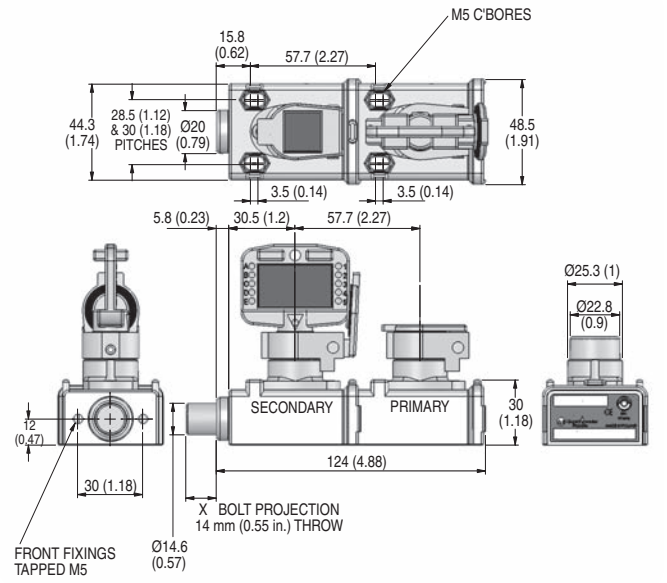


Type	X [mm (in.)]
440T-MDBLE10	0 (0)
440T-MDBLE11	3 (0.12)
440T-MDBLE12	6 (0.24)
440T-MDBLE13	13 (0.51)

Approximate Dimensions [mm (in.)] (continued)

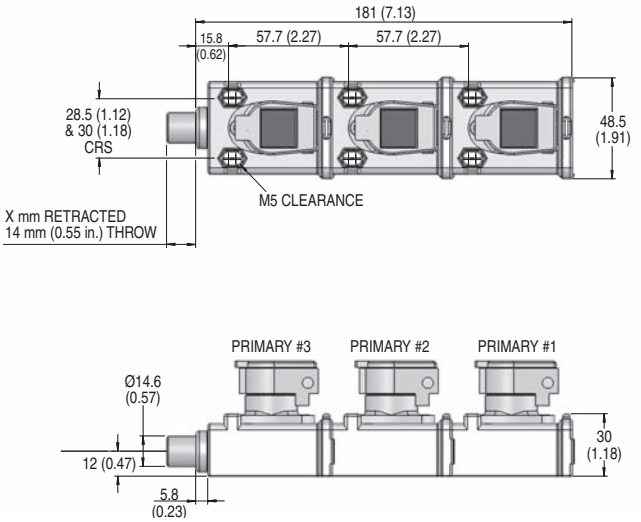
Dimensions are not intended to be used for installation purposes.

MDBLE14, 15, 16, and 17



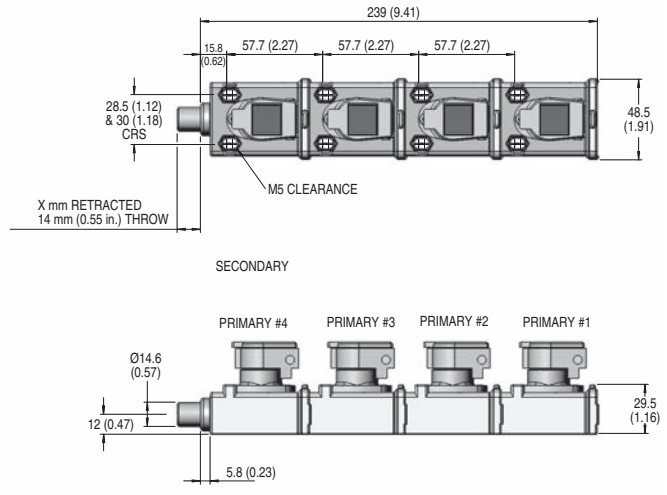
Type	X [mm (in.)]
440T-MDBLE14	0 (0)
440T-MDBLE15	3 (0.12)
440T-MDBLE16	6 (0.24)
440T-MDBLE17	13 (0.51)

MTBLE10, 11, 12, and 13



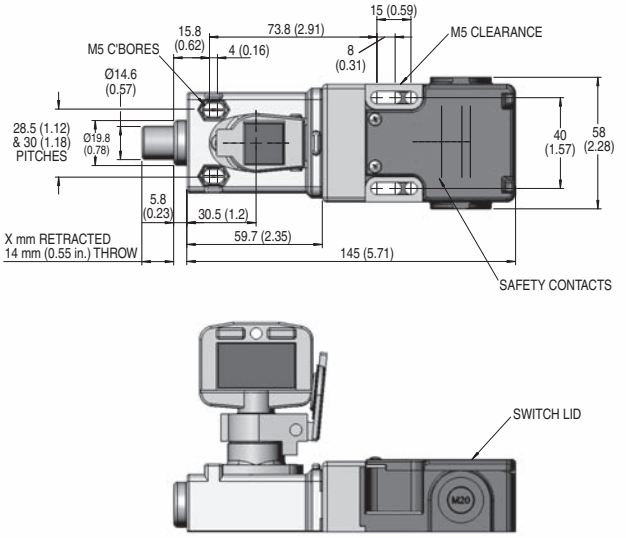
Type	X [mm (in.)]
440T-MTBLE10	0 (0)
440T-MTBLE11	3 (0.12)
440T-MTBLE12	6 (0.24)
440T-MTBLE13	13 (0.51)

MQBLE10, 11, 12, and 13



Type	X [mm (in.)]
440T-MQBLE10	0 (0)
440T-MQBLE11	3 (0.12)
440T-MQBLE12	6 (0.24)
440T-MQBLE13	13 (0.51)

MSBSE10, 11, 12, and 13

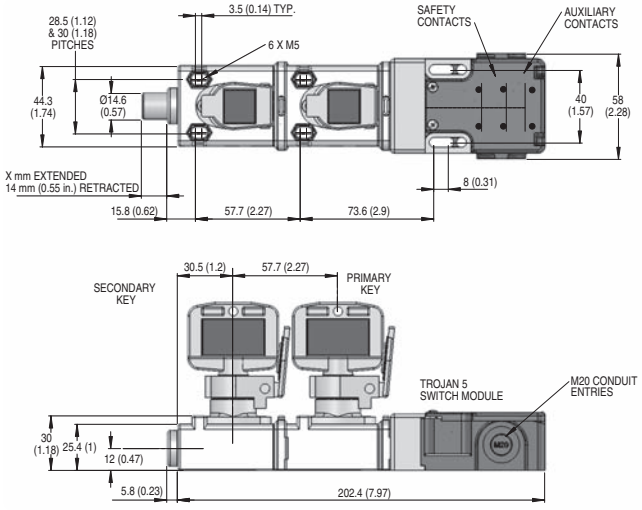


Type	X [mm (in.)]
440T-MSBSE10	0 (0)
440T-MSBSE11	3 (0.12)
440T-MSBSE12	6 (0.24)
440T-MSBSE13	13 (0.51)

Approximate Dimensions [mm (in.)] (continued)

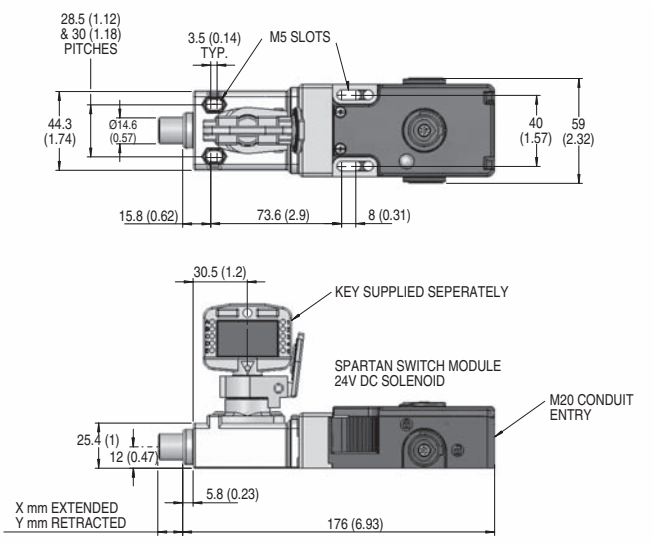
Dimensions are not intended to be used for installation purposes.

MDBSE10, 11, 12, and 13



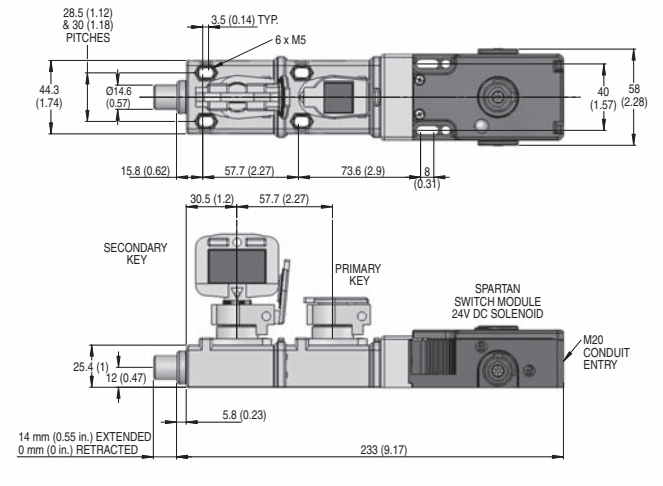
Type	X [mm (in.)]
440T-MDBSE10	0 (0)
440T-MDBSE11	3 (0.12)
440T-MDBSE12	6 (0.24)
440T-MDBSE13	13 (0.51)

MSBUE33, 34, 35, and 36

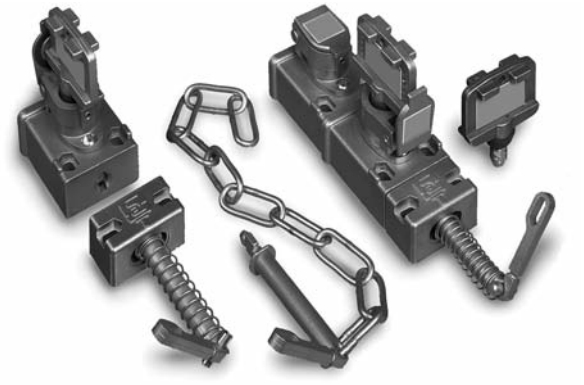


Type	X [mm (in.)]	Y [mm (in.)]
440T-MSBUE33	14 (0.55)	0 (0)
440T-MSBUE34	17 (0.67)	3 (0.12)
440T-MSBUE35	20 (0.79)	6 (0.24)
440T-MSBUE36	27 (1.06)	13 (0.51)

MDBUE14, 15, 16, and 17



Access/Chain Interlocks



Description

The access interlocks are designed to allow access to hazardous areas when an appropriate key is inserted into the interlock. These access interlocks are manufactured in 316L stainless steel to provide rugged, industrial grade method of helping prevent access through gates. They are actuated by either a lever or a rod which is connected to chain.

One advantage of the access interlocks is that there is no need to run power wires to the gate. Power is disconnected by a trapped key rotary switch on a control panel and the key is then hand-carried to the gate by the operator.

The Single-key Access Lock (SAL) and Single-key Chain Lock (SCL) are designed to be used to access hazardous areas where partial body exposure is required. If two keys are needed for partial body access, select the Dual-key Access Lock (DAL) or Dual-key Chain Lock (DCL) with both keys trapped.

When whole body access is needed, the DAL or DCL, with one key trapped and one key free should be used. The secondary key serves the function of a personnel key. The DAL and DCL allow the operator to carry the personnel key into the hazardous area. When the operator returns from the hazardous area and returns the personnel key to the DAL or DCL, the locking sequence can be reversed and the process restarted.

Features

- 316L stainless steel construction
- Direct drive operation
- Fitted with tamper resistant screws
- Stainless steel dust cap as standard
- Replaceable code barrel assembly
- Solenoid and electric versions
- Multiple key options

Specifications

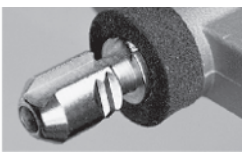
Safety Ratings

Standards	EN1088, ISO12100-1&2, ISO14119, AS4024.1
Category	Cat. 1 per EN 954-1 (ISO 13849-1) Suitable for Cat. 2, 3, or 4 systems
Certifications	CE Marked for all applicable directives and BG; C-Tick not required
Operating Characteristics	
Operating Temperature [C (F)]	Mechanical: -40…+200 ° (-40…+392 °) Electrical: -20…+80 ° (-4…+176 °) Solenoid: -20…+60 ° (-4…+140°)
Relative Humidity	95%
Mechanical Life	100,000 operations
Physical Characteristics	
Misalignment Tolerance	±10 mm (0.39 in.)
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Material	316L stainless steel
Mounting	SAL and SCL: 2 or 4 x M5 counterbored from top or 2 or 4 x M5 from underside with nuts DAL and DCL: 4 or 6 x M5 counterbored from top or 4 or 6 x M5 from underside with nuts
Weight [kg (lbs)]	SAL and SCL: 0.8 (1.8) DAL and DCL: 1.35 (3)

The Prosafe Advantage







Stainless steel construction.

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Publication S117-CA001A-EN-P

Product Selection - Mechanical

Type	Actuator Type	Trapped Key Condition	Cat. No.
Single key	Lever	Key trapped to release lever	440T-MSALE10∗
	Chain	Key trapped to release chain	440T-MSCLE10∗
	Extended Lever	Key trapped to release lever	440T-MSALE20∗
Single key with padlock hasp	Lever	Key trapped to release lever	440T-MSALE11∗
	Chain	Key trapped to release chain	440T-MSCLE11∗
Dual key	Lever	Primary key trapped, secondary key free to release lever	440T-MDALE10∗⊗
		Both keys trapped to release lever	440T-MDALE11∗∗
	Chain	Primary key trapped, secondary key free to release chain	440T-MDCLE10∗⊗
		Both keys trapped to release chain	440T-MDCLE11∗∗
Dual key with padlock hasp	Lever	Primary key trapped, secondary key free to release lever	440T-MDALE45∗⊗
Dual key with eject key	Lever	Primary key trapped, secondary spring eject key	440T-MDALJ10∗⊗
	Chain		440T-MDCLJ10∗⊗
Triple key	Lever	One primary trapped, two secondary keys free to release lever	440T-MTALE11∗⊗⊗
	Chain	One primary trapped, two secondary keys free to release chain	440T-MTCLE11∗⊗⊗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

Product Selection - Electrical

Contact Type	Type	Actuator Type	Trapped Key Condition	Cat. No.
2 N.C. & 1 N.O. break before make	Dual Key	Lever	Both keys trapped to release lever	440T-MDASE21∗∗
			Primary key trapped, secondary key free to release lever	440T-MDASE20∗⊗
		Chain	Both keys trapped to release chain	440T-MDCSE21∗∗
			Primary key trapped, secondary key free to release chain	440T-MDCSE20∗⊗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

Accessories

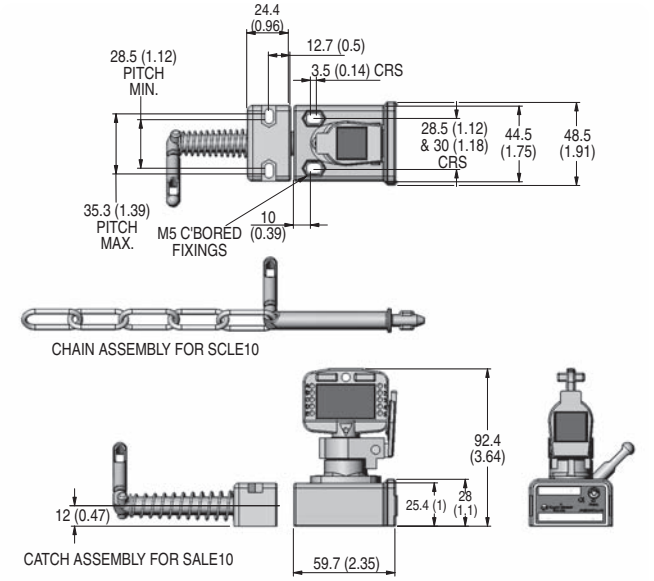
Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10∗
Stainless steel replacement code barrel with dust cap		440T-ASCBE14∗
Stainless steel weatherproof replacement dust cap		440T-ASFC10∗
Replacement actuator type lever	—	440T-ACAD10
Replacement actuator type chain	—	440T-ACHA10
Stainless steel ejector key	—	440T-AKEYE13∗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

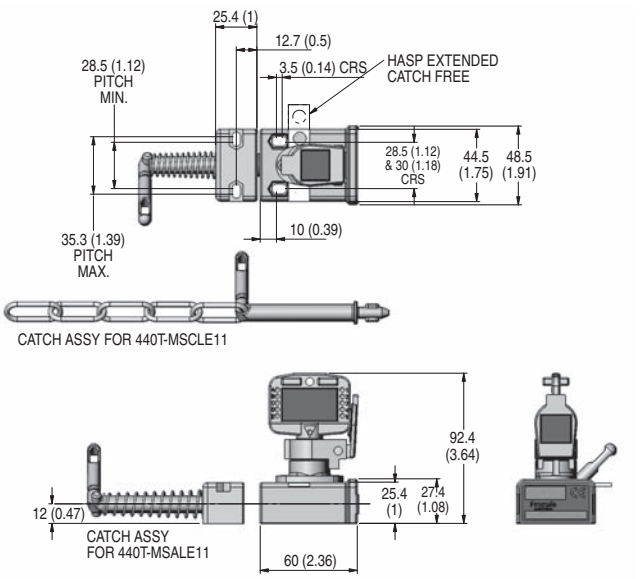
Approximate Dimensions [mm (in.)]

Dimensions not intended to be used for installation purposes.

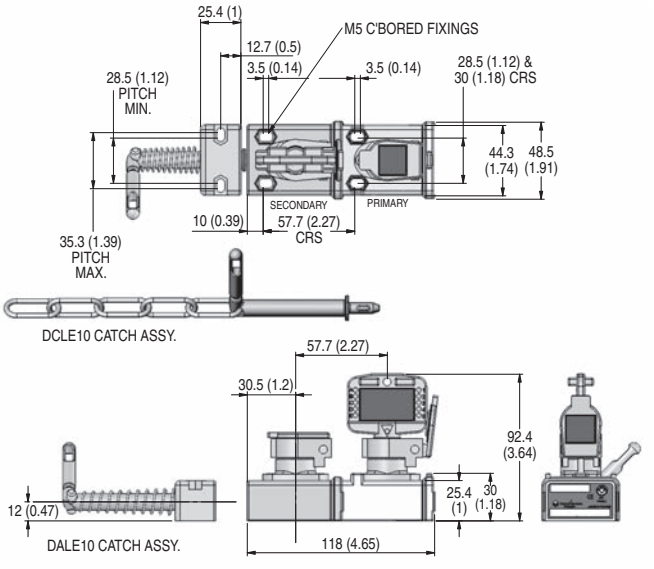
MSALE10



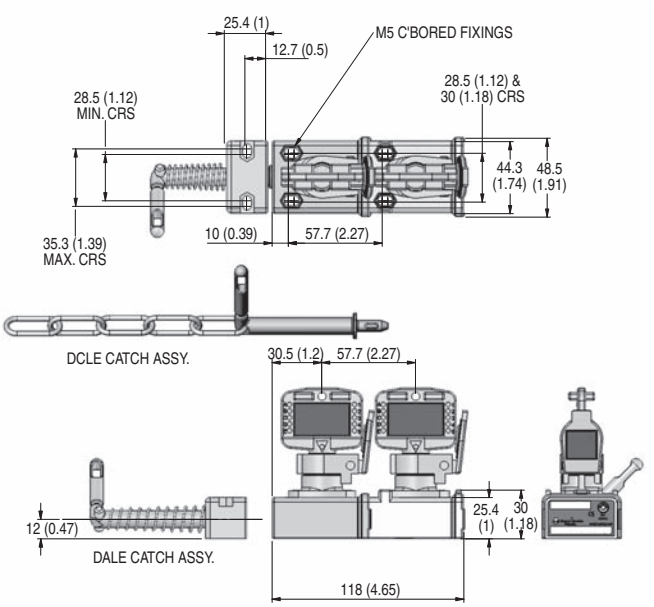
MSALE11



MDALE10 and MDCLE10



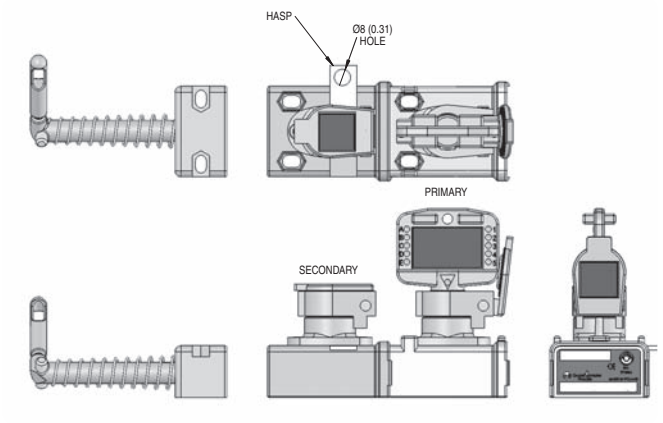
MDALE11



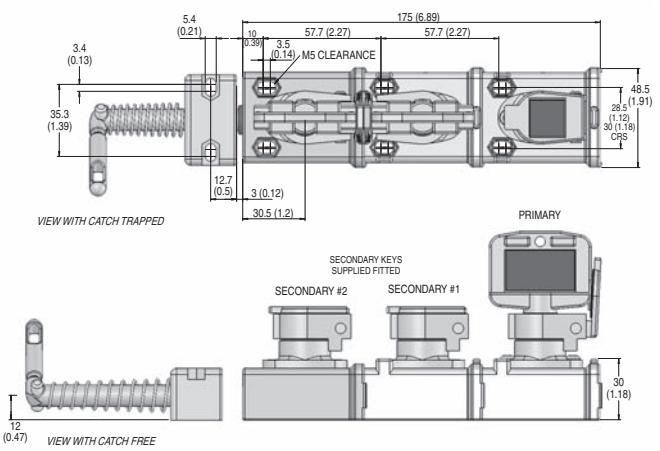
Approximate Dimensions [mm (in.)] (continued)

Dimensions not intended to be used for installation purposes.

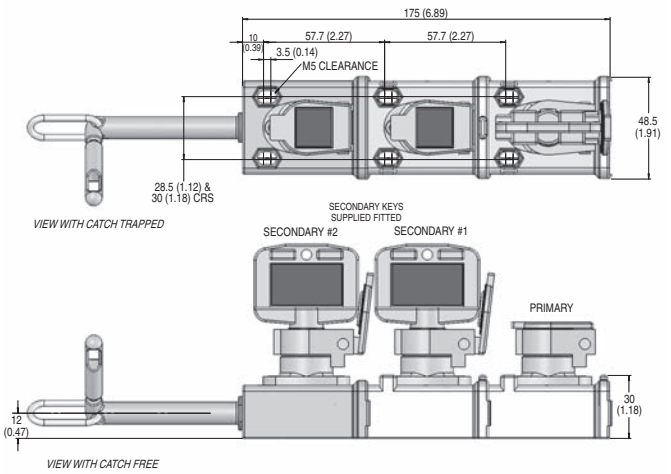
MDALE45



MTALE11



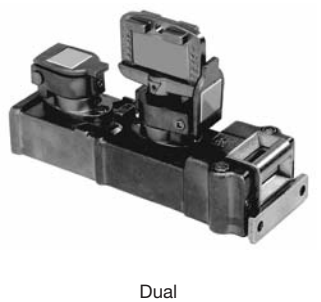
MTCLE11



Slamlock Mechanical



Single



Dual

Description

The Prosafe Slamlock combines the features of trapped keys with tongue actuated interlocks. When the actuator is inserted into the interlock (guard closed), the trapped key can be rotated and removed. With the key free, the actuator can not be removed thus locking closed the guard door. The trapped key must be re-inserted and rotated 90° to unlock the guard.

Slamlocks are manufactured in 316L stainless steel to provide a rugged, industrial grade method of interlocking guard doors.

One advantage of the slamlock is that there is no need to run power wires to the gate. Power is disconnected by a trapped key on a control panel or by a Prosafe RKS type unit and the key is then hand-carried to the gate by the operator.

The Single-key Slamlock (SSL) is used to interlock hatches, guards and doors where full body access is not required.

Dual-key Slamlock (DSL) is similar to the single key version but has a secondary key to allow "two key in" or "key exchange" conditions. The key exchange version may be used where whole body access is required, as the secondary key can be used as a personnel key.

Features

- 316L stainless steel construction
- Selection of actuator types available
- Direct drive operation
- Replaceable code barrel assembly
- Fitted with tamper resistant screws
- Weatherproof stainless steel dust cap as standard
- Multiple key options

Specifications

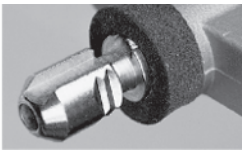
Safety Ratings

Standards	EN1088, IEC/EN60947-5-1, GS-ET-19, ISO12100-1&2, ISO14119, AS4024.1
Category	Cat. 1 per EN 954-1 (ISO 13849-1) Suitable for Cat. 2, 3, or 4 systems
Certifications	CE Marked for all applicable directives and BG; C-Tick not required
Operating Characteristics	
Operating Temperature [C (F)]	-40…+200 ° (-40…+392 °)
Mechanical Life	In excess of 100,000 operations under normal working conditions
Code Barrel Life	Tested to 100,000 operations
Environmental & Physical Characteristics	
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Relative Humidity	95%
Weight [kg (lbs)]	Single Key: 0.76 (1.68) Dual Key: 1.33 (2.93)
Ambient Temperature [C (F)]	-10…+50 ° (14…122 °)
Material	316L stainless steel
Mounting	SSL: 2 x M5 counterbored from top or 2 x M5 from underside with nuts DSS: 4 x M5 counterbored from top or 4 x M5 from underside with nuts
Holding Force, Max.	2000 N (450 lbs)

The Prosafe Advantage







Stainless steel construction.

Product Selection

Type	Actuator Type	Trapped Key Condition	Cat. No.
Single key	Standard	Key trapped to release actuator	440T-MSSLE10∗
	Flexible		440T-MSSLE11∗
	Flat		440T-MSSLE12∗
Dual key	Standard	Primary key trapped, secondary key free to release actuator	440T-MDSLE10∗⊗
	Flexible		440T-MDSLE11∗⊗
	Flat		440T-MDSLE12∗⊗
	Standard	Both keys trapped to release actuator	440T-MDSLE20∗∗
	Flexible		440T-MDSLE22∗∗
	Flat		440T-MDSLE23∗∗
Dual with secondary ejector key	Standard	Primary key trapped, secondary key free to release actuator	440T-MDSLJ10∗⊗
	Flexible		440T-MDSLJ11∗⊗
	Flat		440T-MDSLJ12∗⊗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

Accessories

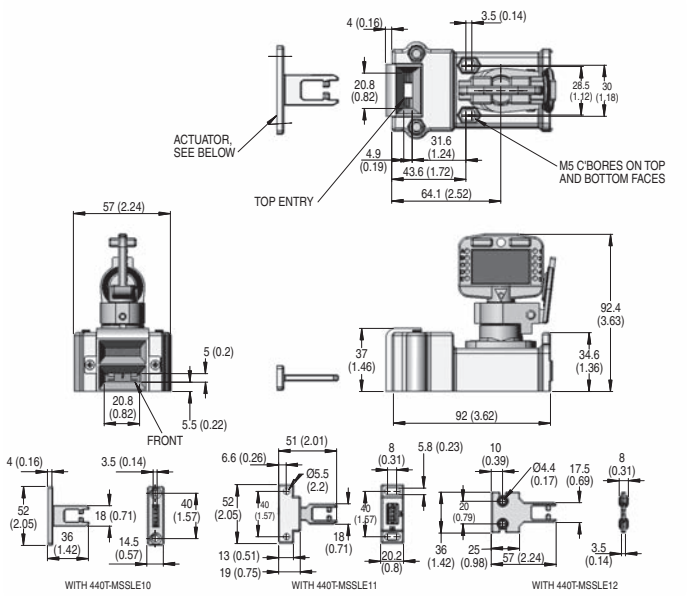
Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10⊗
Stainless steel ejector key		440T-AKEYE13⊗
Stainless steel replacement code barrel with dust cap		440T-ASCBE14∗
Stainless steel weatherproof replacement dust cap		440T-ASFC10⊗
GD2 standard actuator	—	**440G-A27011**
GD2 flat actuator	—	**440K-A11112**
Fully flex actuator	—	**440G-A27143**

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired code for this symbol. See 3-107 for code selection.

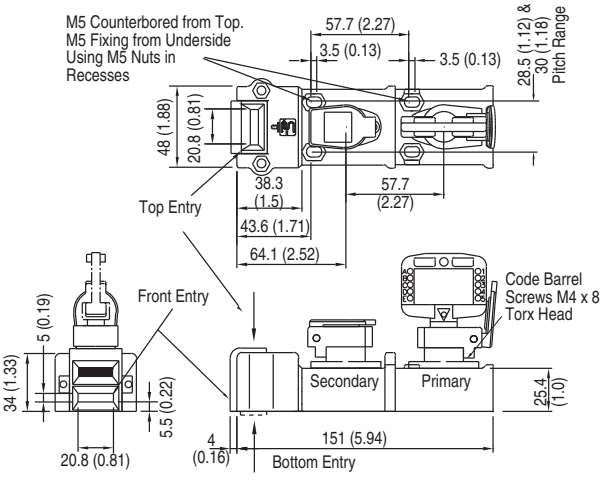
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

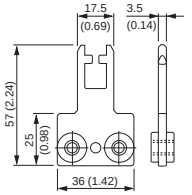
Single Key Slamlock



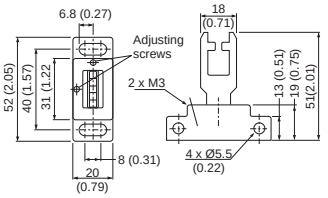
Dual Key Slamlock



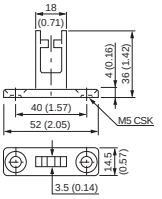
Flat Actuator



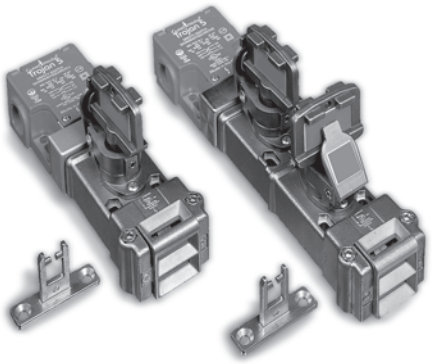
Flexible/Adjustable Actuator



Standard Actuator



Slamlock Electrical



Single Dual

Description

The Prosafe Slamlock with electrical isolation combines the features of trapped key tongue actuated interlocks while also providing sets of electrical safety and auxiliary contacts. When the actuator is inserted into the lock and the key is removed the actuator is trapped in the unit thus locking closed the guard door. In this state the safety contacts are closed and the auxiliary contacts are open. To open the guard door the key must be inserted and rotated 90°, opening the safety contacts, closing the auxiliary contacts and enabling the actuator to be released thus unlocking the guard door. While the guard door is open the key is trapped in the unit.

Slamlocks with electrical isolation offer the features of electrical safety interlock switches with the benefits of a trapped key/enforced sequence systems. They allow a combination of both approaches for safeguarding machinery and processes to be used.

The Single-key Slamlock (SSS) is used to interlock hatches, guards and doors where full body access is not required. The single key locks the actuator and operates the switch in the same action.

Dual-key Slamlock (DSS) is similar to the single key version but has a secondary key to allow "two key in" or "key exchange" conditions. The key exchange version may be used where whole body access is required, as the secondary key can be used as a personnel key.

Features

- Electrical safety contacts combined with trapped key/enforced sequence feature
- Most of unit constructed from 316L stainless steel
- Selection of actuator types available
- Single or dual key versions available
- Direct drive operation
- Replaceable code barrel assembly
- Weatherproof stainless steel dust cap as standard
- Solenoid versions

Specifications

Safety Ratings

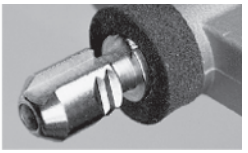
Standards		EN1088, IEC/EN60947-5-1, GS-ET-19, ISO12100-1&2, ISO14119, AS4024.1		
Category		Cat. 1 per EN 954-1 (ISO 13849-1) Suitable for Cat. 2, 3, or 4 systems		
Certifications		CE Marked for all applicable directives and BG; C-Tick not required		
Outputs				
Safety Contacts		2 N.C. positive break		
Switching Current @ Voltage, Max.		500V/500V A		
Thermal Current (Ith)		10 A		
Current, Min.		5 mA @ 5V DC		
Safety Contact Gap		>2 x 2 mm (0.07 in.)		
Rated Insulation Voltage		(Ui) 500V		
Rated Impulse withstand Voltage		(Uimp) 2500V		
Auxiliary Contacts		1 N.O.		
Operating Characteristics				
Break Contact Force, Min.		12 N (2.7 lbs)		
Actuation Speed, Max.		1 ms		
Actuation Frequency, Max.		2 cycle/s		
Utilization Category				
AC 15	(Ue)	500V	250V	100V
	(Ie)	1 A	2 A	5 A
DC		250V	0.5 A, 24V	2 A
Environmental Characteristics				
Enclosure Type Rating		IP67		
Operating Temperature [C (F)]		Electrical: -20…+80 ° (-4…+176°) Solenoid: -20…+60 ° (-4…+140 °)		
Relative Humidity		95%		
Physical Characteristics				
Actuator Travel for Positive Opening		5 mm (0.19 in.)		
Operating Radius, Min.		175 mm (6.88 in.) [60 mm (2.36 in.) with flexible actuator]		
Actuator Holding Force, Max.		2000 N (450 lbs)		
Releasable Load, Max.		100 N (22.5 lbs)		
Case Material		UL Approved glass-filled polyester & 316L stainless steel		
Actuator Material		Stainless steel		
Conduit Entry		3 x M20		
Mounting		SSS: 4 x M5 counterbored from top or 4 x M5 from underside with nuts DSS: 6 x M5 counterbored from top or 6 x M5 from underside with nuts		
Mechanical Life		100,000 operations		
Electrical Life		1,000,000 operations		
Weight [g (lbs)]		SSE: 1160 (2.6) DSSE: 1700 (3.7)		
Color		Red/Stainless		
Shear Force to Key		15.1 k•N (3398 lbs), max.		
Pollution Degree		3		
Torque to Key		14 N•m (124 lb•in), max.		

Note: The safety contacts of the Guardmaster switches are described as normally closed (N.C.), i.e. with the guard closed, actuator in place (where relevant) and the machine able to be started.

The Prosafe Advantage







Stainless steel construction.

Product Selection - Electrical

Contact Type	Type	Trapped Key Condition	Actuator Type	Cat. No.
2 N.C. + 1 N.O. Break before make	Single key	Key trapped to release actuator	Standard	440T-MSSSE10∗
			Flexible	440T-MSSSE11∗
			Flat	440T-MSSSE12∗
		Key free to release actuator	Standard	440T-MSSSE20∗
			Flexible	440T-MSSSE22∗
			Flat	440T-MSSSE23∗
	Dual key	Primary key trapped, secondary key free to release actuator	Standard	440T-MDSSE10∗⊗
		Primary key trapped, secondary key eject to release actuator		440T-MDSSJ10∗⊗
		Primary key trapped, secondary key free to release actuator	Flexible	440T-MDSSE11∗⊗
		Primary key trapped, secondary key eject to release actuator		440T-MDSSJ11∗⊗
		Primary key trapped, secondary key free to release actuator	Flat	440T-MDSSE12∗⊗
		Primary key trapped, secondary key eject to release actuator		440T-MDSSJ12∗⊗
		Both keys free to release actuator	Standard	440T-MDSSE20∗∗
			Flexible	440T-MDSSE22∗∗
			Flat	440T-MDSSE23∗∗
2 N.C. + 2 N.O. Break before make	Single key	Key free to release actuator	Standard	440T-MSSSE26∗
			Flexible	440T-MSSSE27∗
			Flat	440T-MSSSE25∗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired secondary code for this symbol (key included). See 3-107 for code selection.

Product Selection - Solenoid

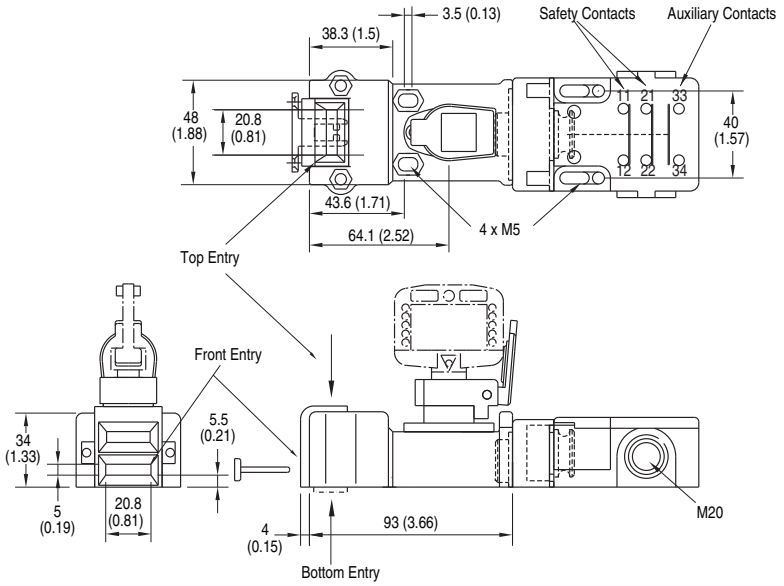
Contact Type	Type	Trapped Key Condition	Solenoid Voltage	Actuator Type	Cat. No.
2 N.C. & 1 N.O. Break before make	Single key	Key free to release actuator	24V DC	Standard	440T-MSSUE20∗
				Flexible	440T-MSSUE22∗
				Flat	440T-MSSUE23∗
	Dual key	Primary key trapped, secondary key free to release actuator	24V DC	Standard	440T-MDSUE10∗
				Flexible	440T-MDSUE11∗
				Flat	440T-MSSUE12∗
	Single key	Key free to release actuator	110V AC	Standard	440T-MSSUE50∗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

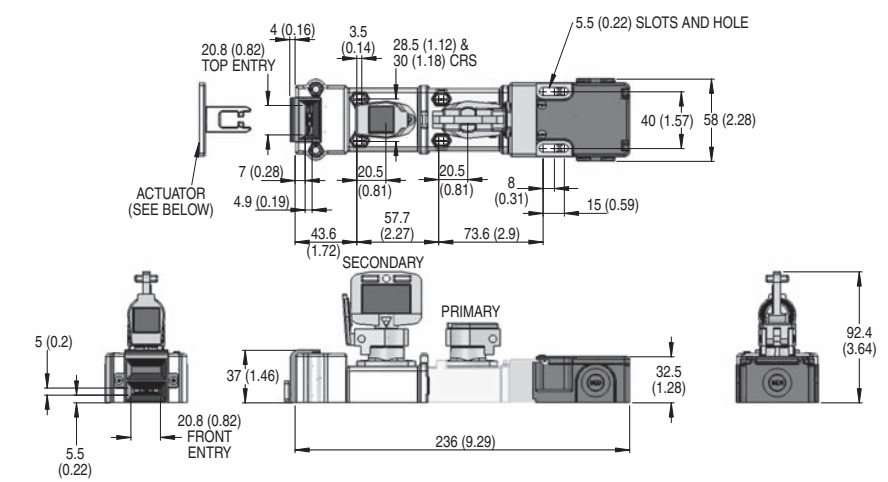
Single Key Slamlock

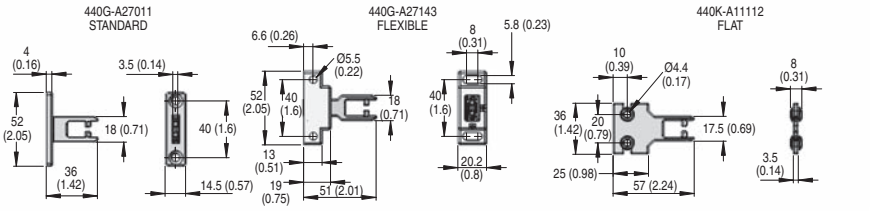


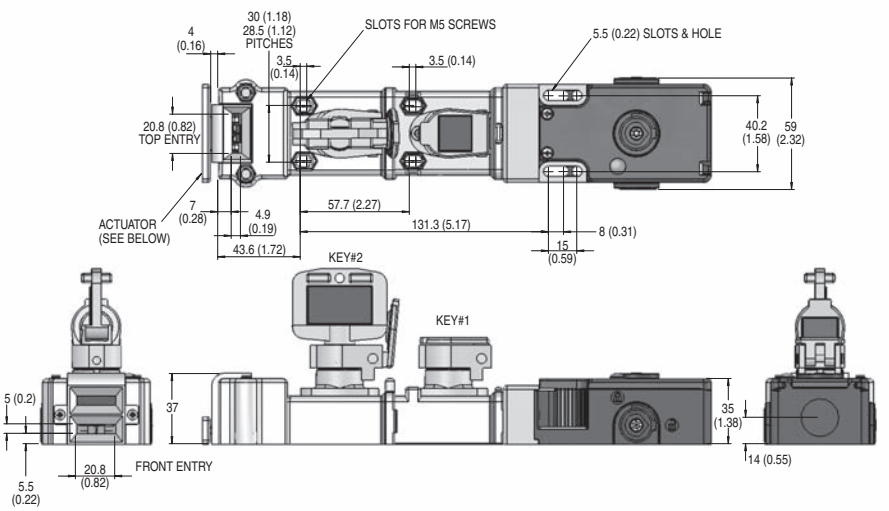
Approximate Dimensions [mm (in.)] (continued)

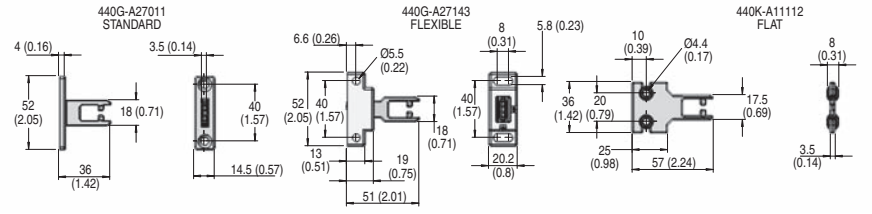
Dimensions are not intended to be used for installation purposes.

Dual Key Slamlock



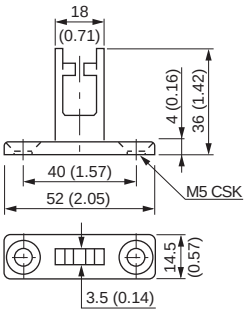
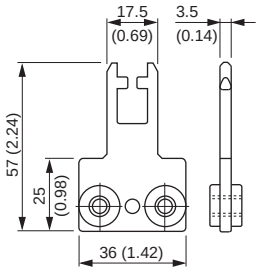
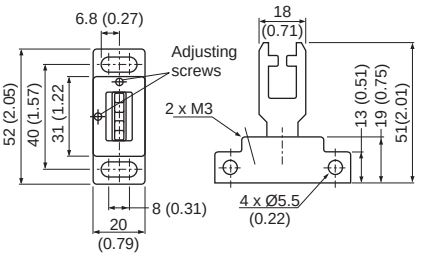






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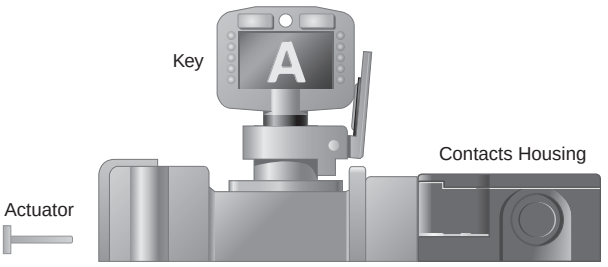
Accessories

Description		Approximate Dimensions [mm (in.)]	Cat. No.
	GD2 standard actuator		**440G-A27011**
	GD2 flat actuator		**440K-A11112**
	Fully flex actuator		**440G-A27143**
	Stainless steel key	page 3-140	440T-AKEYE10⊗
	Stainless steel replacement code barrel with dust cap		440T-ASCBE14✶
	Stainless steel weatherproof replacement dust cap		440T-ASFC10⊗

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
⊗ Substitute the desired code for this symbol. See 3-107 for code selection.

Typical Applications

Actuator out, key trapped, safety contacts open, auxiliary contact closed.



Locking force = 2000 N (450 lb)

Miniature Valve Interlocks

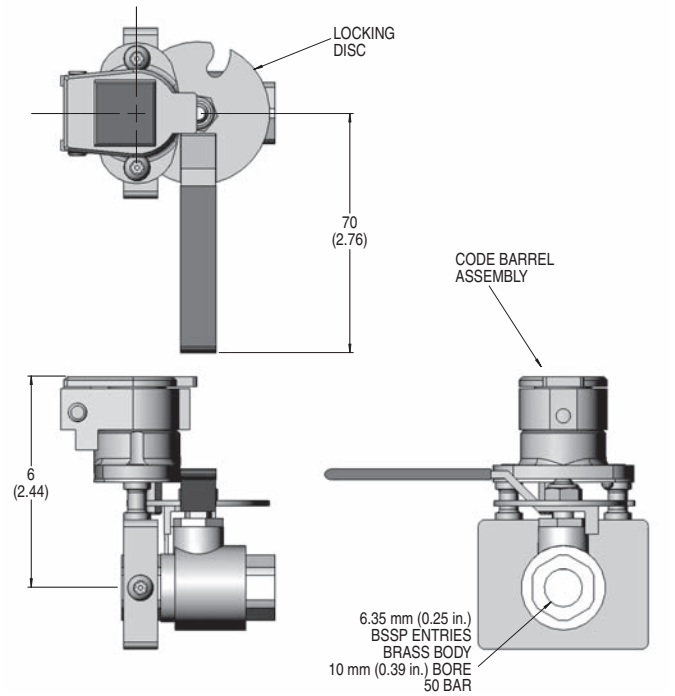


Features

- Direct drive operation
- Supplied with valves 0.25…1 in.
- Direct body mounting with security screws
- Locked open or locked closed options
- Virtually maintenance free
- Weatherproof stainless steel dust cap as standard
- Replaceable code barrel assembly
- Valve is chrome-plated brass

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Approximate Dimensions [mm (in.)]			
Model	A	B	C
440T-VMVLE10	104 (4.1)	68 (2.7)	38 (1.5)
440T-VMVLE11	104 (4.1)	68 (2.7)	38 (1.5)
440T-VMVLE12	112 (4.4)	80 (3.2)	48 (1.9)
440T-VMVLE13	104 (4.1)	68 (2.7)	38 (1.5)
440T-VMVLE14	104 (4.1)	68 (2.7)	38 (1.5)
440T-VMVLE15	112 (4.4)	80 (3.2)	48 (1.9)
440T-VMVLE16	108 (4.3)	110 (4.3)	53 (2.1)
440T-VMVLE17	108 (4.3)	110 (4.3)	53 (2.1)
440T-VMVLE18	115 (4.5)	110 (4.3)	61 (2.4)
440T-VMVLE19	115 (4.5)	110 (4.3)	61 (2.4)

Specifications

Standards	EN1088, ISO12100-1&2, ISO14119, AS4024.1
Certifications	CE Marked for all applicable directives and BG
Operating Temperature [C (F)]	-10…+40 ° (14…104 °)
Mechanical Life	100,000 operations
Shear Force to Key	15.1 k•N (3398 lbs)
Torque to Key	14 N•m (124 lb•in)
Relative Humidity	25…95%
Material	316L stainless steel

Product Selection

Valve Size	Valve Status	Cat. No.
0.25 in. BSP❄	Key Free/Valve Locked Closed	440T-VMVLE10✶
0.375 in. BSP❄		440T-VMVLE11✶
0.5 in. BSP❄		440T-VMVLE12✶
0.25 in. BSP❄	Key Free/Valve Locked Open	440T-VMVLE13✶
0.375 in. BSP❄		440T-VMVLE14✶
0.5 in. BSP❄		440T-VMVLE15✶
1.0 in. BSP❄	Key Free/Valve Locked Closed	440T-VMVLE18✶
	Key Free/Valve Locked Open	440T-VMVLE19✶
2.0 in. BSP❄	Key Free/Valve Locked Closed	440T-VMVLE20✶
	Key Free/Valve Locked Open	440T-VMVLE21✶

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

❄ BSP = British standard pipe threads.

Accessories

Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10✶
Stainless steel replacement code barrel with dust cap		440T-ASCBE14✶
Stainless steel weatherproof replacement dust cap		440T-ASFC10✶

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.



Description

The switch gear adaptor is used to interlock preparatory switch gear applications or other host equipment such as spool valves. Power is isolated and locked off when the key is rotated and removed. The key can then be used in the next sequence of operation.

Features

• Virtually maintenance free

Specifications

Standards	EN1088, ISO12100-1&2, ISO14119, AS4024.1
Category	Cat. 1 per EN 954-1
Certifications	CE Marked for all applicable directives and BG
Operating Temperature [C (F)]	-10…+50 ° (14…122 °)
Mechanical Life	>100,000 operations
Shear Force to Key	15.1 k•N (3398 lbs), max.
Torque to Key	14 N•m (124 lb•in), max.
Relative Humidity	95%
Weight [kg (lbs)]	0.30 (0.66)
Material	316L stainless steel
Mounting	2 x M4
Shaft Dimensions	3/8 in² x 7/8 in long (standard) 9/16 in dia. x 7/8 in long (optional: contact factory)

Product Selection (3/8 square shaft)

Mounting	Trap Direction	Cat. No.
2 x M4	65° CW to trap	440T-MSGAU10∗
	65° CCW to trap	440T-MSGAU11∗
	90° CW to trap	440T-MSGAU12∗
	90° CCW to trap	440T-MSGAU13∗
	±90° to trap	440T-MSGAU14∗
	45° CW to trap	440T-MSGAU17∗
	45° CCW to trap	440T-MSGAU18∗

∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

Accessories

Description	Additional Information	Cat. No.
Stainless steel key	3-140	440T-AKEYE10∗
Stainless steel ejector key		440T-AKEYE13∗
Stainless steel weatherproof replacement dust cap		440T-ASFC10∗

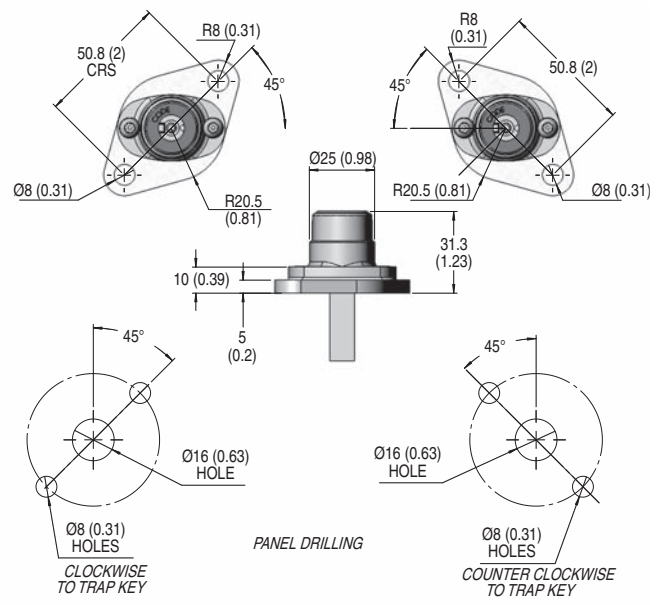
∗ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

45° Mounting Type

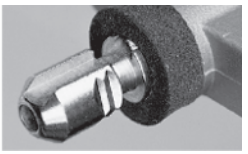
Panel Drilling Detail



The Prosafe Advantage

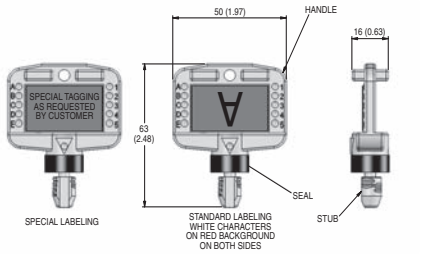
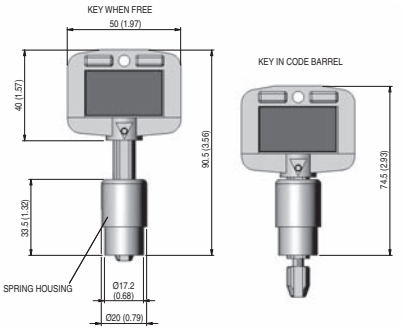
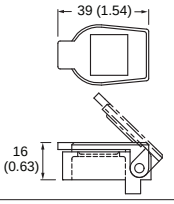
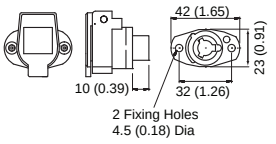
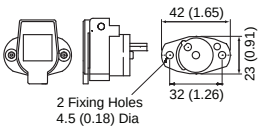






Stainless steel construction.

Accessories

Description		Approximate Dimensions [mm (in.)]	Cat. No.
	Stainless steel key		440T-AKEYE10✶
	Stainless steel ejector key		440T-AKEYE13✶
	Stainless steel weatherproof replacement dust cap		440T-ASFC10✶
	Stainless steel replacement code barrel for 100 A unit rotary switch		440T-ASCBE11✶
	Stainless steel replacement code barrel with dust cap❄		440T-ASCBE14✶

Description	Material	Cat. No.
Emergency break glass key box	Plastic case	440T-AIPB11
	Metal case with hammer	440T-AIPB12

Description	Code	Cat. No.
 Emergency repair kit for code barrels❄ 2 offset pin code barrels with key	ER1	440T-AKITE45ER1
	ER2	440T-AKITE45ER2
	ER3	440T-AKITE45ER3
	ER4	440T-AKITE45ER4
	ER5	440T-AKITE45ER5
	ER6	440T-AKITE45ER6
	ER7	440T-AKITE45ER7
	ER8	440T-AKITE45ER8
	ER9	440T-AKITE45ER9

✶ Substitute the desired primary code for this symbol (key not included). See 3-107 for code selection.
❄ Not suitable for 440T-MRKSE14/440T-MRPSE14 OR 440T-MSGAU units.

WARNING: The presence of spare keys, override keys, or spare actuators can compromise the integrity of safety interlocking systems. Personal injury or death, property damage or economic loss can result from the introduction of spare keys, override keys or spare actuators into interlocking systems without appropriate management controls, working procedures and alternative protective measures to control their use and availability.



22 mm Small Plastic



22 mm Compact Metal



30 mm Large Metal



15 mm Plastic

General Description

The 440P limit switch family offers a full range of international-style solutions for both safety and standard sensing applications. Available in four different body styles—30 mm metal, 22 mm metal and plastic, and 15 mm plastic—with a broad selection of operator types, circuit arrangements and connection options, the 440P is ideal for a wide variety of applications. These include material handling, packaging, elevators, escalators, scissor lifts, industrial trucks and tractors, cranes and hoists, overhead door as well as general safety guarding applications.

Mechanical Enclosure

The large metal-body (440P-M) models feature die-cast alloy construction and conform to EN 50041 (30 x 60 mm), while the small plastic (440P-C) models are constructed of a glass-filled polymer and conform to EN 50047 (22 mm). Both body types are IP66 rated and available with M20 or 1/2 in. NPT conduit opening or in a micro quick-disconnect version. The 15 mm plastic models (440P-M18001 and 440P-M18002) are constructed of glass-filled polyester and are IP30 rated. The 22 mm metal models (440P-A) have a painted body and are IP66/IP67 rated.

Actuator Type

The 440P international-style limit switches are available with a wide variety of actuators to solve a broad range of applications. All lever-type switches include their respective actuator arm. The large, metal-body style is available in the following operator types:

- Metal roller plunger
- Metal dome plunger
- Metal short lever

The compact metal body style is available in the following operator types:

- Roller plunger
- Dome plunger
- Short lever
- Cross roller plunger

All, except the short lever, are available with panel mount threading.

The small, plastic-body style isavailable in the following operator types:

- Short lever
- Hinge lever
- Roller plunger
- Dome plunger
- Offset hinge lever

The 15 mm plastic switch is available with top push roller and top push cross roller actuators.

Contact Arrangements

All 440P international-style limit switches contain positive opening-action contacts, making them ideal for safety-related applications. The small, plastic models include a choice of snap-acting, slow-break/make with 2- or 3-contact configurations, while the large-metal switches contain snap-acting, slow-break contacts in 2-, 3-, or 4-contact configurations. The 15 mm plastic versions are slow-break, 2-circuit models. The small metal models are all snap-acting, 2-circuit.

IEC Style Switches

22 mm Compact Metal Position Switches



Description

The 22 mm IEC style metal safety limit switches have been developed to provide a small metal case with a choice of actuator heads. All units are supplied with an integral 2 m cable. For safety applications it is important that upon actuation, the guard or other moving objects should not pass completely over the switch and allow the plunger or lever to return to its original position.

Features

- Rugged die cast enclosure
- Positive operation, forced disconnection of contacts (direct opening action)
- Snap-acting contact actuation
- Contacts 1 N.C. + 1 N.O.
- Pre-wired 2 m cable, bottom or side exit

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, NFPA 79, EN 1088, ISO 14119, IEC/EN 60947-5-1, ANSI B11.19, AS 4024.1
Safety Classification	Cat. 1 Device per EN 954-1 Dual channel limit switch suitable for Cat. 3 or 4 systems when ganged together
Certifications	UL Recognized, TÜV and CE Marked for all applicable directives
Outputs	
Safety Contacts ❄	1 N.C. snap acting
Auxiliary Contacts	1 N.O. snap acting
Thermal Current	10 A
Rated Insulation Voltage	300V AC
Contact Rating	

Maximum AC Contact Rating Per Pole

NEMA Rating	Max. Voltage	Amperes		Continuous Carrying Current (Amp.)	Volt Amperes	
		Make	Break		Make	Break
AC15/B300	120	30	3.0	5	3600	360
AC15/B300	240	15	1.5			

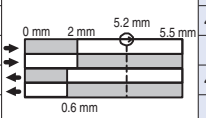
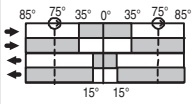
Maximum DC Contact Rating Per Pole

DC13/Q300	240	0.27	0.27	2.5	69	69

Operating Characteristics	
Actuation Speed, Max.	250 mm/s
Actuation Speed, Min.	100 mm/min
Actuation Frequency, Max.	6000 operations per hr
Mechanical Life	1 x 10^7
Environmental	
Enclosure Type Rating	NEMA 1, IP66/67
Operating Temperature [C (F)]	2…70 ° (35.6…158 °)
Pollution Degree	3
Physical Characteristics	
Housing Material	Die-cast alloy
Actuator Material	Various polymers and metals
Mounting	2 x M14, any position
Vibration	IEC 68-2-6 (10…55 Hz, 0.35 mm amplitude)
Shock	IEC 68-2-7 (30 Gn 3 pulses per axis)
Connection Type	2 m (6.5 ft) cable
Color	Red body/black head

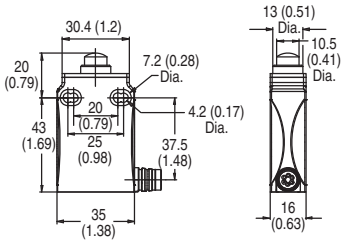
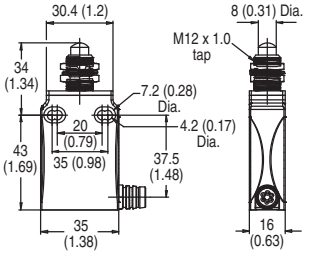
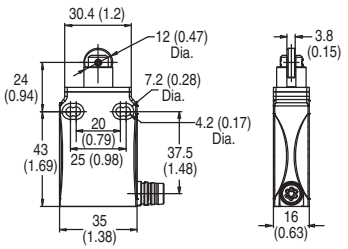
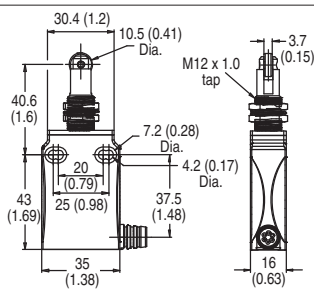
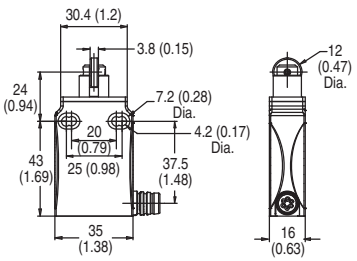
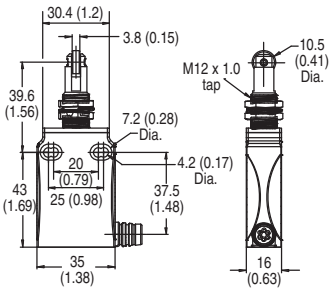
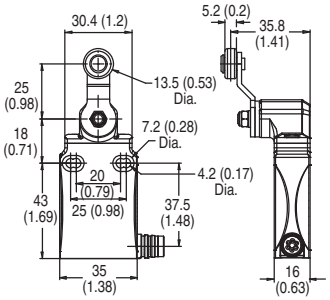
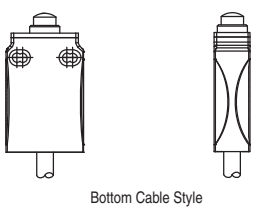
❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Operator Type	Contact			Typical Force/Torque to Operate	Panel Mount	Contact Opening Characteristics	Cat. No.	
	Safety	Auxiliary	Type			□Open ■Closed ⊖ Positive Opening Point	Bottom Cable Style	Side Cable Style
Roller Plunger	1 N.C.	1 N.O.	Snap Acting	10 (2.25)	No		**440P-ARPS11C**	**440P-ARPS11CS**
					Yes		440P-ARP1S11C	440P-ARP1S11CS
Dome Plunger	1 N.C.	1 N.O.	Snap Acting	10 (2.25)	No		440P-ADPS11C	440P-ADPS11CS
					Yes		440P-ADP1S11C	440P-ADP1S11CS
Cross Roller Plunger	1 N.C.	1 N.O.	Snap Acting	10 (2.25)	No		440P-ACRS11C	440P-ACRS11CS
					Yes		440P-ACR1S11C	440P-ACR1S11CS
Lever	1 N.C.	1 N.O.	Snap Acting	0.7 N•m (0.62 lb•in)	—		**440P-ASLS11C**	**440P-ASLS11CS**

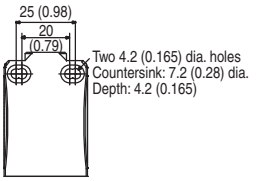
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

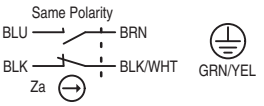
	Nonpanel Mount	Panel Mount
Dome Plunger		
Roller Plunger		
Cross Roller Plunger		
Lever Type		 Bottom Cable Style

- Side cable style shows strain relief only. Units include a 2 m integral cable.
- Bottom cable style units have same dimensions as side cable style.
- Panel mount clearance hole = 13 mm (0.51 in.)

Countersink Hole



Typical Wiring Diagrams



IEC Style Switches

22 mm Plastic Body



Description

These 22 mm plastic-body safety limit switches conform to EN 50047 standards and are available with snap-acting or slow-break/make 2- or 3-contact configurations as well as a variety of actuator heads.

These switches also feature an optional rotating head that can be adjusted in 90° increments before installation to allow for ease of mounting.

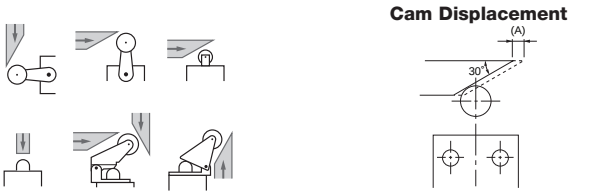
Allen-Bradley Guardmaster limit switches can be used in guard door applications as well as on moving machine beds, crane arms, lifts, elevators, etc.

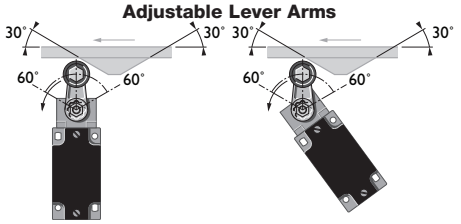
Operation of these limit switches is achieved by the sliding action of a guard, or other moving object, deflecting the plunger or lever. For safety applications, it is important that upon actuation, the guard or moving object should not pass completely beyond the switch to allow the plunger or lever to return to its original position—the plunger or lever must remain engaged by the guard or object.

Features

- Large selection of actuator heads
- Positive operation, forced disconnection of contacts
- Snap-acting, slow make before break or slow break before make contact blocks
- Contacts 1 N.C. + 1 N.O., 2 N.C. + 1 N.O. 3 N.C.
- Conforms to EN 50047, EN 1088, EN 60947-5-1, EN 292 and EN 60204-1

Operating Examples





The actuating cam should be profiled at 30° for optimum operation.

Note: Plunger-type switches operate from a flat profile.

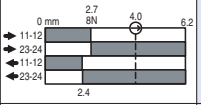
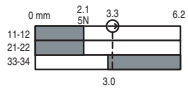
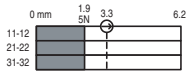
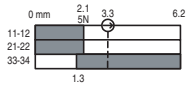
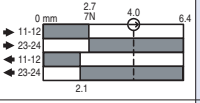
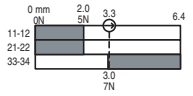
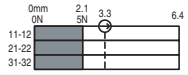
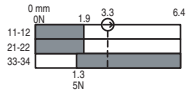
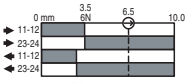
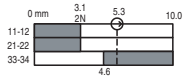
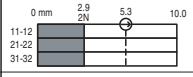
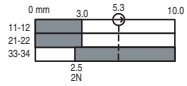
Specifications

Safety Ratings					
Standards		EN 954-1, ISO 13849-1, IEC/EN 60204-1, NFPA 79, EN 1088, ISO 14119, IEC/EN 60947-5-1, ANSI B11.19, AS 4024.1			
Safety Classification		Cat. 1 Device per EN 954-1 Dual channel limit switch suitable for Cat. 3 or 4 systems and used with a safety monitoring device			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: > 3 x10^{-7} MTTFd: > 385 years Dual channel limit switch may be suitable for performance levels Ple or Pld (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics			
Certifications		CE Marked for all applicable directives, cULus, and TÜV			
Outputs					
Safety Contacts ❄		1 N.C. snap acting, 2 N.C. or 3 N.C. slow acting			
Auxiliary Contacts		1 N.O. (except 3 N.C. versions)			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		600V AC			
Switching Current @ Voltage, Min.		25 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
N600/DC-13	(Ue)	600V	500V	250V	125V
	(Ie)	0.4 A	0.55 A	1.1 A	2.2 A
Operating Characteristics					
Actuation Speed, Max.		250 mm/s			
Actuation Speed, Min.		100 mm/min			
Actuation Frequency, Max.		6000 operation per hour			
Mechanical Life		1 x 10^7			
Environmental					
Enclosure Type Rating		IP66			
Operating Temperature [C (F)]		-25…80° (-18…+176°)			
Pollution Degree		3			
Physical Characteristics					
Housing Material		UL Approved glass-filled polybutylene terephthalate			
Actuator Material		Various polymers and metals			
Mounting		2 x M4, Any position			
Vibration		IEC 68-2-6 (10…55 Hz, 0.35 mm amplitude)			
Shock		IEC 68-2-7 (30 Gn 3 pulses per axis)			
Conduit Entry		M20 or 1/2 inch NPT			
Color		Red			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

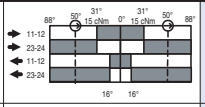
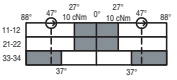
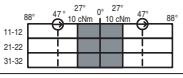
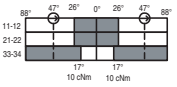
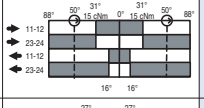
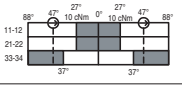
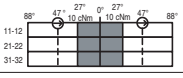
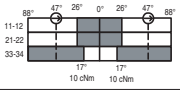
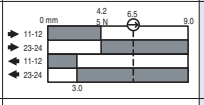
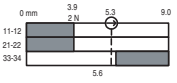
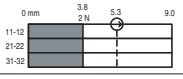
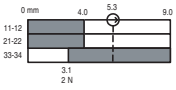
Description	Contact			Typical Force/Torque to Operate	Contact Opening Characteristics □Open ■Closed ⊖ Positive Opening Point	Cat. No.		
	Safety	Auxiliary	Type			1/2 inch NPT Conduit	M20 Conduit	Connector Style✶
	1 N.C.	1 N.O.	Snap acting	5 N		**440P-CRPS11E**	440P-CRPS11B	440P-CRPS11D4
	2 N.C.	1 N.O.	BBM	6 N		440P-CRPB12E	440P-CRPB12B	440P-CRPB12R6
	3 N.C.	—	—	5 N		440P-CRPB03E	440P-CRPB03B	440P-CRPB03R6
Roller Plunger	2 N.C.	1 N.O.	MBB	6 N		440P-CRPM12E	440P-CRPM12B	440P-CRPM12R6
	1 N.C.	1 N.O.	Snap acting	5N		**440P-CDPS11E**	440P-CDPS11B	440P-CDPS11D4
	2 N.C.	1 N.O.	BBM	6N		440P-CDPB12E	440P-CDPB12B	440P-CDPB12R6
	3 N.C.	—	—	5N		440P-CDPB03E	440P-CDPB03B	440P-CDPB03R6
Dome Plunger	2 N.C.	1 N.O.	MBB	6N		440P-CDPM12E	440P-CDPM12B	440P-CDPM12R6
	1 N.C.	1 N.O.	Snap Acting	5N		**440P-CHLS11E**	440P-CHLS11B	440P-CHLS11D4
	2 N.C.	1 N.O.	BBM	6N		**440P-CHLB12E**	440P-CHLB12B	440P-CHLB12R6
	3 N.C.	—	—	5N		440P-CHLB03E	440P-CHLB03B	440P-CHLB03R6
Hinge Lever	2 N.C.	1 N.O.	MBB	6N		440P-CHLM12E	440P-CHLM12B	440P-CHLM12R6
Recommended standard cordset, 2 m, 4-pin, DC Micro (M12) connector.								889D-F4AC-2
Recommended standard cordset, 2 m, 6-pin, AC Micro (M12) connector.								889R-F6ECA-2

✶ D4 suffix uses a 4-pin DC Micro (M12) connector and R6 suffix uses a 6-pin AC Micro (dual keyway) consumer.

IEC Style Switches

22 mm Plastic Body

Product Selection (continued)

Description	Contact			Typical Force/Torque to Operate	Contact Opening Characteristics □Open ■Closed ⊖ Positive Opening Point	Cat. No.		
	Safety	Auxiliary	Type			1/2 inch NPT Conduit	M20 Conduit	Connector Style*
 Short Lever Plastic Roller	1 N.C.	1 N.O.	Snap acting	0.15 N•m		**440P-CSLS11E**	440P-CSLS11B	440P-CSLS11D4
	2 N.C.	1 N.O.	BBM	0.14 N•m		**440P-CSLB12E**	440P-CSLB12B	440P-CSLB12R6
	3 N.C.	—	—	0.14 N•m		440P-CSLB03E	440P-CSLB03B	440P-CSLB03R6
	2 N.C.	1 N.O.	MBB	0.14 N•m		440P-CSLM12E	440P-CSLM12B	440P-CSLM12R6
 Short Lever Metal Roller	1 N.C.	1 N.O.	Snap acting	0.15 N•m		440P-CMHS11E	440P-CMHS11B	440P-CMHS11D4
	2 N.C.	1 N.O.	BBM	0.14 N•m		440P-CMHB12E	440P-CMHB12B	440P-CMHB12R6
	3 N.C.	—	—	0.14 N•m		440P-CMHB03E	440P-CMHB03B	440P-CMHB03R6
	2 N.C.	1 N.O.	MBB	0.14 N•m		440P-CMHM12E	440P-CMHM12B	440P-CMHM12R6
 Offset Hinge	1 N.C.	1 N.O.	Snap acting	5 N		**440P-COHS11E**	440P-COHS11B	440P-COHS11D4
	2 N.C.	1 N.O.	BBM	6 N		**440P-COHB12E**	440P-COHB12B	440P-COHB12R6
	3 N.C.	—	—	5 N		440P-COHB03E	440P-COHB03B	440P-COHB03R6
	2 N.C.	1 N.O.	MBB	6 N		440P-COHM12E	440P-COHM12B	440P-COHM12R6
Recommended standard cordset, 2 m, 4-pin, DC Micro (M12) connector.								889D-F4AC-2
Recommended standard cordset, 2 m, 6-pin, AC Micro (M12) connector.								889R-F6ACA-2

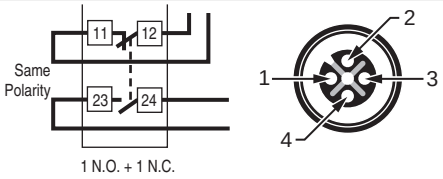
* D4 suffix uses a 4-pin DC Micro (M12) connector and R6 suffix uses a 6-pin AC Micro (dual keyway) consumer.

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Publication S117-CA001A-EN-P

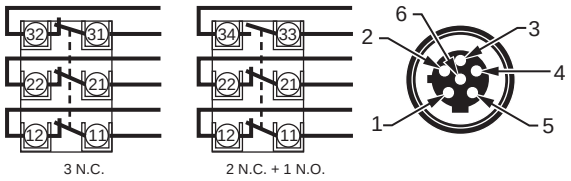
Allen-Bradley
Guardmaster®

Typical Wiring Diagrams *

Two-Circuit Type D4 4-Pin Micro Connector

Connector Pinout		1 N.C. + 1 N.O.	
		Terminal	Contact
	1	11	N.C.
	3	12	
	2	23	N.O.
	4	24	

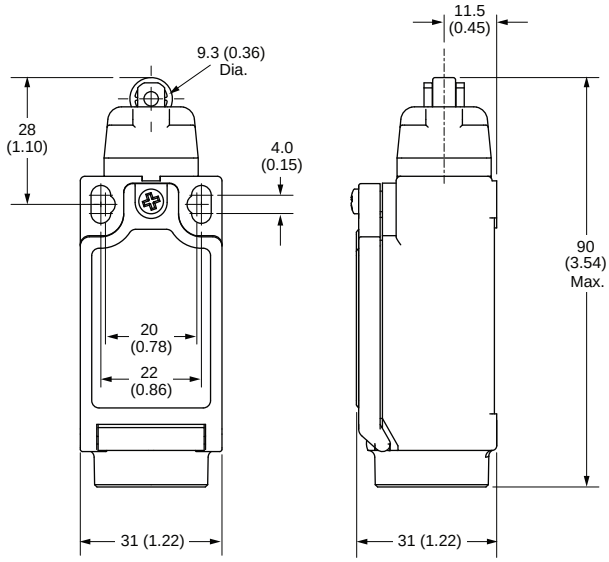
Three-Circuit Type R6 6-Pin Micro Connector

Connector Pinout		3 N.C.		2 N.C. + 1 N.O.	
		Terminal	Contact	Terminal	Contact
	1	11	N.C.	11	N.C.
	5	12		12	
	2	21	N.C.	21	N.C.
	6	22		22	
	3	33	N.O.	31	N.C.
	4	34		32	

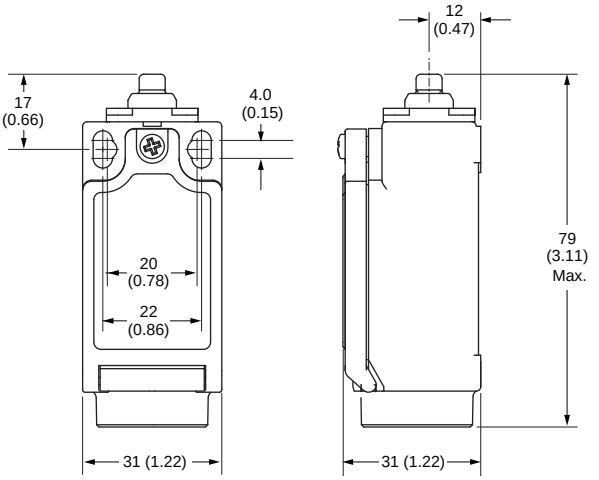
* See page 3-145 for positive opening circuits.

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



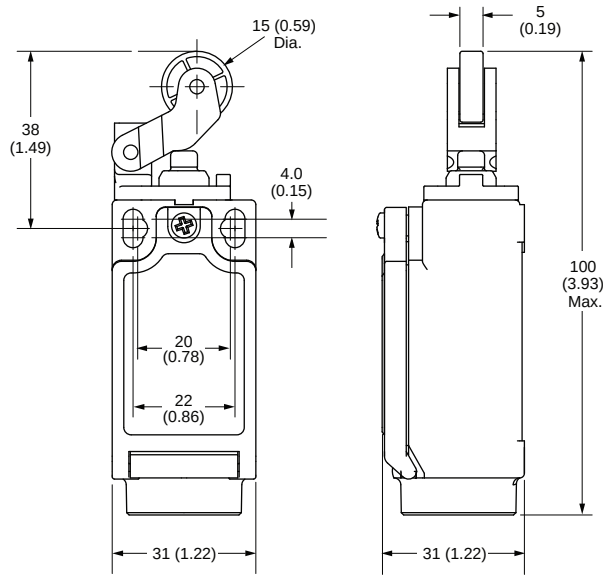
Roller Plunger



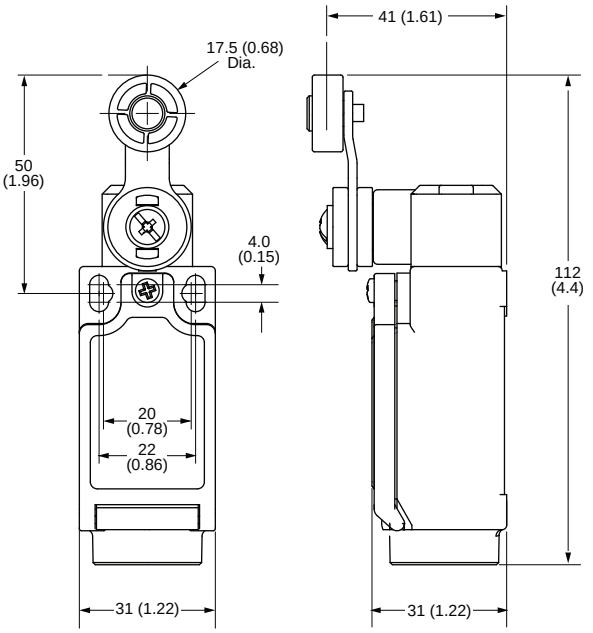
Dome Plunger

Approximate Dimensions [mm (in.)] (continued)

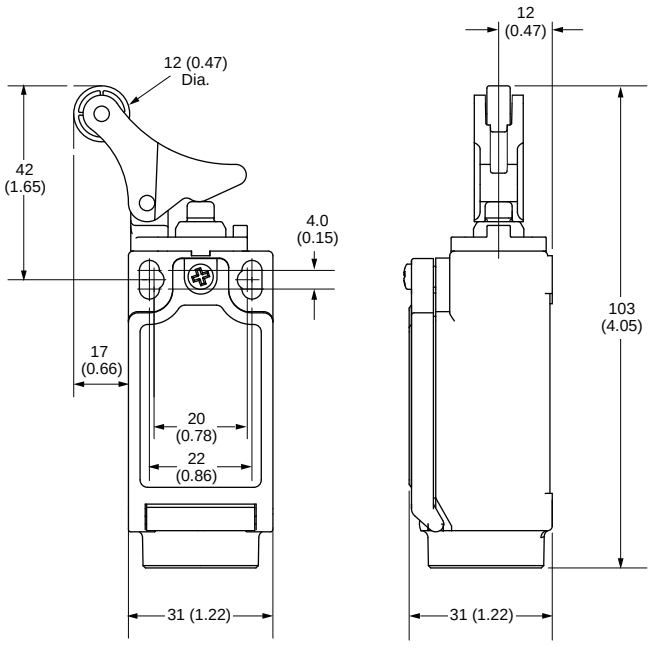
Dimensions are not intended to be used for installation purposes.



Hinge Lever



Short Lever,
Metal and Plastic Roller



Offset Hinge



Description

These 30 mm metal-body safety limit switches conform to EN 50041 standards and are available in snap acting or slow break/make with 2-, 3- or 4-contact configurations.

These switches feature a rotating head that can be adjusted in 90° increments before installation to allow for ease of mounting.

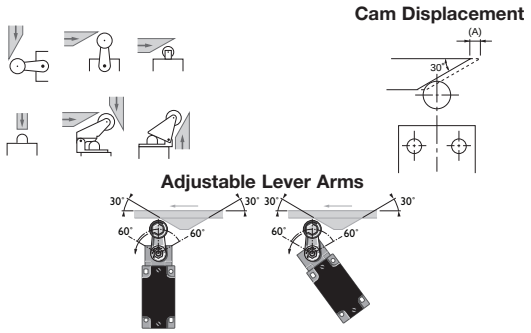
Allen-Bradley Guardmaster can be used in guard door applications as well as on moving machine beds, crane arms, lifts, elevators, etc.

Operation of these limit switches is achieved by the sliding action of a guard, or other moving object, deflecting the plunger or lever. For safety applications, it is important that upon actuation, the guard or moving object should not pass completely beyond the switch to allow the plunger or lever to return to its original position—the plunger or lever must remain engaged by the guard or object.

Features

- Large selection of actuator heads
- Positive operation, forced disconnection of contacts
- Snap-acting, slow make before break or slow break before make contact blocks
- Contacts 1 N.C. + 1 N.O., 2 N.C. + 2 N.O., 3 N.C. + 1 N.O., or 4 N.C.
- Conforms to EN 50041, EN 1088, EN 60947-5-1, EN 292 and EN 60204-1

Operating Examples



For optimum cam operation, the actuating arm should be adjusted with a 30° offset profile.

Note: Plunger-type switches operate from a flat profile.

Specifications

Safety Ratings					
Standards		EN 954-1, ISO 13849-1, IEC/EN 60204-1, NFPA 79, EN 1088, ISO 14119, IEC/EN 60947-5-1, ANSI B11.19, AS 4024.1			
Safety Classification		Cat. 1 Device per EN954-1 Dual-channel limit switch suitable for Cat. 3 or 4 systems and used with a safety monitoring device			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: > 3 x10^{-7} MTTFd: > 385 years Dual channel limit switch may be suitable for performance levels Ple or Pld (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics			
Certifications		CE Marked for all applicable directives, cULus, and TÜV			
Outputs					
Safety Contacts ❄		1 N.C. snap acting, 2 N.C., 3 N.C. or 4 N.C. slow acting			
Auxiliary Contacts		1 N.O., 2 N.O., or zero			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		600V AC			
Switching Current @ Voltage, Min.		25 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
N600/DC-13	(Ue)	600V	500V	250V	125V
	(Ie)	0.4 A	0.55 A	1.1 A	2.2 A
Operating Characteristics					
Actuation Speed, Max.		250 mm/s			
Actuation Speed, Min.		100 mm/min			
Actuation Frequency, Max.		6000 operation per hour			
Mechanical Life		1 x 10^7			
Environmental					
Enclosure Type Rating		IP66			
Operating Temperature [C (F)]		-25…80° (-18…+176°)			
Pollution Degree		3			
Physical Characteristics					
Housing Material		Die-cast alloy			
Actuator Material		Various polymers and metals			
Mounting		2 x M5, Any position			
Vibration		IEC 68-2-6 (10…55 Hz, 0.35 amplitude)			
Shock		IEC 68-2-7 (30 Gn 3 pulses per axis)			
Conduit Entry		M20 or 1/2 inch NPT			
Color		Red			

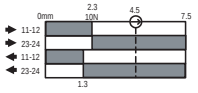
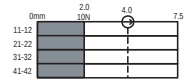
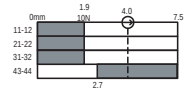
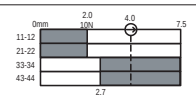
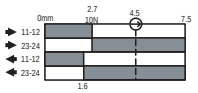
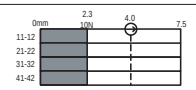
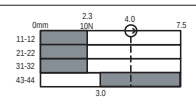
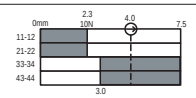
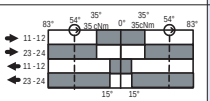
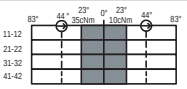
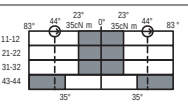
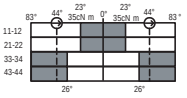
✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

IEC Style Switches

30 mm Metal Body

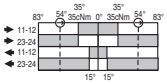
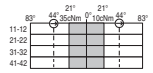
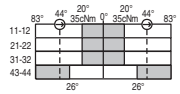
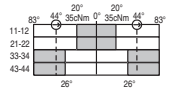
Product Selection

Description	Contact			Typical Force/Torque to Operate	Contact Opening Characteristics □Open ■Closed ⊖ Positive Opening Point	Cat. No.		
	Safety	Auxiliary	Type			1/2 inch NPT Conduit	M20 Conduit	Connector ✶
 Metal Roller Plunger	1 N.C.	1 N.O.	Snap Acting	13 N		440P-MRPS11E	440P-MRPS11B	440P-MRPS11N5
	4 N.C.	—	—	11 N		440P-MRPB04E	440P-MRPB04B	440P-MRPB04M9
	3 N.C.	1 N.O.	BBM	11 N		440P-MRPB13E	440P-MRPB13B	440P-MRPB13M9
	2 N.C.	2 N.O.	BBM	11 N		**440P-MRPB22E**	440P-MRPB22B	440P-MRPB22M9
 Metal Dome Plunger	1 N.C.	1 N.O.	Snap Acting	13 N		**440P-MDPS11E**	440P-MDPS11B	440P-MDPS11N5
	4 N.C.	—	—	11 N		440P-MDPB04E	440P-MDPB04B	440P-MDPB04M9
	3 N.C.	1 N.O.	BBM	11 N		440P-MDPB13E	440P-MDPB13B	440P-MDPB13M9
	2 N.C.	2 N.O.	BBM	11 N		440P-MDPB22E	440P-MDPB22B	440P-MDPB22M9
 Metal Short Lever	1 N.C.	1 N.O.	Snap Acting	0.34 N•m		**440P-MSLS11E**	440P-MSLS11B	440P-MSLS11N5
	4 N.C.	—	—	0.20 N•m		440P-MSLB04E	440P-MSLB04B	440P-MSLB04M9
	3 N.C.	1 N.O.	BBM	0.34 N•m		440P-MSLB13E	440P-MSLB13B	440P-MSLB13M9
	2 N.C.	2 N.O.	BBM	0.34 N•m		440P-MSLB22E	440P-MSLB22B	440P-MSLB22M9
Recommended standard cordset, 2 m, 5-pin mini connector.								889N-F5AE-6F
Recommended standard cordset, 2 m, 12-pin 9-wire.								889M-FX9AE-2

✶ N5 = 5-pin mini connector.
M9 = 12-pin M23 connector (use 9 wire).

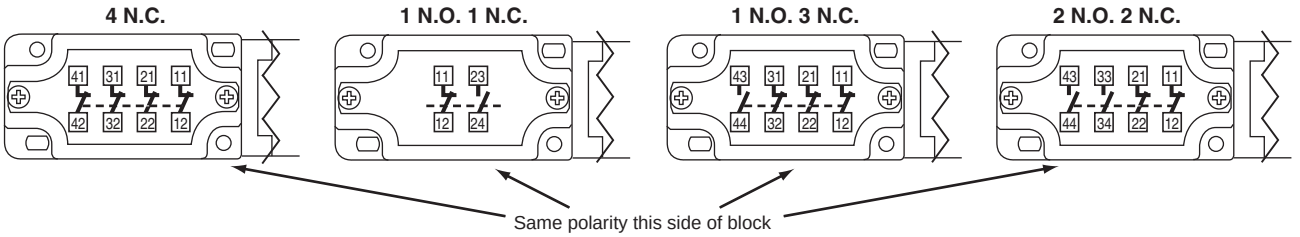
Allen-Bradley
GuardMaster®

Product Selection (continued)

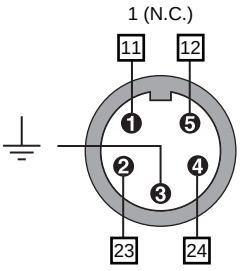
Description	Safety Contacts	Auxiliary Contacts	Contact Type	Typical Force/Torque to Operate	Contact Opening Characteristics □Open ■Closed ⊖ Positive Opening Point	Cat. No. 1/2 inch NPT Conduit	Cat. No. M20 Conduit	Cat. No. Connector ∗
 Metal Short Lever, Metal Roller	1 N.C.	1 N.O.	Snap Acting	0.34 N•m		440P-MMHS11E	440P-MMHS11B	440P-MMHS11N5
	4 N.C.	—	—	0.20 N•m		440P-MMHB04E	440P-MMHB04B	440P-MMHB04M9
	3 N.C.	1 N.O.	BBM	0.34 N•m		440P-MMHB13E	440P-MMHB13B	440P-MMHB13M9
	2 N.C.	2 N.O.	BBM	0.34 N•m		440P-MMHB22E	440P-MMHB22B	440P-MMHB22M9
Recommended standard cordset, 2 m, 5-pin mini connector.								889N-F5AE-6F
Recommended standard cordset, 2 m, 12-pin 9-wire.								889M-FX9AE-2

∗ N5 = 5-pin mini connector.
M9 = 12-pin M23 connector (use 9 wire).

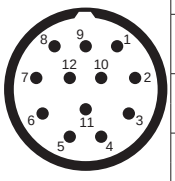
Typical Wiring Diagrams



N5 Connector 2 Circuit 5-Pin Mini Connector

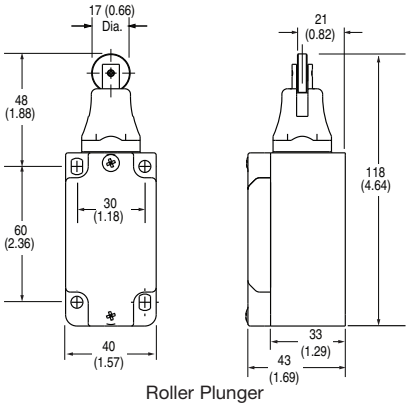


M9 12-Pin M23 Connector

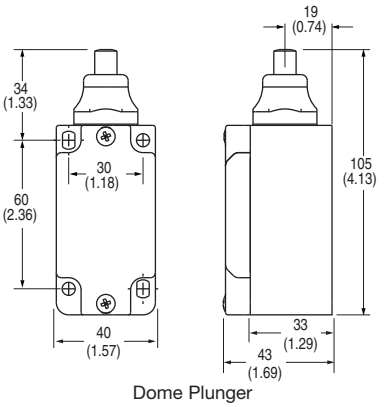
Connector Pinout		4 N.C. Terminal	4 N.C. Contact	3 N.C. 1 N.O. Terminal	3 N.C. 1 N.O. Contact	3 N.C. Terminal	3 N.C. Contact
	1	11	N.C.	11	N.C.	11	N.C.
	3	12		12		12	
	4	21	N.C.	21	N.C.	21	N.C.
	6	22		22		22	
	7	31	N.C.	31	N.C.	33	N.O.
	8	32		32		34	
	9	41	N.C.	43	N.O.	43	N.O.
	10	42		44		44	
	12	Ground					

Approximate Dimensions [mm (in.)]

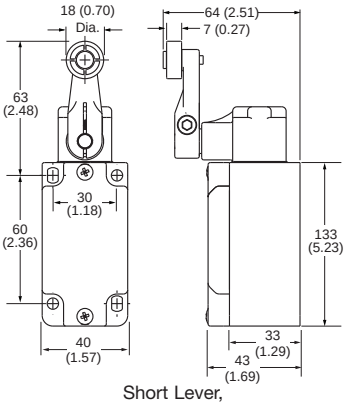
Dimensions are not intended to be used for installation purposes.



Roller Plunger



Dome Plunger



Short Lever,
(Metal & Plastic Roller)



Imp 1



Imp 2

Description

The Imp offers safety switch performance of bigger units in the most compact case available. Designed with two mounting hole options and a choice of actuator positions, the Imp will fit in most confined spaces.

Features

- Positive operation, forced disconnection of contacts
- Contacts 1 N.C. + 1 N.O.

Specifications

Safety Ratings				
Standards		EN 954-1, ISO 13849-1, IEC/EN 60204-1, NFPA 79, EN 1088, ISO 14119, IEC/ EN 60947-5-1, ANSI B11.19, AS 4024.1		
Safety Classification		Cat. 1 Device per EN954-1 Dual channel limit switch suitable for Cat. 3 or 4 systems		
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: > 3 x10^{-7} MTTFd: > 385 years Dual channel limit switch may be suitable for performance levels Ple or Pld (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics		
Certifications		CE Marked for all applicable directives and CSA NRTL/C		
Outputs				
Safety Contacts ❄		1 N.C. positive break		
Auxiliary Contacts		1 N.O.		
Thermal Current I_{lth}		10 A (Ith)		
Rated Insulation Voltage		(Ui) 500V		
Switching Current @ Voltage, Min.		25 mA @ 5V DC		
Utilization Category				
AC-15	(Ue)	500V	250V	100V
	(Ie)	1 A	2 A	5 A
DC	(Ue)	250V	24V	
	(Ie)	0.5 A	2 A	
Operating Characteristics				
Actuation Speed, Max.		160 mm (6.29 in.)/s		
Actuation Speed, Min.		100 mm (3.93 in.)/min		
Actuator Travel, Max.		5 mm (0.20 in.)		
Actuation Frequency, Max.		2 cycles/s		
Mechanical Life		10,000,000 operations		
Electrical Life		1,000,000 operations		
Mechanical Life		10,000,000 operations		
Environmental				
Enclosure Type Rating		IP30		
Operating Temperature [C (F)]		-25…80° (-13…176°)		
Pollution Degree		3		
Physical Characteristics				
Housing Material		UL Approved glass-filled PBT		
Actuator Material		Stainless steel		
Mounting		2 x M4 front or 2 x M3 top		
Vibration		10…55 Hz		
Shock		11 ms @ 30 g		
Conduit Entry		3x break-outs		
Color		Red		

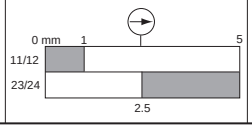
✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

IEC Style Switches

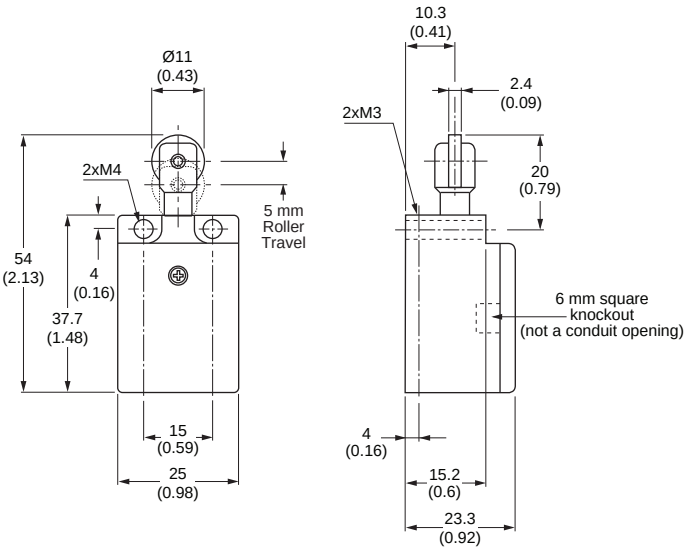
15 mm Plastic Body

Product Selection

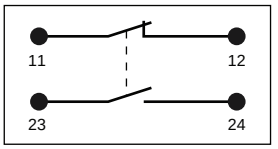
Actuator Type	Contact		Contact Action □Open ■Closed ⊖ Positive Opening Point	Conduit	Type	Cat. No.
Top push roller	Slow break before make	1 N.C. & 1 N.O.		3 x breakouts	Imp 1 (roller parallel to switch front)	**440P-M18001**
Top push cross roller					Imp 2 (roller perpendicular to switch front)	**440P-M18002**

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



Wiring Diagrams





Description

The 802T Direct Opening Action limit switches have been designed for use in control reliable applications and safety applications per ISO 14119. These limit switches utilize the same mounting dimensions as other NEMA style limit switches. The rugged metal construction and plug-in body are designed for use in harsh industrial environments.

Direct Opening Action allows the normally closed contacts to open when the limit switch is actuated. This opening will occur even in the event of a contact weld condition, up to 10 Newtons.

ATTENTION: To ensure that the normally closed (safety) contacts open, the limit switch actuator must be displaced beyond the point of Direct Opening Action (see specifications).

Features

- Direct opening action
- Snap acting contacts
- Rugged metal construction
- Long life and reliability
- Plug-in design
- NEMA 12, 13, 4, 6P/IP67 sealing

Typical Applications

- Machine guards
- Access gates and doors
- Cranes or hoists
- Transfer stations
- Indexing tables
- Robotic cells

Specifications

Safety Ratings					
Standards		EN 954-1, ISO 13849-1, IEC/EN 60204-1, NFPA 79, EN 1088, ISO 14119, IEC/EN 60947-5-1, ANSI B11.19, AS 4024.1			
Safety Classification		Cat. 1 Device per EN 954-1 Dual channel limit switch suitable for Cat. 3 or 4 systems			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d = > 2 x 10^6 operations at min. load PFH_D = > 3 x10^{-7} MTTFd = > 385 years Dual channel limit switch may be suitable for Performace levels Ple or Pld (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on application characteristics			
Certifications		CE Marked for all applicable directives, cULus Listed, and TÜV for 2- and 4-circuit models			
Outputs					
Safety Contacts ❄		1 N.C. snap acting or 2 N.C. snap acting			
Auxiliary Contacts		1 N.O. snap acting or 2 N.O. snap acting			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		300V AC or 600V AC			
Switching Current @ Voltage, Min.		—			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3.0 A	6.0 A
N600/DC-13	(Ue)	600V	500V	250V	125V
	(Ie)	0.4 A	0.55 A	1.1 A	2.2 A
Operating Characteristics					
Actuation Speed, Max.		200 ft/min varies with applied loading and actuation method✶			
Actuation Speed, Min.		200 ft/min varies with applied loading and actuation method✶			
Actuation Frequency, Max.		8000 operations per hour			
Mechanical Life		20 million cycles			
Environmental					
Enclosure Type Rating		NEMA 4, 6P, 12, 13 and IP65/67			
Operating Temperature [C (F)]		-18…+110° (0…+230°)			
Pollution Degree		3			
Physical Characteristics					
Housing Material		Die-cast alloy			
Actuator Material		Various metals or plastics			
Mounting		2 #10 equal length fasteners			
Vibration		Contact fragility (10…2000 Hz @ 0.06 inch peak-to-peak)			
Shock		Contact fragility (25 Gn 3 pulses per axis)			
Conduit Entry		1/2 inch NPT or M20			
Color		Grey			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data other than B10d is based on:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

AC Contact Rating (Maximum per Pole, 50 or 60Hz, 2 Circuits)

NEMA Rating Designation	Max Voltage	A		Continuous Carrying Current	VA	
		Make	Break		Make	Break
A600	120	60	6.00	10	7200	720
	240	30	3.00	10	7200	720
AC-15	480	15	1.50	10	7200	720
	600	12	1.20	10	7200	720

AC Contact Rating (Maximum per Pole, 50 or 60Hz, 4 Circuits)

NEMA Rating Designation	Max Voltage	A		Continuous Carrying Current	VA	
		Make	Break		Make	Break
A300	120	60	6.00	10	7200	720
	240	30	3.00	10	7200	720

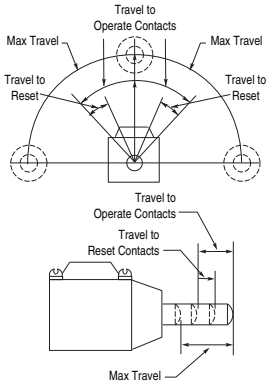
DC Contact Rating (Maximum per Pole)

NEMA Rating Designation	Max Voltage	A		Continuous Carrying Current	VA	
		Make	Break		Make	Break
Q300	250	0.27	0.27	2.5	69	69
	125	0.55	0.55	2.5	69	69
DC 13						

Low Voltage DC

24V DC @ 1.1 Amps resistive load

Range of Operation





Lever Type Spring Return



Top Push Roller Spring Return

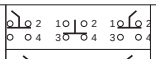
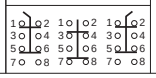


Side Push Vertical Roller Spring Return



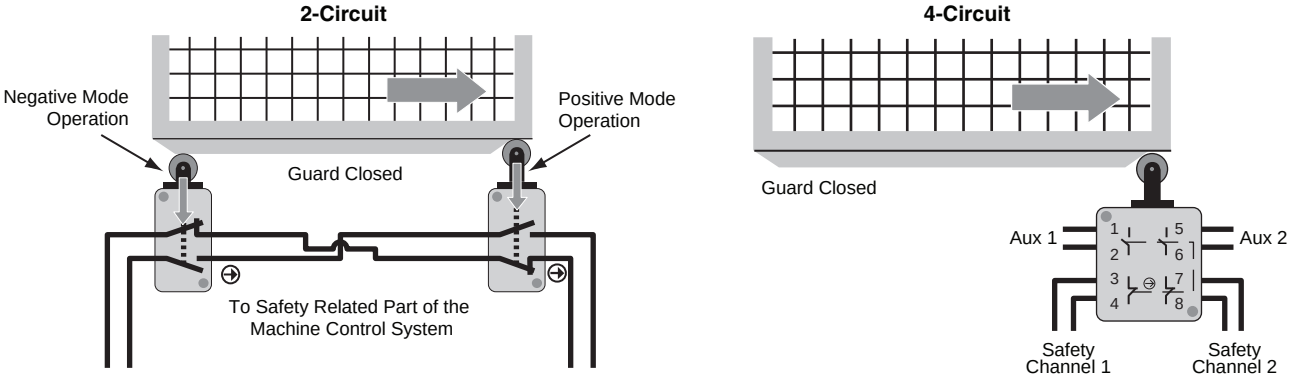
Side Push Horizontal Roller Spring Return

Product Selection

Number of Circuits	Lever Movement	Description	Typical Force/Torque to Operate	Travel to Operate Contacts [mm (in.)]	Torque/Force to Operate Direct Opening Action	Travel to Operate Direct Opening Action [mm (in.)]	Maximum Travel [mm (in.)]	Travel to Reset Contacts [mm (in.)]	Cat. No.
Lever Type • Spring Return									
2	Clockwise or Counter Clockwise		0.45 N•m (4.0 lb•in), max.	13°, max.	0.90 N•m (8 lb•in), min.	25°, min.	90°	7°, max.	Switch w/o Lever 802T-APD
4									802T-ATPD
Top Push Roller • Spring Return									
2	Normal	Operated	28.47 N•m (6.4 lb•in), max.	1.17 (0.046), max.	66.72 N (15.0 lb), min.	2.29 (0.090), min.	5.99 (0.236)	0.64 (0.025), max.	Complete Switch 802T-DPD
									
4									802T-DTPD
Side Push Vertical Roller • Spring Return									
2	Normal	Operated	24.5 N•m (5.5 lb•in), max.	2.08 (0.082), max.	53.4 N (12.0 lb), min.	4.19 (0.165), min.	5.74 (0.226)	1.14 (0.045), max.	Complete Switch 802T-KPD
									
4									802T-KTPD
Side Push Horizontal Roller • Spring Return									
2	Normal	Operated	24.5 N•m (5.5 lb•in), max.	2.08 (0.082), max.	53.4 N (12.0 lb), min.	4.19 (0.165), min.	5.74 (0.226)	1.14 (0.045), max.	Complete Switch 802T-K1PD
									
4									802T-K1TPD

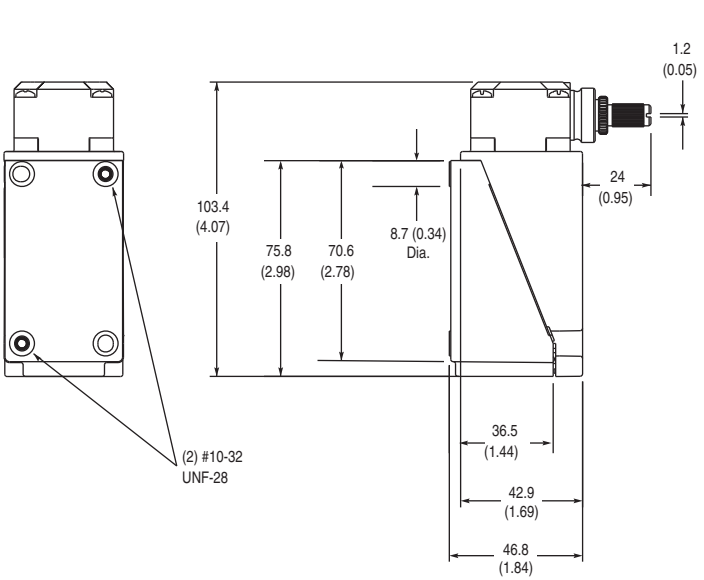
Modifications and Typical Levers—page 3-159.

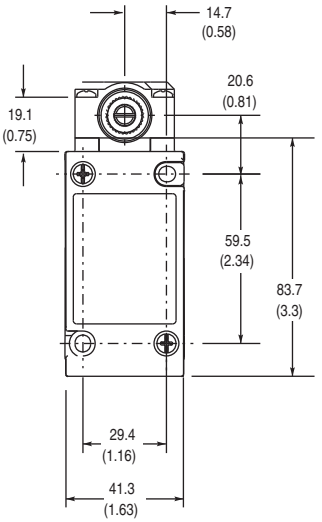
Typical Example of a Dual Channel Safety Application



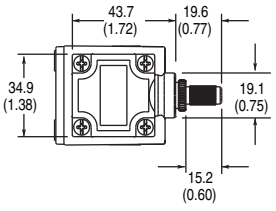
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

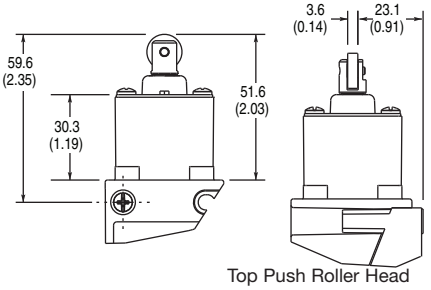




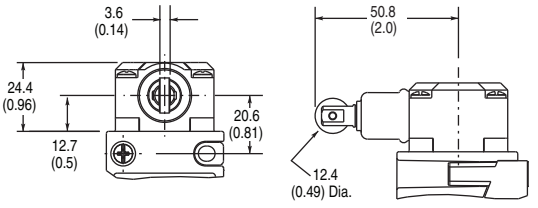
Plug-In Switch



Lever Type Head



Top Push Roller Head



Side Push Roller Head

Modifications

Metric Conduit Entry

To order a limit switch with a 20 mm conduit entry, add the suffix **S6** to the cat. no. **Example: 802T-APDS6.**

Pre-wired Cable

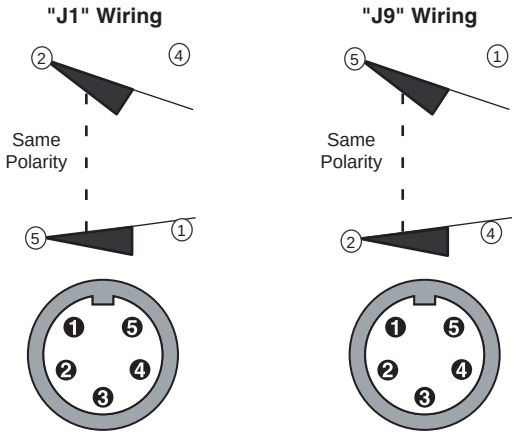
To order a factory-installed pre-wired type STOOW-A cable (5-conductor), add the suffix **Y** plus the number of feet required. The standard cable length is 1.52 m (5 ft). Extended cable lengths are available in multiples of 1.22 m (4 ft) only.

Example: To order a limit switch with a factory-installed 1.52 m (5 ft) cable, the cat. no. would become **802T-APDY5**. To order a limit switch with a factory-installed 2.44 m (8 ft) cable, the cat. no. would become **802T-APDY8**.

Mini-Style Quick-Disconnect

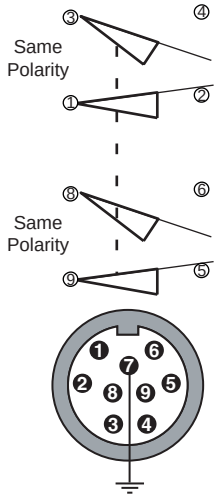
To order an 802T pre-wired limit switch with a 5-pin (2 circuit) or 9-pin (4 circuit) mini connector, add the suffix **J1** or **J9** depending on desired wiring (J9 wiring not available for 4-circuit models) to the cat. no. **Example: 802TAPDJ1**.

5-Pin Mini-Type Receptacle (2 circuit)



9-Pin Mini-Type Receptacle (4 circuit)

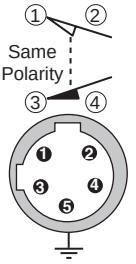
"J1" Wiring ("J9" wiring not available for 4 circuit)



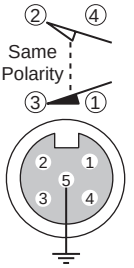
Micro-Style Quick-Disconnect

Micro quick-disconnects are available with a 5-pin 2-keyway AC or 5-pin single keyway DC. To order a limit switch with a AC micro quick-disconnect, add the suffix **R5** to the cat. no. To order a limit switch with a DC micro quick-disconnect, add the suffix **D5** to the cat. no. **Example: 802TAPDR5** and **802TAPDD5**.

AC Micro QD



DC Micro QD



Levers

Type	Roller [mm (in.)]			Cat. No.
	Material	Diameter	Width	
	Nylon	19.05 (0.75)	7.11 (0.28)	802T-W1
	Nylon	19.05 (0.75)	25.4 (1.0)	802T-W1H
	Steel	19.05 (0.75)	6.35 (0.25)	802T-W1A
Non-Adj. Cast Lever 38.1 mm (1.5 in.) Radius Roller on Front	Ball Bearing	19.05 (0.75)	5.84 (0.23)	802T-W1B

Note: Additional lever options are available in the Limit Switch section of the *Sensors* catalog.

Notes

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Operator Interface

Emergency Stop Devices

Cable Pull Switches

Overview 4-2
LIfeline™ Rope Tensioner System (LRTS) 4-4
Lifeline™ 3 4-6
Lifeline™ 4 4-10
Lifeline™ 4 Stainless Steel 4-16

Enabling Switches

GripSwitch 4-24

Push Button Switches

22.5 mm 4-29
30 mm 4-41

Two-Hand Control Devices

Touch Buttons

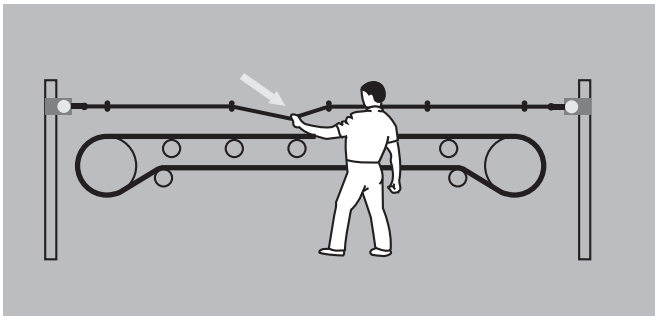
800Z Zero-Force Touch Buttons 4-48

Cable Pull Switches

Overview

Cable Pull Switches Overview

For machinery such as conveyors, it is often more convenient and effective to use a cable pull device along the hazard area (as shown in the figure below) as the emergency stop device. These devices use a steel wire rope connected to latching pull switches so that pulling on the rope in any direction at any point along its length will trip the switch to cut off the machine power.



The cable pull switches must detect both a pull on the cable as well as when the cable goes slack. Slack detection ensures that the cable is not cut and is ready for use.

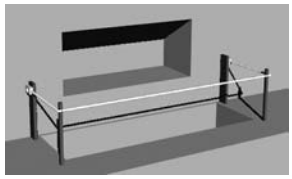
Rockwell Automation developed a unique Lifeline Rope Tensioner System (LRTS) which helps enable quicker installations.

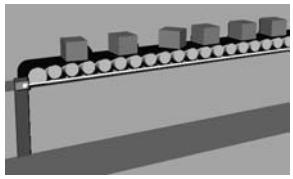
A dedicated stainless steel installation kit must be used with the stainless steel Lifeline 4 instead of the LRTS.

Selection Guide

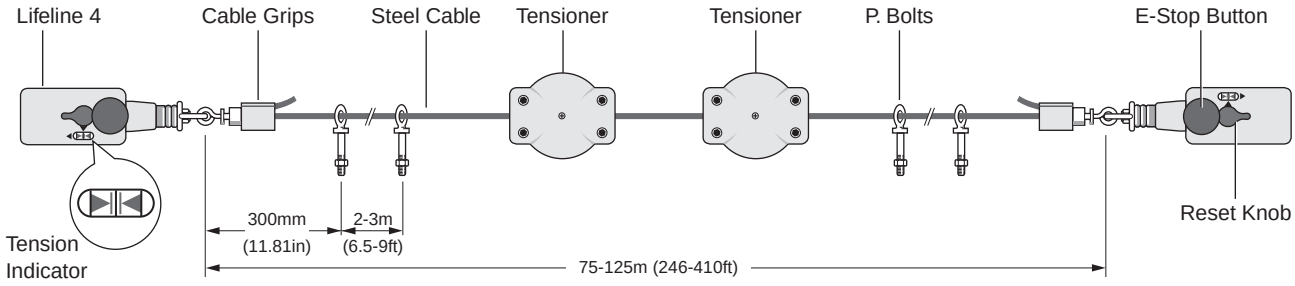
Description	Lifeline 3	Lifeline 4	Stainless Steel Lifeline 4
Material	Painted Zinc Alloy	Painted Aluminum Alloy	Stainless Steel 316
Reset	Yes	Yes	Yes
E-Stop	No	Yes	Yes
Cable Span	30 m (98.42 ft)	75 m (246 ft) 125 m (410 ft) extended model	75 m (246 ft)

Typical Applications





Mounting Specifications for Extended Length Models



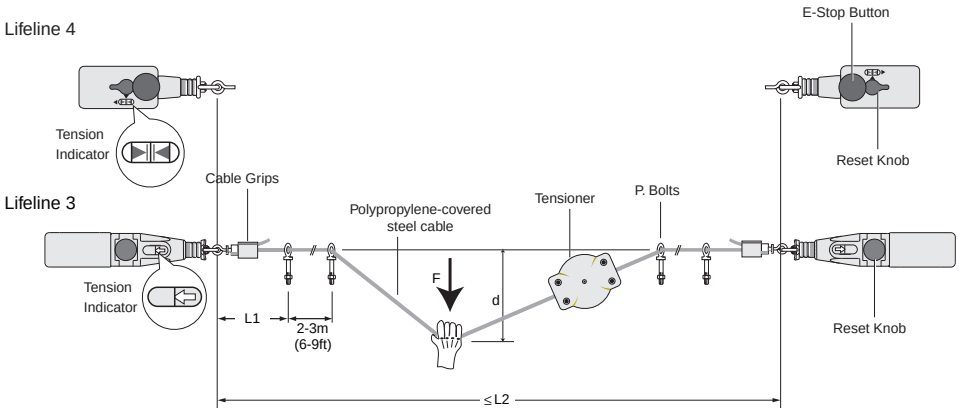
Notes:

1. The first and last **P. bolt/eye bolt** must be located as close as possible to the switch eyelet while maintaining adequate clearance (125 mm/5 in) from the cable grips to allow free movement. This provides for a straight and efficient pulling action on the switches.
2. Additional **P. bolts/eye bolts**, spaced 2-3 m (6-9 ft) apart, help keep the perpendicular pull force, F, and distance, d, within IEC60947-5-5 specifications of 200 N (45 lbs) and 400 mm (15.75 in).
3. We recommend using a switch at both cable ends, especially in applications with long cable runs or cable runs going around bends. This helps ensure that the safety function is fulfilled upon actuation of the cable in any direction.
4. ISO 13850 requires that the full length of cable to be within view when the reset is turned to the run position or the machine must be inspected over the whole length of the cable, both before and after resetting.
5. On shorter cable runs (max 10 m), a Lifeline tensioner spring may be used at one end of the span. The installation must be such that the above requirements can be met. When a spring is used, the last **P. Bolt/eye bolt** must be located as close as possible to the spring while maintaining adequate clearance (125 mm/5 in) from the cable grips to allow free movement. This is intended to help to ensure that a pull near the end of the cable will be between **P. Bolts/eye bolts**. This should result in operation of the switch contacts instead of only the spring moving.
6. Careful attention is required for the design of the installation to ensure that the cable is not likely to become trapped or snagged. This is especially important when using a tensioner spring because a cable snag between the location of the pull and the switch could prevent the actuation of the safety function.
7. It is essential that when the installation is complete, a thorough functional test is made. This should include checking all types and directions of pull over the length of the cable as well as checking for slack-cable tripping.

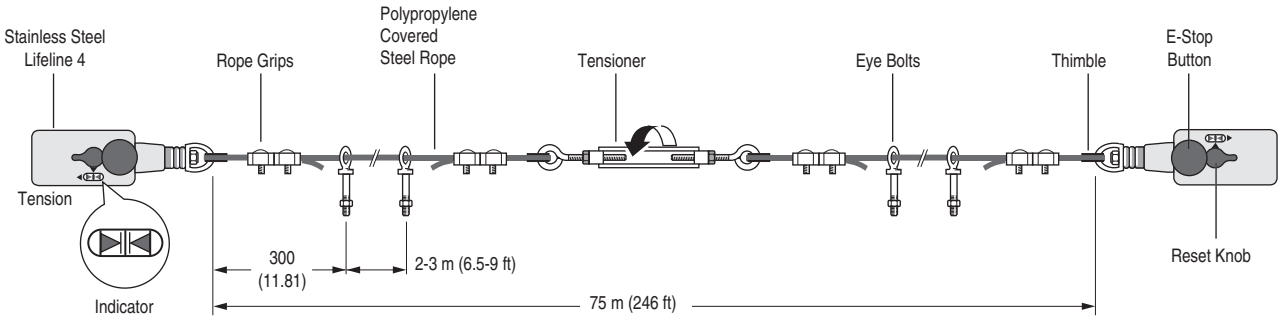
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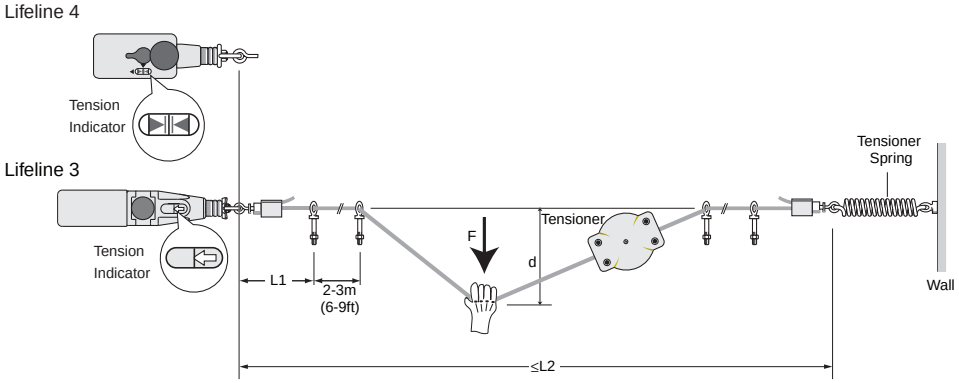
Mounting Specifications for Standard Rope Length Models



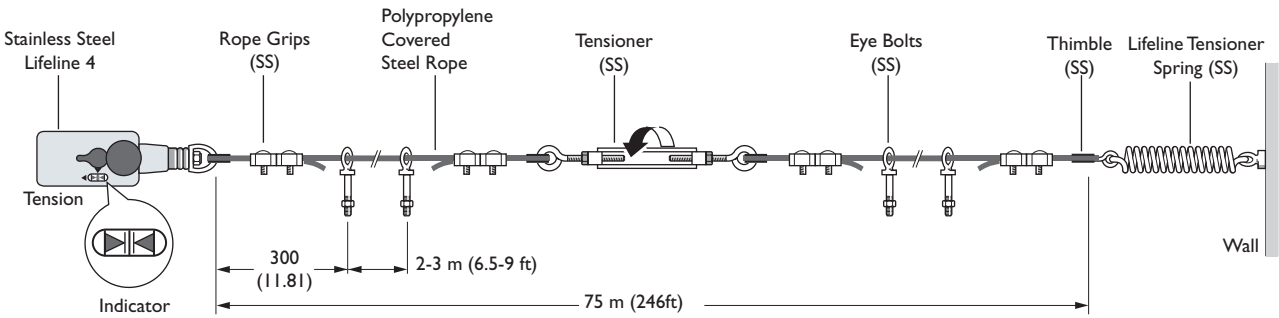
	L1	L2
Lifeline 4	300 mm (11.81 in)	75 m (246 ft)
Lifeline 3	125 mm (5 in)	30 m (98 ft)



Mounting Specifications with Spring Tensioner



	L1	L2
Lifeline 4	300 mm (11.81 in)	75 m (246 ft)
Lifeline 3	125 mm (5 in)	30 m (98 ft)



The choice between using two switches or one switch and a spring is a matter of a risk assessment taking into consideration the probability of a trapped rope along the span. See also notes 3 and 6 on the previous page.

Cable Pull Switches

Lifeline™ Rope Tensioner System (LRTS)



Description

The LRTS is a unique cable (rope) tensioning system which enables quicker installation of cable actuated systems. Other methods are traditionally time consuming and sometimes awkward to fit. Features of the system include:

1. Cable adjustment up to 300 mm (11.8 in) (150 mm (5.9 in) either side of tensioner)
2. Quick thread and grip of cable with cable grip
3. Cable tidy incorporated into the cable grips
4. Simple tensioning via the tensioner with allen key.

Due to the appeal of quick installation and universal use, the LRTS can also be used for applications other than cable actuated emergency stop systems.

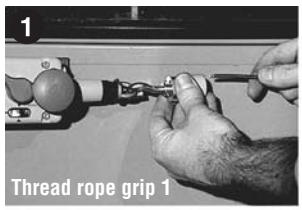
Features

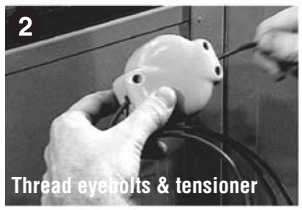
- Unique cable grip system
- Can be installed and commissioned in approximately 3 minutes
- Ease of installation, no specialty tools required
- Up to 300 mm (11.8 in) of cable adjustment
- Cable tidy incorporated into cable grips

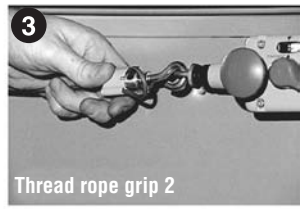
Specifications

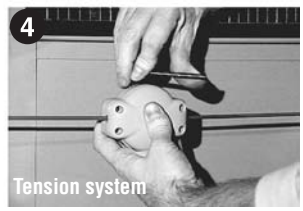
Material	Tensioner: Glass-filled nylon Cable gripper: Acetal, zinc alloy, stainless steel Cable gripper gears: Stainless steel Cable: Cable to BS 302:1987, wire Ø4.0 Steel Core with polypropylene sheath P. Bolt: Stainless steel
Color	Tensioner: Yellow Cable gripper: Yellow/natural Cable: Red P. Bolt: Natural
Weight [g (lb)]	Tensioner: 140 (0.31) Cable gripper: 80 (0.17)
Operating Temperature [C (F)]	-25…80° (-13…176°)
Cable O.D.	4 mm (0.15 in.)
Cable Adjustment Range, Max.	300 mm (11.8 in.)
Tensioner Holding Force, Max.	500 N (112.5 lbf)
Gripper Holding Force, Max.	280 N (63.0 lbf)
Enclosure Type Rating	IP30
Tensioner Adjustment Tool	5 mm A/F Allen key

Four Steps to Install









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Allen-Bradley
Guardmaster®

Product Selection

Description		No. of P-Bolts	Cat. No.
	Installation Kit—5 m (16.4 ft)	3	**440E-A13079**
	Installation Kit—10 m (32.8 ft)	6	440E-A13080
	Installation Kit—15 m (49.2 ft)	8	**440E-A13081**
	Installation Kit—20 m (65.6 ft)	10	440E-A13082
	Installation Kit—30 m (98.4 ft)	14	440E-A13083
	Installation Kit—50 m (164 ft)	22	440E-A13084
	Installation Kit—75 m (246 ft)	32	440E-A13085

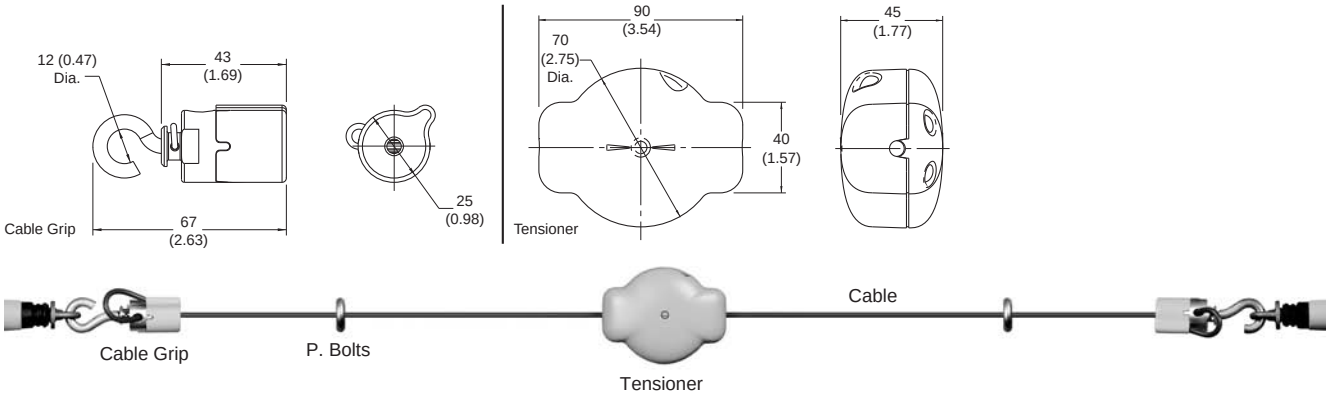
A stainless steel tensioner kit is available for use with the Lifeline 4 Stainless Steel, see page 4-18.

Accessories

Description			Cat. No.
	Lifeline tensioner and Allen key only		**440E-A17105**
	Lifeline gripper two pack		440E-A17107
	Lifeline gripper 20 pack		440E-A17106
	Lifeline tensioner, two grippers and Allen wrench		**440E-A17112**
	Two Lifeline tensioners, two grippers and Allen wrench		440E-A17140
 Red Cable	Polypropylene covered steel cable	15 m (49.2 ft)	440E-A17026
		30 m (98.4 ft)	440E-A17027
		100 m (328 ft)	440E-A17028
		125 m (410 ft)	440E-A17129
		300 m (984 ft)	440E-A17095
		500 m (1640 ft)	440E-A17032
	UV resistant polypropylene covered steel cable	100 m (328 ft)	440E-A14739
		300 m (984 ft)	440E-A14740

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Cable Pull Switches

Lifeline™ 3



Description

The Lifeline 3 is a cable (rope) operated emergency stop device designed to meet the stringent requirements of ISO 13850 (Safety of Machinery—Emergency Stop Equipment). The Lifeline 3 system can be installed along or around awkward machinery such as conveyors and provides a constant-access emergency-stop facility.

1. The positive-mode mechanism helps ensure that the contacts are immediately latched open on actuation and can only be reset by the intentional action of turning the blue reset knob. The design also protects against nuisance tripping and the effects of thermal expansion.
2. The cable-status indicator makes the system easy to set up and maintain for spans up to 30 m (98 ft).
3. Four sets of contacts are provided: 2 N.C. + 2 N.O., or 3 N.C. + 1 N.O. contacts.
4. Sealed to IP 67 with rugged construction using die-cast alloy and stainless steel to withstand harsh conditions.

Features

- Switches up to 30 m (98 ft) span
- Universal mounting and operation
- Switch lockout on cable pulled and cable slack
- Cable-status indicator on switch lid
- Industry standard fixing centers to DIN/EN 50041
- Quick disconnect styles available

Specifications

Safety Ratings					
Standards		ISO 13850, EN ISO 12100, IEC 60947-5-1, IEC 60947-5-5			
Safety Classification		Cat. 1 device per EN 954-1 May be suitable for use in Cat 3 or Cat 4 systems depending on the architecture and application characteristics			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs					
Safety Contacts ❄		2 N.C. direct-opening action		3 N.C. direct-opening action	
Auxiliary Contacts		2 N.O. direct-opening action		1 N.O. direct-opening action	
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Cable Span Between Switches, Max.		30 m (98 ft)			
Tensioning Force to Run Position		103 N (23.17 lbf) typical			
Tensioning Force to Lockout		188 N (42.3 lbf) typical			
Operating Force, Min.		<125 N (28.1 lb) at 300 mm deflection			
Actuation Frequency, Max.		1 cycle/s			
Operating Life @ 100 mA load		1 x 10^6			
Environmental					
Enclosure Type Rating		IP67			
Operating Temperature [C (F)]		-25…80° (-13…176°)			
Physical Characteristics					
Housing Material		Heavy-duty painted zinc-based die-cast alloy			
Indicator Material		Glass-filled nylon			
Eye Nut Material		Stainless steel			
Weight [g (lb)]		610 (1.34)			
Color		Yellow body, blue reset button			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Note: It is recommended that the LRTS (Lifeline Rope Tensioning System) should be used with the Lifeline 3 cable rope switch.

Product Selection

Contacts		Cat. No.				
		Conduits		Connectors✶		
Safety	Auxiliary	M20	1/2 inch NPT	12-Pin M23	8-Pin Micro (M12)❄	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)‡
2 N.C.	2 N.O.	**440E-D13118**	**440E-D13120**	440E-D13132	440E-D21BNYH	440E-D2NNNYS
3 N.C.	1 N.O.	**440E-D13112**	440E-D13114	440E-D13124	—	—

✶ For connector ratings, see page 3-9.
❄ With an 8-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 4-9 for wiring details.
‡ For connection to ArmorBlock Guard I/O. With a 5-pin micro (M12) connector, not all contacts are connected. See *Typical Wiring Diagram* on page 4-9 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see the Safety Relays section (page 5-8) of this catalog.
For additional Safety I/O and Safety PLC connectivity, see the Programmable Safety System section (page 5-115) of this catalog.
For application and wiring diagrams, see the Safety Applications section (page 10-1) of this catalog.

Connection Systems

Description	5-Pin Micro (M12)⌘	8-Pin Micro (M12)	12-Pin M23
Cordset	—	889D-F8AB-§	889M-FX9AE-§
Patchcord	889D-F5ACDM-♣	889D-F8ABDM-♣	889M-F12AHMU-➢

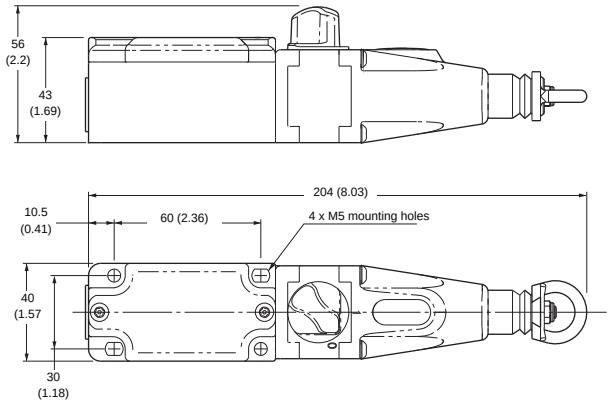
§ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
♣ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
➢ Replace symbol with 0M3 (0.3 m), 0M6 (0.6 m), 1 (1 m), 2 (2 m) or 3 (3 m) for standard lengths.
⌘ To connect to ArmorBlock Guard I/O.

Accessories

Description		Cat. No.
	Lifeline P. bolt M8 x 1.25 thread size, 58 mm (2.28 in.) threaded length, 12 mm (0.47 in.) dia. eye, 95 mm (3.74 in.) overall length	**440E-A17003**
	Lifeline tensioner spring 19 mm (0.75 in.) diameter, 210 mm (8.27 in.) overall length, 50 N force	**440E-A13078**
	Lifeline inside corner pulley Internal diameter 16 mm (0.64 in.) zinc-plated mild steel	**440A-A17101**
	Lifeline outside corner pulley Outside diameter 38 mm (1.5 in.) zinc-plated mild steel	440A-A17102
	Blanking plug, M20 conduit	440A-A07265
	Cable grip, M20 conduit, accommodates cable diameter 7…10.5 mm (0.27…0.41 in.)	440A-A09028
	Adaptor, conduit, M20 to 1/2 inch NPT, plastic	440A-A09042
	Screwdriver including security bit	440A-A09018

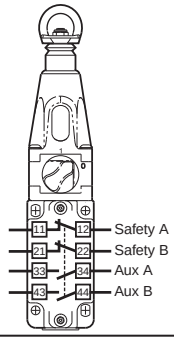
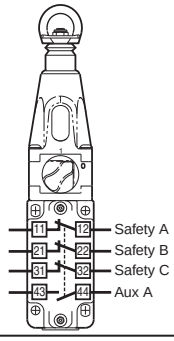
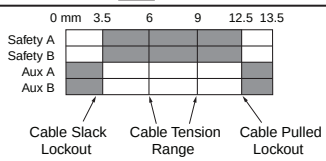
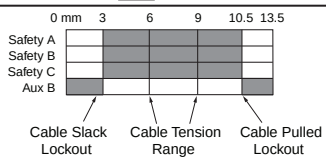
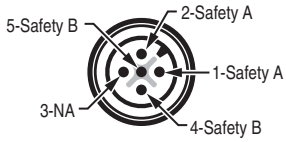
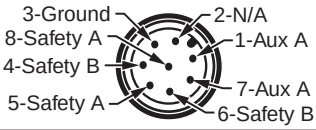
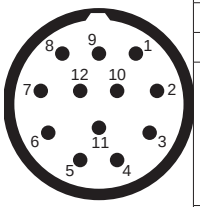
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



***Note**: 2D, 3D and electrical drawings are available on www.ab.com.*

Typical Wiring Diagrams

Description		2 N.C. & 2 N.O.	3 N.C. & 1 N.O.
Contact Configuration			
Contact Action ☐Open ■Closed			
5-Pin Micro (M12) for ArmorBlock Guard I/O			—
8-Pin Micro (M12)			—
12-Pin M23  Pins 2, 5, 11 not connected	1-3	Safety A	Safety A
	4-6	Safety B	Safety B
	7-8	Aux A	Safety C
	9-10	Aux B	Aux A
	12	Ground	Ground
8-Pin Cordset 889D-F8AB-∗	Grey Red	Safety A	
	Yellow Pink	Safety B	
	White Blue	Aux A	
	Green	Ground	
	Brown	Not Used	
12-Pin Cordset 889M-FX9AE-❄	Brown Blue	Safety A	Safety A
	White Green	Safety B	Safety B
	Yellow Grey	Aux A	Safety C
	Pink Red	Aux B	Aux A
	Green Yellow	Ground	Ground

∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 0F5 (0.5 ft) or 1F (1 ft) for standard cable lengths.

Cable Pull Switches

Lifeline™ 4



Description

The Lifeline 4 cable/push button operated system can be installed along or around awkward machinery such as conveyors and provide a constant emergency stop access.

The Lifeline 4 is the only device of its kind to incorporate the following features in one unit making it the most versatile cable switch on the market.

1. The positive mode mechanism helps ensure that the contacts are immediately latched open on actuation and can only be reset by the intentional action of turning the blue reset knob. The design also protects against nuisance tripping and the effects of thermal expansion.
2. A mushroom head emergency stop button is included on the unit to provide E-Stop access even at the extreme ends of the span.
3. The cable status indicator makes the system easy to set up and maintain for spans up to 125 meters.
4. Four sets of contacts are provided: 2 N.C. + 2 N.O. or 3 N.O. + 1 N.O. contacts
5. Sealed to IP66 with rugged construction using die-cast alloy and stainless steel to withstand harsh conditions.

Features

- Switches up to 125 meter span
- Universal mounting and operation
- Lid mounted emergency stop button, designed to conform to ISO 850
- Switch lockout on cable pulled and cable slack
- Cable status indicator on switch lid

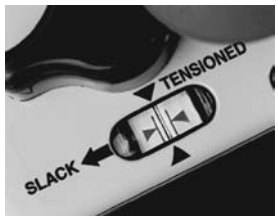
Lid mounted E-Stop button

A mushroom head emergency stop button is included on the unit to provide total E-Stop access even at the extreme ends of the span.



Cable status indicator on lid

The cable status indicator makes the system easy to setup and maintain for spans up to 125 meters.



Specifications

Safety Ratings					
Standards		ISO 13850, EN ISO 12100, IEC 60947-5-1, IEC 60947-5-5			
Safety Classification		Cat. 1 device per EN 954-1 May be suitable for use in Cat 3 or Cat 4 systems depending on the architecture and application characteristics			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus, TÜV, and CCC			
Outputs					
Safety Contacts ❄		2 N.C. direct-opening action		3 N.C. direct-opening action	
Auxiliary Contacts		2 N.O. direct-opening action		1 N.O. direct-opening action	
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Cable Span Between Switches, Max.		75 m (246 ft) standard model and 75…125 m (146…410 ft) extended length model			
Tensioning Force to Run Position		103 N (23.16 lbf) typical			
Tensioning Force to Lockout		188 N (42.3 lbf) typical			
Operating Force, Min.		<125 N (28.1 lbf) at 300 mm deflection			
Actuation Frequency, Max.		1 cycle/s			
Operating Life @ 100 mA load		1 x 10^6			
Environmental					
Enclosure Type Rating		IP66			
Operating Temperature [C (F)]		-25…80° (-13…176°)			
Physical Characteristics					
Housing Material		Heavy-duty painted zinc-based die-cast alloy (LM24)			
Indicator Material		Glass-filled nylon			
Eye Nut Material		Stainless steel			
Weight [g (lb)]		630 (1.38)			
Color		Yellow body, blue reset button			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Note: It is recommended that the LRTS (Lifeline Rope Tensioning System) should be used with the Lifeline 4 cable rope switch.

Product Selection

Cable Span	Safety Contacts	Auxiliary Contacts	Cat. No.				
			Conduits		Connectors✶		
			M20	1/2 inch NPT	12-Pin M23	8-Pin Micro❄	Connect to ArmorBlock Guard I/O 5-Pin Micro (M12)‡
75 m (246 ft)	2 N.C.	2 N.O.	**440E-L13137**	**440E-L13133**	440E-L13140	440E-L21BNYH	440E-L2NNNYS
	3 N.C.	1 N.O.	**440E-L13042**	**440E-L13043**	440E-L13141	—	—
75…125 m (146…410 ft)	2 N.C.	2 N.O.	440E-L13153	440E-L13155	440E-L13163	440E-L21BTYH	—
	3 N.C.	1 N.O.	440E-L13150	440E-L13152	440E-L13164	—	—

✶ For connector ratings, see page 3-9.
❄ For connection to ArmorBlock Guard I/O. With a 5-pin micro (M12) connector, not all contacts are connected. See page 4-15 for wiring details.
‡ With an 8-pin micro (M12) connector, not all contacts are connected. See page 4-15 for wiring details.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-4.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	5-Pin Micro (M12)	8-Pin Micro (M12)	12-Pin M23
Cordset	—	889D-F8AB-§	889M-FX9AE-§
Patchcord	889D-F5ACDM-✶	889D-F8ABDM-♣	889M-F12AHMU-➢

✶ Replace symbol with 0M3 (0.3 m), 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard lengths.
§ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
♣ Replace symbol with 1 (1 m), 2 (2 m), 3 (3 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
➢ Replace symbol with 0M3 (0.3 m), 0M6 (0.6 m), 1 (1 m), 2 (2 m) or 3 (3 m) for standard length.

Accessories

Description		Cat. No.
	Lifeline P. bolt	**440E-A17003**
	Lifeline tensioner spring	**440E-A13078**
	Replacement cover for Lifeline 4 cable/push button	440E-A13054
	Replacement cover for Lifeline 4 cable/push button, no E-Stop	440E-A17115
	Lifeline inside corner pulley	**440A-A17101**
	Lifeline outside corner pulley	440A-A17102
	Mounting bracket for Lifeline 4 cable/push button	440E-A17130
	Blanking plug, M20 conduit	440A-A07265
	Cable grip, M20 conduit, accommodates cable diameter 7…10.5 mm (0.27…0.41 in.)	440A-A09028
	Adaptor, conduit, M20 to 1/2 inch NPT, plastic	440A-A09042
	Screwdriver including security bit	440A-A09018

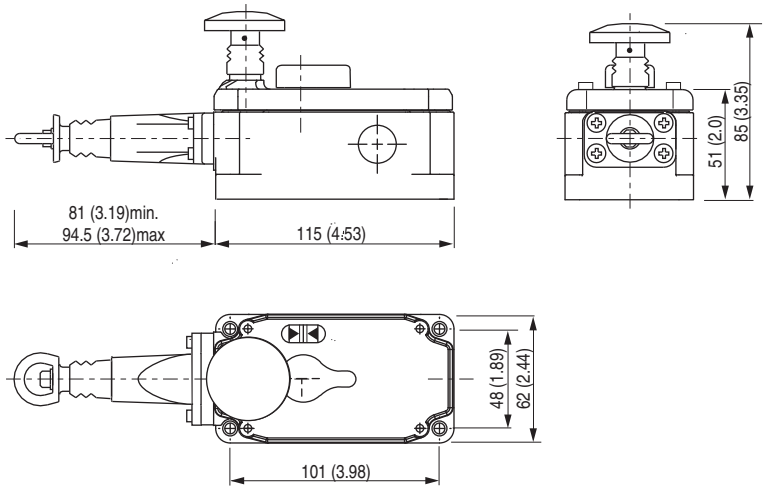
Accessories (continued)

	Description	Cat. No.
	Indicator, M20 Conduit Pilot Light—Amber Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19001
	Indicator, 1/2in NPT Conduit Pilot Light—Amber Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19005
	Indicator, M20 Conduit Pilot Light—Amber Lens Bayonet Style Insert Use LED Bulb (Sold Separately)	440A-A17124
	Indicator, 1/2in NPT Conduit Pilot Light—Amber Lens Bayonet Style Insert Use LED Bulb (Sold Separately)	440A-A17122
	Indicator, M20 Conduit Pilot Light—Red Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19002
	Indicator, 1/2in NPT Conduit Pilot Light—Red Lens T-3 1/4 Insert Use T-3 1/4 Bulb (Sold Separately)	440A-A19007
	Indicator, M20 Conduit Pilot Light—Red Lens Bayonet Style Insert Use LED Bulb (Sold Separately)	440A-A17125
	Indicator, 1/2in NPT Conduit Pilot Light—Red Lens Bayonet Style Insert Use LED Bulb (Sold Separately)	440A-A17123
	Bulb, 24V for Conduit Pilot Light 2.8W T-3 1/4 Bulb, Miniature Screw Base	440A-A09056
	Bulb, 110V for Conduit Pilot Light 2.6W T-3 1/4 Bulb, Miniature Screw Base	440A-A09055
	Bulb, 240V for Conduit Pilot Light 0.75W T-3 1/4 Bulb, Miniature Screw Base	440A-A09054
	Red LED Bulb, 24V AC/DC for Conduit Pilot Light Bayonet Style Insert	800T-N319R
	Amber LED Bulb, 24V AC/DC for Conduit Pilot Light Bayonet Style Insert	800T-N319A
	Red LED Bulb, 120V AC for Conduit Pilot Light Bayonet Style Insert	800T-N320R
	Amber LED Bulb, 120V AC for Conduit Pilot Light Bayonet Style Insert	800T-N320A

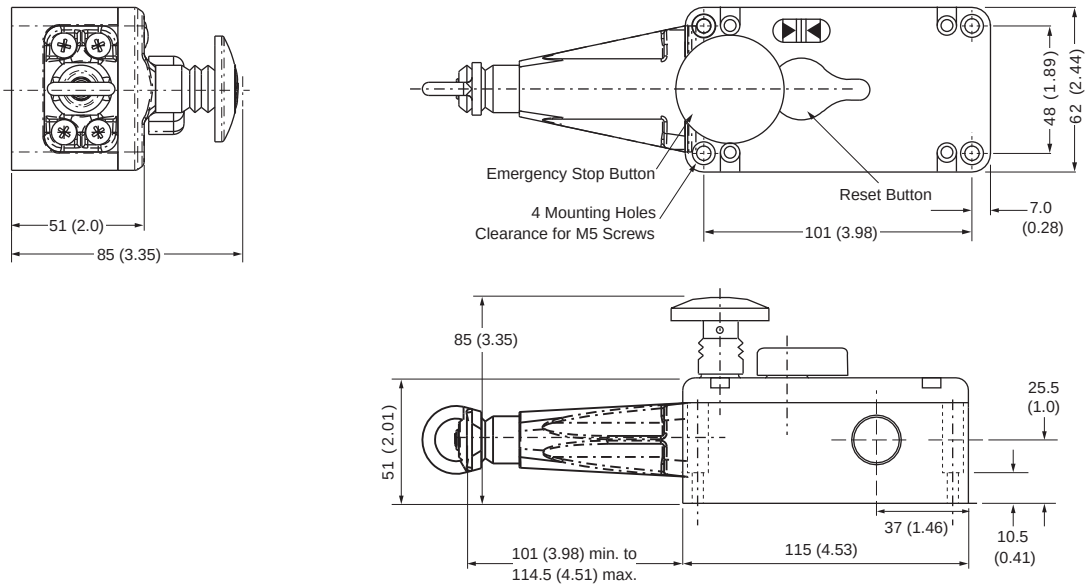
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Standard Model

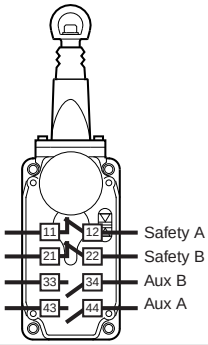
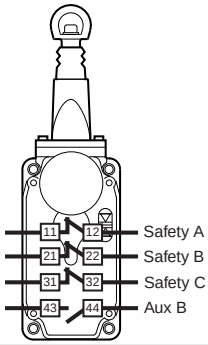
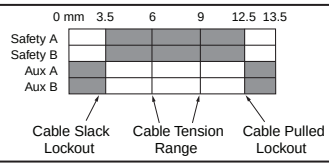
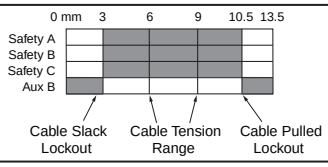
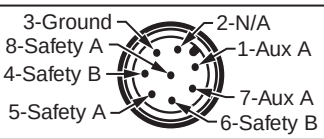
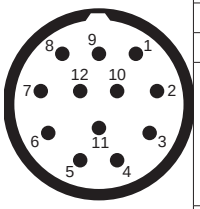
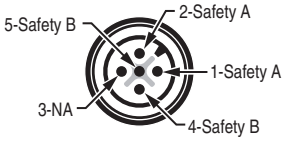


Extended Length Models (75…125 m cable span)



Note: 2D, 3D and electrical drawings are available on www.ab.com.

Typical Wiring Diagrams

Description		2 N.C. & 2 N.O.	3 N.C. & 1 N.O.
Contact Configuration			
Contact Action □Open ■Closed			
8-Pin Micro (M12)			—
12-Pin M23  Pins 2, 5, 11 not connected	1-3	Safety A	Safety A
	4-6	Safety B	Safety B
	7-8	Aux A	Safety C
	9-10	Aux B	Aux A
	12	Ground	Ground
5-Pin Micro for ArmorBlock Guard I/O			—
8-Pin Cordset 889D-F8AB-∗	Grey Red	Safety A	—
	Yellow Pink	Safety B	—
	White Blue	Aux A	—
	Green	Ground	—
	Brown	Not Used	
12-Pin Cordset 889M-FX9AE-∗	Brown Blue	Safety A	Safety A
	White Green	Safety B	Safety B
	Yellow Grey	Aux A	Safety C
	Pink Red	Aux B	Aux A
	Green Yellow	Ground	Ground

∗ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 0F5 (0.5 ft) or 1F (1 ft) for standard cable lengths.

Cable Pull Switches

Lifeline™ 4 Stainless Steel



Description

The stainless steel Lifeline 4 cable/push button operated system can be installed along or around awkward machinery such as conveyors and provide a constant emergency stop access. This switch is made from stainless steel 316 and is suitable for external use, applications where there are hygiene requirements and other situations where a level of corrosion resistance is required.

The Lifeline 4 is the only device of its kind to incorporate the following features in one unit making it the most versatile cable switch on the market.

1. The positive mode mechanism helps ensure that the contacts are immediately latched open on actuation and can only be reset by the intentional action of turning the blue reset knob. The design also protects against nuisance tripping and the effects of thermal expansion.
2. A mushroom head emergency stop button is included on the unit to provide E-Stop access even at the extreme ends of the span.
3. The cable status indicator makes the system easy to set up and maintain for spans up to 75 meters.
4. Four sets of contacts are provided: 2 N.C. + 2 N.O.
5. Sealed to IP66 and IP69K with rugged construction using stainless steel 316 to withstand harsh conditions.

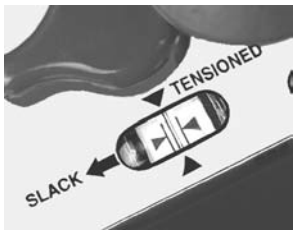
Features

- Switches up to 75 m (246 ft) span
- Universal mounting and operation
- Lid mounted emergency stop button, designed to conform to ISO 850
- Switch lockout on cable pulled and cable slack
- Cable status indicator on switch lid
- Made from stainless steel 316

Lid mounted E-Stop button
A mushroom head emergency stop button is included on the unit to provide total E-Stop access even at the extreme ends of the span.



Cable status indicator on lid
The cable status indicator makes the system easy to setup and maintain for spans up to 75 m (246 ft).



Specifications

Safety Ratings					
Standards		EN 60947-5-5, ISO 13850, EN ISO 12100, IEC 60947-5-1			
Safety Classification		Cat. 1 device per EN 954-1 May be suitable for use in Cat 3 or Cat 4 systems depending on the architecture and application characteristics			
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*		B10d: > 2 x 10^6 operations at min. load PFH_D: < 3 x10^{-7} MTTFd: > 385 years May be suitable for use in performance levels Ple or Pld systems (according to ISO 13849-1:2006) and for use in SIL2 or SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics			
Certifications		CE Marked for all applicable directives, cULus Certified and TÜV			
Outputs					
Safety Contacts ❄		2 N.C. direct opening action			
Auxiliary Contacts		2 N.O.			
Thermal Current I_{th}		10 A			
Rated Insulation Voltage		(Ui) 500V			
Switching Current @ Voltage, Min.		5 mA @ 5V DC			
Utilization Category					
A600/AC-15	(Ue)	600V	500V	240V	120V
	(Ie)	1.2 A	1.4 A	3 A	6 A
DC-13	(Ue)	24V			
	(Ie)	2 A			
Operating Characteristics					
Cable Span Between Switches, Max.		75 m (246 ft)			
Tensioning Force to Run Position		103 N (23.17 lbf) typical			
Tensioning Force to Lockout		188 N (42.3 lbf) typical			
Operating Force, Min.		<125 N (28.1 lbf) at 300 mm deflection			
Actuation Frequency, Max.		1 cycle/s			
Operating Life @ 100 mA load		1 x 10^6			
Environmental					
Enclosure Type Rating		IP66, IP67, IP69K			
Operating Temperature [C (F)]		-25…80° (-13…176°)			
Physical Characteristics					
Housing Material		Stainless steel 316			
Indicator Material		Acetal			
Eye Nut Material		Stainless steel			
Weight [g (lb)]		1442 (3.17)			
Color		Unpainted metal			

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the B10d value given and:
- Usage rate of 1op/10 mins., 24 hrs/day, 360 days/year, representing 51840 operations per year
- Mission time/Proof test interval of 38 years

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Note: It is recommended that the stainless steel installation kit should be used with the stainless steel Lifeline 4 as it is made of suitable materials for harsh conditions.

Product Selection

Cable Span	Safety Contacts	Auxiliary Contacts	Cat. No.		
			Conduits		Connectors§
			M20	1/2 inch NPT	12-Pin M23
Up to 75 m (246 ft)	2 N.C.	2 N.O.	**440E-L22BNSM**	**440E-L22BNST**	440E-L22BNSL

§ For connector ratings, see 3-9.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
MSR126T	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	5-24	**440R-N23117**
MSR30RT	2 N.O. Solid State	1 N.O. Solid State	Removable	Auto./Manual or Monitored Manual	24V DC	5-16	440R-N23198
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-4.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	12-Pin M23
Cordset	889M-FX9AE-✶
Patchcord	889M-F12AHMU-❄

✶ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 0M3 (0.3 m), 0M6 (0.6 m), 1 (1 m), 2 (2 m) or 3 (3 m) for standard length.

Cable Pull Switches

Lifeline™ 4 Stainless Steel

Accessories

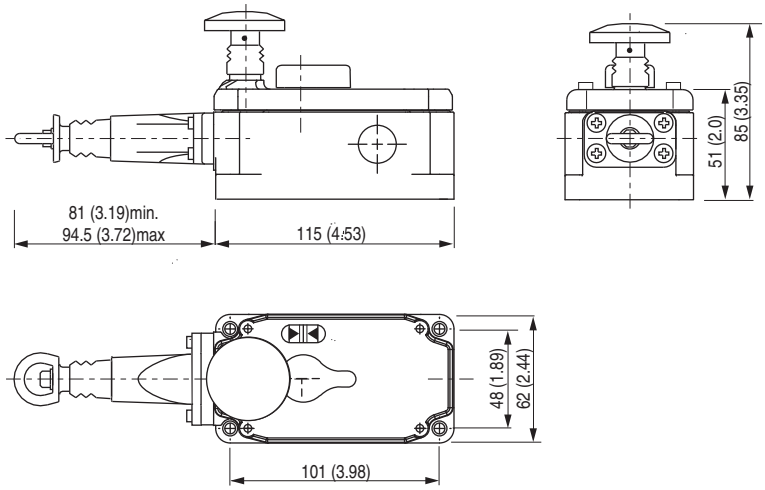
	Description	Eye Bolts	Cat. No.
	Stainless steel installation kit—5 m (16.4 ft)—polypropylene	4	440E-A13194
	Stainless steel installation kit—10 m (32.8 ft)—polypropylene	4	440E-A13195
	Stainless steel installation kit—15 m (49.2 ft)—polypropylene	7	440E-A13196
	Stainless steel installation kit—20 m (65.6 ft)—polypropylene	8	440E-A13197
	Stainless steel installation kit—30 m (98.4 ft)—polypropylene	12	440E-A13198
	Stainless steel installation kit—50 m (164 ft)—polypropylene	20	440E-A13199
Polypropylene Covered Steel Cable	Stainless steel installation kit—75 m (246 ft)—polypropylene	30	440E-A13200
	Stainless steel installation kit—5 m (16.4 ft)—UV resistant	4	440E-A13220
	Stainless steel installation kit—10 m (32.8 ft)—UV resistant	4	440E-A13221
	Stainless steel installation kit—15 m (49.2 ft)—UV resistant	7	440E-A13222
	Stainless steel installation kit—20 m (65.6 ft)—UV resistant	8	440E-A13223
	Stainless steel installation kit—30 m (98.4 ft)—UV resistant	12	440E-A13224
	Stainless steel installation kit—50 m (164 ft)—UV resistant	20	440E-A13225
UV Resistant Polypropylene-Covered Steel Cable	Stainless steel installation kit—75 m (246 ft)—UV resistant	30	440E-A13226
	Stainless steel turn buckle kit (no cable)		440E-A13227
	Stainless steel 304 eyebolt complete M8 x 1.25 thread size, 58 mm (2.28 in) threaded length, 12 mm (0.47 in) dia. eye 95 mm (3.74 in) overall length		**440E-A13201**
	Stainless steel 316 tensioner spring, 19 mm (0.75 in) dia. 210 mm (8.27 in) overall length		**440E-A13202**
	Replacement Cover		440E-A13203
	Replacement cover no E-Stop		440E-A13204
	Stainless steel 316 inside corner pulley		440E-A13205
	Stainless steel outside corner pulley		440E-A13206

Note: Installation Kits include the following parts: one rope, one turnbuckle tensioner, four thimbles, eight rope grips and eyebolts, nuts and washers depending on the length of the rope.

Approximate Dimensions

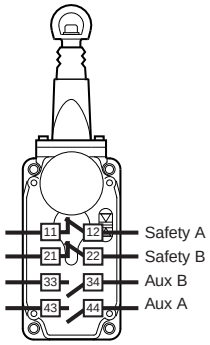
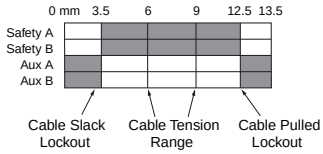
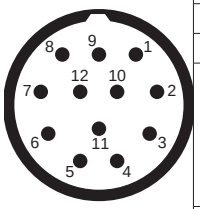
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Standard Model



Note: 2D, 3D and electrical drawings are available on www.ab.com.

Typical Wiring Diagrams

Description		2 N.C. & 2 N.O.
Contact Configuration		
Contact Action □Open ■Closed		
12-Pin M23  Pins 2, 5, 11 not connected	1-3	Safety A
	4-6	Safety B
	7-8	Aux A
	9-10	Aux B
	12	Ground
12-Pin Cordset 889M-FX9AE-∗	Brown Blue	Safety A
	White Green	Safety B
	Yellow Grey	Aux A
	Pink Red	Aux B
	Green Yellow	Ground

∗ Replace symbol with 0F5 (0.5 ft) or 1F (1 ft) for standard cable lengths.

Enabling Switches

Overview

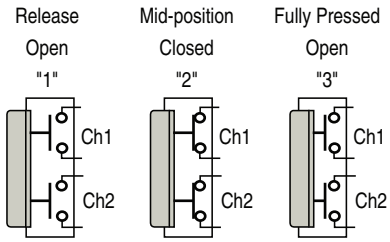


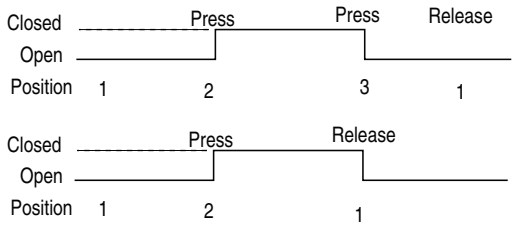
Overview

An enabling device is a manually operated control device used in conjunction with a start control. The safety function of the enabling switch has two parts: 1) when continuously actuated, the enabling device allows machine operation, and 2) when not actuated, the enabling device initiates a stop command to prevent machine operation.

Historically, many enabling devices used a two-position switch. In the event of an unexpected incident, the two-position switch is designed to open when the muscles relax. The three-position switch provides enhanced performance as it is designed to open when the muscles either relax or contract. The trend in machine safeguarding is towards the use of three-position switches. Various types of devices use the three-position switch as enabling devices. These are typically push buttons, grip switches and foot switches.

The Allen-Bradley Guardmaster 440J is a hand-operated grip style enabling device. Underneath the rubber boot, called the trigger switch, the 440J enabling device has two three-position switches. The contacts are closed when the actuator is in the mid-position (partly depressed). The contacts are open when the actuator is in the rest (released) position and in the fully pressed position. When transitioning from fully pressed to released, the contacts remain open. The 440J meets the requirements of IEC 60947-5-8:2006, which was written to describe the performance and design requirements of three-position enabling devices.





Enabling devices are typically used when access to the hazardous portion of the machine is needed while the machine is running. Visual observations, minor adjustments, troubleshooting, calibration, tool changes, and lubrication are examples of tasks that may utilize an enabling device. Before accessing the machine, the operator must usually place the machine in a reduced performance role. A risk assessment must be performed to determine the level of reduced performance. The concept is that in the event of an unexpected event, the operator will either release or squeeze the actuator of the enabling device and disable the machine, prior to getting injured.

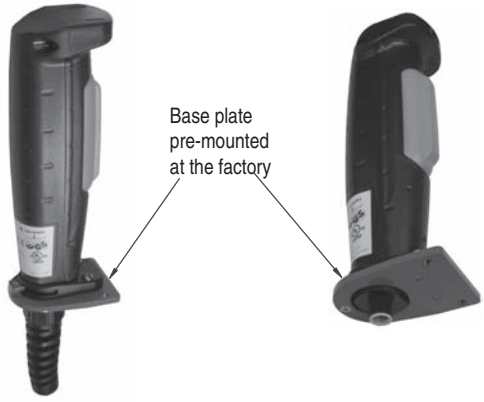
The 440J enabling switches come in three models: 1) standard switch with no additional buttons, 2) switch with an additional single normally open contact, and 3) switch with an additional dual channel e-stop button.

The model with the normally open contact is typically used as a jog or reset function. The safety system design must only allow the use of the jog or reset function when the trigger switch is in the mid-position.

The e-stop button has two normally closed contacts with direct opening action. The e-stop button latches when the contacts open per IEC 60947-5-5 and ISO 13850. When this model is selected with the quick disconnect option, the user must store the enabling switch in an out-of-sight location if it is disconnected.

Mounting Considerations

All three 440J enabling switches come with a base plate. All three models are offered with either a cable strain-relief or an M12 micro quick-disconnect connector.



Cable Strain Relief M12 Micro Quick Disconnect

In some applications, the operation of the switch contacts is all that is needed. In this case, the holding bracket 440J-A00N is used.



440J-A00N

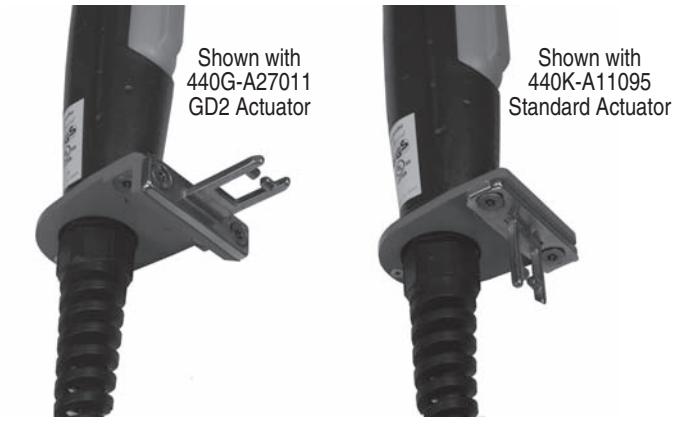


Additional accessory brackets can be added to achieve various arrangements. Cat. No. 440J-A01N right angle bracket is designed to accommodate Cat. No. 440K-A11238 (standard actuator) which is used with the standard Trojan 6 or Trojan T15 and Cat. No. 440G-A27011 (GD2 actuator) which is used with the GD2 interlocks.



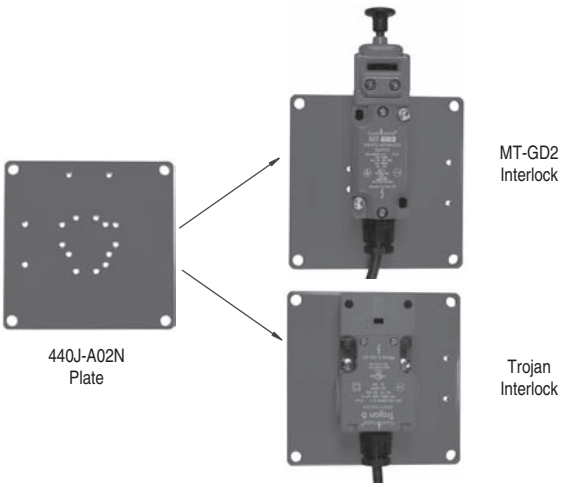
440J-A01N
Bracket
Shown with
GD2 Actuator

With two additional screws, the right angle bracket can be mounted to the 440J enabling switch for horizontal mounting. An actuator can also be mounted for vertical use without the 440J-A01N bracket.



Horizontal Mounting Vertical Mounting

The mounting plate (Cat. No. 440J-A02N) has multiple pre-drilled and tapped holes to facilitate mounting of a single 440K-MT (MT-GD2) or 440K-T (Trojan) interlock. Four additional through-holes at the corners allow mounting of the plate to a flat surface.



The MT-GD2 with the manual latch release should be used for horizontal actuator mounting. The Trojan should only be used with vertical mounting. To use the 440K-T (Trojan 6 or T15), the head must be rotated 180°. The Trojan GD2 models cannot be used with the 440J-A02N as its head cannot be rotated.

The recommended method for single-switch mounting is to use the 440K-MT (MT-GD2) with the latch release. The latch holds the contacts closed when the enabling switch is bumped or rattled. An alternative is to use the 440K-T (Trojan 6 or T15) with a vertical mounting. The holding force of these interlocks is enough to keep the contacts closed under minor bumps and rattles.



Horizontal Mount
with MT-GD2



Vertical Mount
with Trojan

In some applications, additional contacts are needed when the enabling switch is used. Two additional accessories are used to allow the enabling switch to interact with two interlocks.

Cat. No. 440J-A03N accessory mounts to the enabling switch base plate. This accessory has two sets of holes to accommodate either two standard or two GD2 actuators. This arrangement is used in conjunction with Cat. No. 440K-A04N accessory.



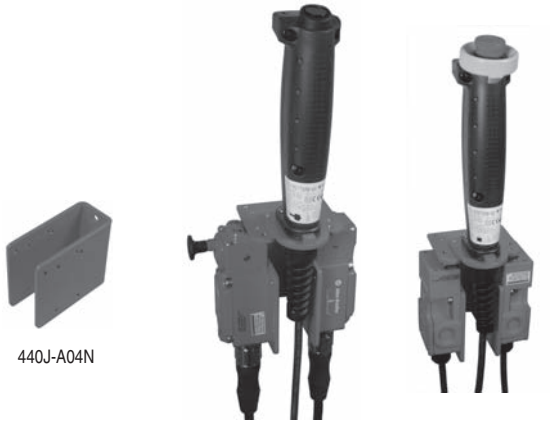
440J-A03N



Enabling Switch mounted on
440J-A03N, shown with
two standard actuators

The U-shaped 440J-A04N can accommodate two interlocks: either 440K-MT or 440K-T. Using the 440J-A03N plate with dual actuators, a total of eight contacts, four in each switch, can be made available for the safety and control system.

Application Considerations



Dual Interlock Switches
Provide Eight Contacts

Safety system designers will quickly realize that the enabling device by itself is easy to understand; it is simply a set of contacts. The application of the enabling device into a machine safeguarding system is the challenge.

Consideration must be given to the following:

1. Setting the machine in reduced performance mode.

In some cases, the speed or other characteristic of the machine must be reduced to allow the operator to avoid the hazard by releasing or squeezing the trigger switch. The control system must be designed so that the machine is not changed back to normal performance during the enabling task. A key-operated mode selector switch is one method of setting the machine in a reduced performance mode. The operator selects reduced mode and then removes the key from the switch, taking the key with him or her. Holding the trigger switch then allows the hazard to operate in a reduced mode.

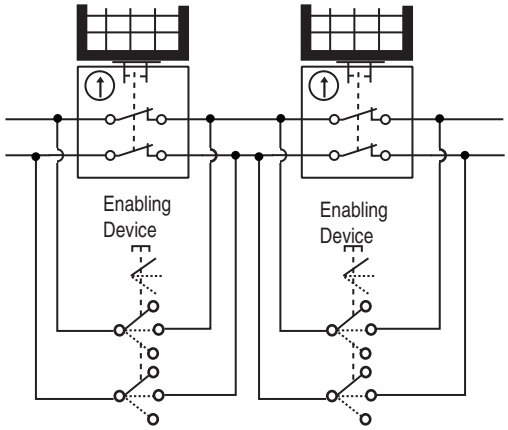
2. Knowing the machine is in reduced performance mode

Sensors can be used to determine that reduced performance of the machine is maintained. Position sensors, encoders or other devices, monitored by an appropriated logic device, provide feedback to the control system. If the performance (e.g., operating speed) were to increase beyond a predetermined limit, the control system would execute a stop command. Releasing the enabling device could also be used to execute a stop command.

3. Type of access

The safety system architecture will differ depending on whether partial body or full body access is required.

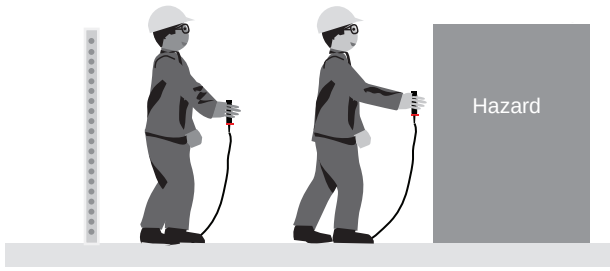
When partial body access is required, the enabling device must continuously bypass the primary safeguard (e.g. gate interlock, light curtain, safety mat, or safety scanner). Enabling devices must only bypass one primary safeguard—bypassing multiple safeguards with one enabling device must be avoided as access to the hazard may not be detected by the other bypassed safeguards.



If full body access is required, consideration must be given to whether the primary safeguard can or must be active during the operation of the enabling device. With the primary safeguard active, additional entries into the hazard area will be detected. If the primary safeguard must remain inactive, administrative procedures must ensure that additional personnel do not enter the hazard area.

4. Multiple Personnel Access

When more than one person must access the hazard, all persons must utilize their own enabling device. All enabling devices must be active to energize the hazard.



The table below summarizes when additional interlocking devices must be used in conjunction with the enabling device. For partial body access, three cases exist, depending on the type of device being bypassed and the logic unit used by the safety system.

1. The enabling switch can be connected directly across the safeguarding device that has dry contacts.
2. Devices with OSSD outputs, like the GuardShield Light curtain will need a single interlock with four contacts to avoid nuisance faults when a monitoring safety relay is used as the safety system logic device.
3. When a safety PLC is used as the logic device, the enabling device can be connected to separate inputs and internal programming logic can be used to bypass the light curtain when the enabling switch is needed.

For full body access, there are two cases, which depend on the logic device used by the safety system.

1. When a safety PLC is used, a single interlock with four contacts is needed. These four contacts are used to interlock the safety system reset function and the machine start function.
2. When a monitoring safety relay is used, two interlocks with four contacts each are needed. Four contacts are used to bypass the primary safeguarding device. Two contacts are used to reset the safety system. Two contacts are used to interlock the machine start control to prevent starting of the machine from the control panel.

Access Type	Safeguard Type	Logic Device	Interlocks Required
Partial Body	Dry Contact Interlocks (e.g., Elf, Cadet, Trojan, MT-GD2, Sipha, Ferrogard, 440G-MT, TLS-GD2, Atlas)	Monitoring Safety Relay or Safety PLC	None
	Devices with OSSD Outputs (e.g., GuardShield Light Curtain, SensaGuard, SafeZone Multizone)	Safety PLC	
		Monitoring Safety Relay	Single Interlock with Four Contacts
Full Body	All Types	Safety PLC	Single Interlock with Four Contacts
		Monitoring Safety Relay	Dual Interlocks, each with Four Contacts

Enabling Switches

GripSwitch



Description

The three position enabling switch can be used as part of the conditions required to allow safe working inside a machine guard, e.g., set-up, maintenance, or troubleshooting. It is lightweight and ergonomically designed for easy use. The standard model includes two independent three-position switches which are actuated by squeezing the trigger. Additional models are available with an optional jog button or dual channel e-stop button.

The trigger switch has three positions. The mid-position is the "enabled" position.

Position 1—there is no pressure on the trigger switch, and the safety contacts are open.

Position 2—the trigger switch is squeezed to the mid-position, and the safety contacts are closed. This mid-position is the "enabled" position.

Position 3—the trigger switch is fully pressed and the safety contacts are open.

When the trigger switch is released from position three back to position one, the safety contacts remain open, as it passes through position two.

Features

- Dual three position enabling switches
- Lightweight and ergonomic
- Optional jog and e-stop functions

Specifications

Safety Ratings				
Standards		IEC/EN60947-5-8, IEC/EN 60947-5-1, IEC/EN 60204-1, NFPA 79, ANSI B11.19, ANSIR15.06, ISO 10218, ISO 11161		
Safety Classification		Cat. 1 Device per EN954-1; Dual channel suitable for Cat. 3 or 4 systems		
Certifications		CE Marked for all applicable directives, cULus Listed, BG		
Outputs				
Safety Contacts ❄		2 N.C. direct opening action		
Auxiliary Contacts		1 N.C.		
Jog Contact		1 N.O.		
E-Stop		2 N.C. Direct-Opening Action		
Thermal Current I_{th}		3 A		
Rated Insulation Voltage		(Ui) 250V (jog button 125V)		
Switching Current @ Voltage, Min.		5 mA @ 3V AC/DC		
Utilization Category		30V DC	125V AC	250V AC
3-Position Switch Terminals 1-2 and 3-4	DC-12 or AC-12 Resistive	2 A	3 A	0.5 A
	DC-13 or AC-15 Inductive	1 A	1.5 A	0.5 A
Monitor Switch Terminals 5-6	DC-12 or AC-12 Resistive	2 A	2 A	1 A
	DC-13 or AC-15 Inductive	1 A	1 A	0.5 A
E-Stop Switch Terminals 5-6 and 7-8	DC-12 or AC-12 Resistive			
	DC-13 or AC-15 Inductive			0.5 A
Operating Characteristics				
Operating Force, Min.		Position 2: 15 N (3.37 lbf) approx. Position 3: 50 N (11.2 lbf) max.		
Direct Opening Force		90 N (20 lbf)		
Actuation Frequency, Max.		1200 operations per hour		
Environmental				
Enclosure Type Rating		IP66 Standard Switch (NEMA 6) IP65 Jog Button and E-Stop Switches		
Relative Humidity		45…85%		
Operating Temperature [C (F)]		-10…+60° (14…140°)		
Vibration		5…55 Hz, 0.5 mm		
Shock		10 g		
Physical Characteristics				
Wire Size		0.14…1.5 mm^2 (24…14 AWG)		
Cable Size		7…13 mm (0.27… 0.51 in.)		
Terminal Screw Torque		0.5…0.6 N•m (4.4…5.3 ibf•in)		
Conduit Type		M20		
Material		Polyamide (Nylon) PA66		
Boot Material		NBR/PVC Nitrile Blended with PVC		
Weight [g (lb)]		250 (0.55) with E-stop 210 (0.46) standard and jog		
Color		Black/grey		

❄ The safety contacts are described as normally closed (N.C.) i.e., with the guard closed, actuator in place (where relevant) and the machine able to be started.

Product Selection

Description	Cat. No. M20 Conduit with Cable Strain Relief
Standard Switch (No additional buttons)	440J-N21TNPM
Switch with Jog Button	440J-N21TNPM-NP
Switch with Emergency Stop Button	440J-N2NTNPM-NE

Note: Base plate included with all switches.

Recommended Logic Interfaces

Description	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. Page No.	Cat. No.
Single-Function Safety Relays for 2 N.C. Contact Switch							
MSR127RP	3 N.O.	1 N.C.	Removable (Screw)	Monitored Manual	24V AC/DC	5-26	**440R-N23135**
MSR127TP	3 N.O.	1 N.C.	Removable (Screw)	Auto./Manual	24V AC/DC	5-26	**440R-N23132**
Modular Safety Relays							
MSR210P Base 2 N.C. only	2 N.O.	1 N.C. and 2 PNP Solid State	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	5-82	440R-H23176
MSR220P Input Module	—	—	Removable	—	24V DC	5-86	440R-H23178
MSR310P Base	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	5-102	440R-W23219
MSR320P Input Module	—	2 PNP Solid State	Removable	—	24V DC from the base unit	5-106	440R-W23218

Note: For additional Safety Relays connectivity, see page 5-4.
For additional Safety I/O and Safety PLC connectivity, see page 5-116.
For application and wiring diagrams, see page 10-1.

Connection Systems

Description	Cat. No. 4-Pin Micro (M12) Quick Disconnect	5-Pin Micro (M12) Quick Disconnect‡	8-Pin Micro (M12) Quick Disconnect
Cordset	889D-F4AC-♣	889D-F5AC-♣	889D-F8AB-♣
Patchcord	889D-F4ACDM-§	889D-F5ACDM-§	889D-F8ABDM-§

♣ Replace symbol with 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
§ Replace symbol with 1 (1 m), 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable lengths.
‡ To connect to ArmorBlock Guard I/O.

Accessories

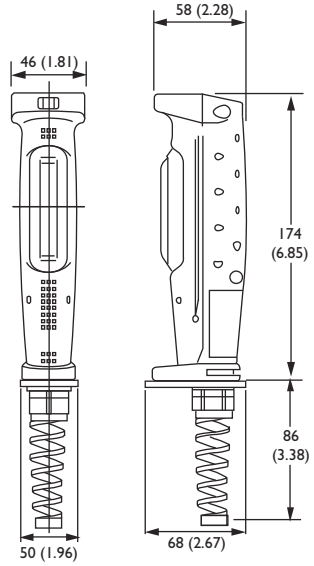
	Description	Cat. No.
	Mounting bracket suitable for single enabling switch∗	440J-A00N
	Mounting bracket suitable for one actuator mounted onto switch∗ Includes four flat head screws and one resistorx bit.	440J-A01N
	Mounting bracket suitable for single enabling switch and single safety switch∗	440J-A02N
	Mounting bracket suitable for two actuators mounted onto switch∗ Includes six flat head screws and one resistorx bit.	440J-A03N
	Mounting bracket suitable for single enabling switch and two safety switches∗	440J-A04N
	NBR/PVC (silicone free) rubber boot kit	440J-A10N

∗ The bracket has predrilled holes suitable for mounting either the MT-GD2, Trojan 5, or Trojan 6. Please note that the enabling switch, safety switch, and actuator are not supplied with the mounting bracket and are available separately.

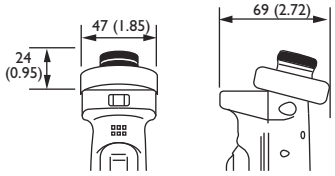
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

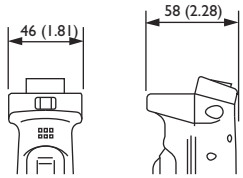
Standard Switch

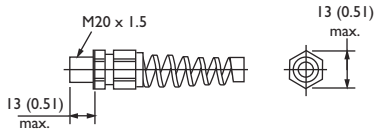


Emergency Stop Button

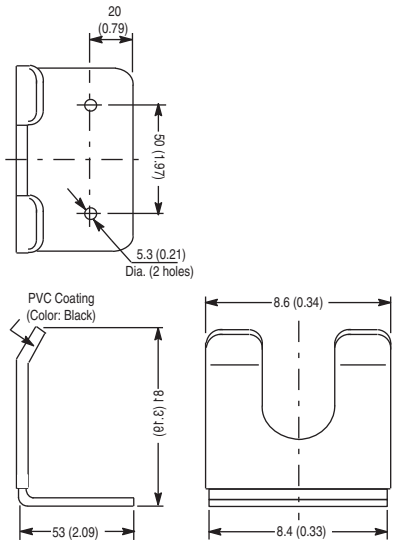


Jog Button

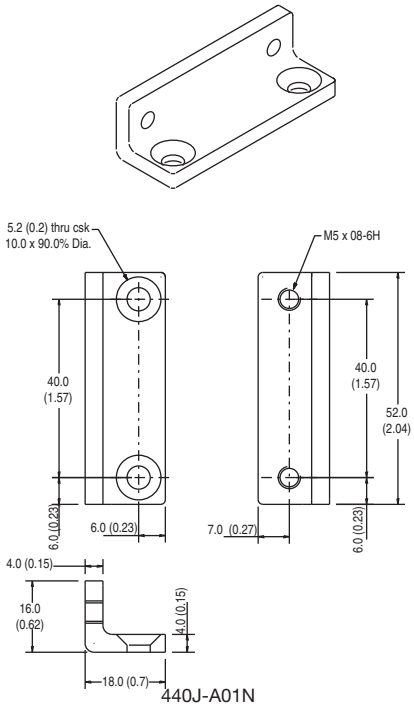




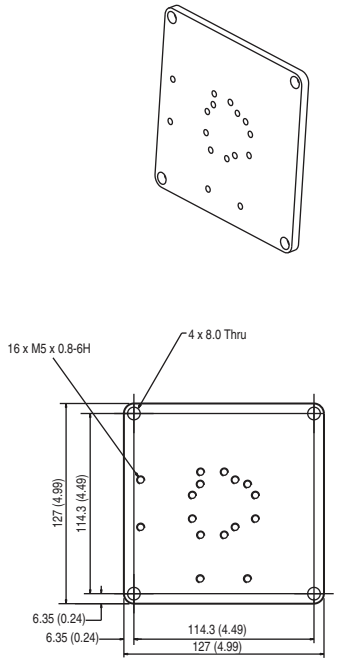
A range of brackets are available to allow the enabling switch to be mounted alone, or with one or two safety switches. A small bracket has already been fitted to the enabling switch onto which the actuator bracket is mounted. An Application Note on the use of the enabling switch in conjunction with a safety switch is available.



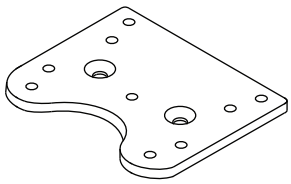
440J-A00N
Enabling Switch Mounting Bracket

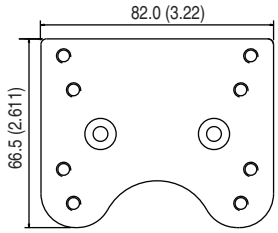


440J-A01N
Single Actuator Bracket

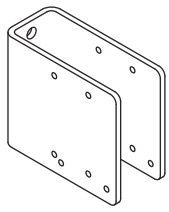


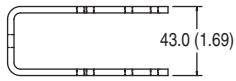
440J-A02N
Single Safety Switch Plate

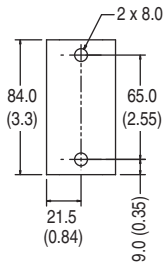


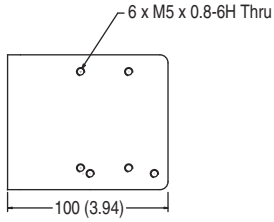


440J-A03N
Double Actuator Plate



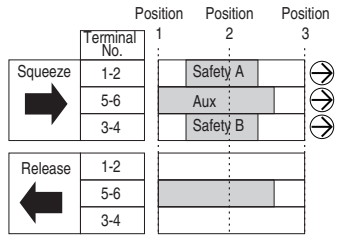
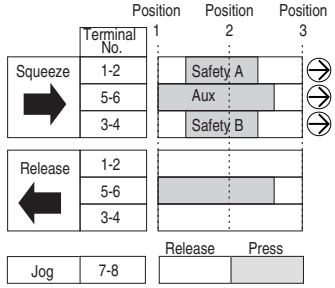
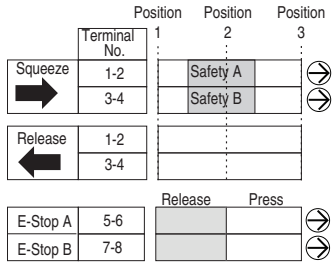
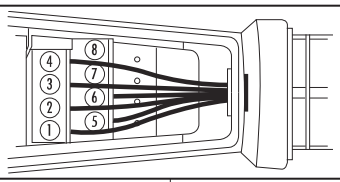
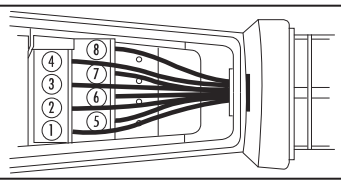
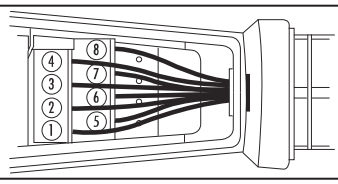
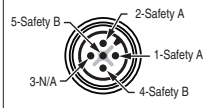
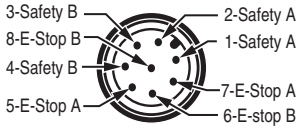






440J-A04N
Double Safety Switch Bracket

Typical Wiring Diagram

	Standard	With Jog Button	With E-Stop Button
Contact Operation			
Cable Termination			
Quick Disconnect Termination				
Mating Cordsets	889D-F4AC-*	889D-F5AC-*	889D-F8AB-*	889D-F8AB-*

889D-F4AC-*		889D-F5AC-*		889D-F8AB-*		889D-F8AB-*	
1 Brown 2 White	Safety A	1 Brown 2 White	Safety A	1 White 2 Brown	Safety A	1 White 2 Brown	Safety A
—		3 Blue	NA	3 Green 4 Yellow	Safety B	3 Green 4 Yellow	Safety B
3 Blue 4 Black	Safety B	4 Black 5 Grey	Safety B	5 Grey 6 Pink	Aux	5 Grey 6 Pink	E-Stop A
				7 Blue 8 Red	Jog	7 Blue 8 Red	E-Stop B



Specifications — 22.5 mm*

Front-of-Panel (Operators)

Description		Plastic (Bulletin 800FP)	Metal (Bulletin 800FM)
Mechanical Ratings			
Vibration (assembled to panel)		Tested at 10…2000 Hz, 1.52 mm displacement (peak-to-peak) max./10 G max. for 3 hr duration, no damage	
Shock		Tested at 1/2 cycle sine wave for 11 ms; no damage at 100 G	
Degree of protection❄		IP65/66 (Type 3/3R/4/4X/12/13)	IP65/66 (Type 3/3R/4/12/13)
Mechanical durability per EN 60947-5-1 (Annex C)	10 000 000 Cycles	Momentary push buttons, momentary mushroom	
	1 000 000 Cycles	Multi-function, selector switch, key selector switch, selector jog, SensEject™ key selector switch	
	500 000 Cycles	Non-illuminated push-pull E-stop	
	300 000 Cycles	Twist-to-release E-stop, illuminated push-pull E-stop, alternate action push buttons	
	100 000 Cycles	Potentiometer, toggle switch	
Operating forces (typical with one contact block)		Flush/extended = 5 N, E-stop = 36 N Mushroom = 9 N	
Operating torque (typical application with one contact block)		Selector switch = 0.25 N•m (2.2 lb•in)	
Mounting torque	Plastic	1.7 N•m (15 lb•in)	
	Metal	4.4 N•m (40 lb•in)	
Environmental			
Temperature range (operating)		–25…+70 °C (-13…158 °F)‡	
Temperature range (short term storage)		–40…+85 °C (-40…185 °F)	
Humidity		50…95% RH from 25…60 °C (77…140 °F)	

* Performance Data — see page Important-3 of the Industrial Controls catalog.
❄ Momentary mushroom operators are IP65. Plastic keyed operators are IP66, Type 4/13; not Type 4X.
‡ Operating temperatures below 0 °C (32 °F) are based on the absence of freezing moisture and liquids, UL Recognized to 55 °C (131 °F) - Incandescent module Max 40 °C (104 °F).

Product Certifications

Certifications	UR/UL, CSA, CCC, CE
Standards Compliance — CE Marked	NEMA ICS-5; UL 508, EN ISO 13850, EN 60947-1, EN 60947-5-1, EN 60947-5-5
Terminal Identification	EN/IEC 60947-1
Shipping Approvals	ABS
RoHS	✓

Back-of-Panel Components

Electrical Ratings				
Standard contact block ratings		A600, Q600 600V AC AC 15, DC 13 to IEC/EN 60947-5-1 and UL 508, 17V, 5 mA min.		
Low voltage contact block ratings❄		5V, 1 mA DC min. C300, R150, AC 15, DC 13 to EN 60947-5-1 and UL 508		
	Nominal Voltage	**Range**	**Current Draw**	**Frequency**
LED Module Ratings	24V AC 24V DC 120V AC 240V AC	10…29V AC 10…30V DC 70…132V AC 180…264V AC	31 mA 24 mA 25 mA 22 mA	50/60 Hz DC 50/60 Hz 50/60 Hz
Thermal current		10 A max. enclosed (40 °C ambient) to UL508, EN 60947-5-1		
Insulation voltage (Ui)		Screw terminal = 690V, spring-clamp = 300V		
Wire capacity (screw terminal)‡		#18…12 AWG (0.75…2.5 mm²) Max. (2) #14 AWG or (1) #12 AWG		
Wire capacity (spring-clamp terminal)		#18…14 AWG (0.75…1.5 mm²) One per spring clamp, two spring clamps per terminal		
Recommended tightening torque on screw terminals		0.7…0.9 N•m (6…8 lb•in)		
Dielectric strength (minimum)		2500V for one minute		
External short circuit protection	Standard blocks	10 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class C to UL 248-4)		
	Low voltage contact blocks	6 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class C to UL 248-4)		
Electrical shock protection		Finger-safe conforming to IP2X		
Mechanical Ratings				
Vibration (assembled to panel)		Tested at 10…2000 Hz, 1.52 mm displacement (peak-to-peak) max./10 G max. 6 hr		
Shock		Tested at 1/2 cycle sine wave for 11 ms and no damage at 100 G max.		
Contact durability per EN 60947-5-1 (Annex C)		10 000 000 cycles		
Contact operation	N.O.	Slow double make and break		
	N.C.	Slow double make and break — positive opening 		
	N.O.E.M.	Double break / double make, early make		
	N.C.L.B.	Double break / double make, late break — positive opening 		
	N.C.E.B.	Double break / double make, early break — positive opening		
Push button travel to change electrical state		N.C. and N.O.E.M.	1.5 mm (0.060 in.)	
		N.O. and N.C.L.B.	2.5 mm (0.1 in.)	
Operating forces (typical)	Single circuit contact block	3.4 N		
	Dual circuit contact block	5…6.5 N		
Illumination				
LED Dominant Wavelength	Green Red Yellow Blue White	525 nm 629 nm 590 nm 470 nm —		
LED Luminous Intensity	Green Red Yellow Blue White	780 mcd 780 mcd 600 mcd 168 mcd 360 mcd		
Incandescent maximum wattage		2.6 W		
Materials				
Springs		Stainless steel and zinc coated music wire		
Electrical contacts	Standard	Silver-nickel		
	Low voltage	Gold-plated over silver		
Terminals	Screw	Brass		
	Spring-clamp	Silver-plated brass		

✶ Performance Data — see page Important-3 of the Industrial Controls catalog.
❄ Low voltage contacts are recommended for applications below 17V, 5 mA.
‡ Wires less than #18 AWG (0.75 mm²) may not hold in terminal securely.

Material Listing

Component	For Use with	Material Used
Panel gasket	All operators	Nitrile, TPE
Diaphragm seal	Illuminated push button, non-illuminated push button	Automotive industry acceptable silicone
K-seal	Selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom	Nitrile
Diaphragm retainer, return spring I	Illuminated push button, non-illuminated push button, momentary mushroom	Stainless steel
Return spring II	Reset, selector switch, key selector switch, alternate action, push/twist-to-release E-stop, key E-stop, push/pull mushroom	Zinc-coated music wire
Button cap/mushroom head	Non-illuminated push button, momentary mushroom, reset, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function	PBT/polycarbonate blend
2-color molded button cap	Non-illuminated push button	PBT/polycarbonate blend
Lens	Multi-function	Acetal
Lens, knob	Illuminated push button, illuminated momentary mushroom, illuminated selector switch	Polyamide
Knob	Non-illuminated selector switch	Glass-filled polyamide
Plastic bezel/bushing I	Non-illuminated push button, illuminated push button, momentary mushroom, selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function, reset	Glass-filled polyamide
Plastic bezel/bushing II, jam nut	Pilot light, reset jam nut, reset pushers	Glass-filled PBT
Metal bezel/bushing	All metal operators	Zinc
Diffuser	Illuminated push button, pilot light	Polycarbonate
Legend frames	—	Glass-filled polyamide
Plastic mounting ring	All plastic operators	Glass-filled polyamide
Metal mounting ring	All metal operators	Chromated zinc
Plastic latch	—	Glass-filled polyamide
Metal latch	—	Chromated zinc + stainless steel
Plastic enclosure	—	PBT/polycarbonate blend
Metal enclosure	—	Aluminum
Terminal screws	LED module, incandescent module, contact blocks	Zinc-plated steel with chromate
Terminals	LED module, incandescent module, contact blocks	Brass with silver-nickel contacts
Spring clamps	LED module, incandescent module, contact blocks	Stainless steel
Lamp socket	Incandescent module	Brass
Housing	Incandescent module, LED module	Glass-filled polyamide
Low-voltage terminals	Contact blocks	Gold-plated silver-nickel contacts
Low-voltage spanner	Contact blocks	Gold-plated silver-nickel contacts
Spanner	Contact blocks	Brass with silver-nickel contacts
Boot	Toggle Switch, illuminated push button, non-illuminated push button, multi-function illuminated and non-illuminated	Automotive industry acceptable silicone

Emergency Stop Operators*

Non-Illuminated Twist-to-Release, Push-Pull



60 mm Non-Illuminated Twist-to-Release
Cat. No. 800FP-MT64



40 mm Non-Illuminated Push-Pull
Cat. No. 800FP-MP44

Color	Size	Pkg. Quantity	Twist-to-Release (Trigger Action)		Push-Pull (Trigger Action)	
			Plastic	Metal	Plastic	Metal
			Cat. No.	Cat. No.	Cat. No.	Cat. No.
Red	30	1	800FP-MT34	800FM-MT34	–	–
	40		800FP-MT44	800FM-MT44	800FP-MP44	800FM-MP44
	60		800FP-MT64	800FM-MT64	–	–

Illuminated — Twist-to-Release, Push-Pull‡



40 mm Illuminated Twist-to-Release
Cat. No. 800FP-LMT44



40 mm Mushroom Push/Pull
Cat. No. 800FM-LMP44

Color	Size	Pkg. Quantity	Twist-to-Release (Trigger Action)		Push-Pull (Trigger Action)	
			Plastic	Metal	Plastic	Metal
			Cat. No.	Cat. No.	Cat. No.	Cat. No.
Red	30	1	–	–	800FP-LMP34	800FM-LMP34
	40		800FP-LMT44	800FM-LMT44	800FP-LMP44	800FM-LMP44
	60		800FP-LMT64	800FM-LMT64	800FP-LMP64	800FM-LMP64

‡ LED module required for illumination, can not use incandescent module.

Key Release Mushroom Operator



40 mm Non-Illuminated Key Release
Cat. No. 800FP-MK44

Color	Size	Pkg. Quantity	Ronis Key Lock (Trigger Action)❄	
			Plastic	Metal
			Cat. No.	Cat. No.
Red	40 mm	1	800FP-MK44	800FM-MK44

* All emergency stop operators are EN ISO 13850 compliant with standard NC, NCLB, or self-monitoring contact blocks.
❄ For key options, see the Industrial Controls catalog.

2-Position Push-Pull Operators, Non-Illuminated — Twist-to-Release (Trigger Action), Push-Pull (Trigger Action)∗



40 mm Trigger Action Twist-to-Release Mushroom
Cat. No. 800FP-MT44



40 mm Trigger Action Push-Pull Mushroom
Cat. No. 800FP-MP44



90 mm Half-Dome
Cat. No. 800FP-MP94

Color	Pkg. Quantity	40 mm Mushroom (Trigger Action) Twist-to-Release		40 mm Mushroom (Trigger Action) Push-Pull	
		Plastic	Metal	Plastic	Metal
		Cat. No.	Cat. No.	Cat. No.	Cat. No.
Red	1	800FP-MT44	800FM-MT44	800FP-MP44	800FM-MP44

800F P – MT4 4
a b c d

a

Operator Construction	
Code	Description
P	Round plastic operator (IP66, Type 4/4X/13)
M	Round metal operator (IP66, Type 4/13)

b

Operator Type	
Push, Twist-to-Release➢	
Code	Type
MT3	30 mm color cap
MT4	40 mm color cap
MT6	60 mm color cap
Push-Pull	
Code	Type
MP4	40 mm color cap
Half-Dome Push-Pull	
Code	Type
MP9	90 mm color cap❄

c

Color Cap	
Code	Color
2	Black
3	Green
4	Red
5	Yellow
6	Blue

d‡§♣

Engraving	
Code	Description
Blank	No engraving on cap
LE	EMO laser engraved
E	EMO printed

∗ All emergency stop operators are EN ISO 13850 compliant with standard NC, NCLB, or self-monitoring contact blocks.
➢ Only available with red color cap.
‡ For EMO guards, see page 4-45.
§ Only available on 40 mm color cap.
♣ Only available on red, 40 mm push, twist-to-release operator type (MT44).
❄ Half-dome operators only available with black, red, and yellow color caps.

2-Position Push-Pull Operators, Illuminated — Twist-to-Release (Trigger Action), Push-Pull (Trigger Action)∗❄



40 mm Mushroom Trigger Action Twist-to-Release
Cat. No. 800FP-LMT44



40 mm Mushroom Push/Pull
Cat. No. 800FM-LMP44



90 mm Half-Dome
Cat. No. 800FP-LMP94

Color	Pkg. Quantity	40 mm Mushroom (Trigger Action) Twist-to-Release		40 mm Mushroom (Trigger Action) Push-Pull	
		Plastic	Metal	Plastic	Metal
		Cat. No.	Cat. No.	Cat. No.	Cat. No.
Red	1	800FP-LMT44	800FM-LMT44	800FP-LMP44	800FM-LMP44

800F **P** **–** **LMP4** **3**
a ***b*** ***c***

a

Operator Construction	
Code	Description
P	Round plastic operator (IP66, Type 4/4X/13)
M	Round metal operator (IP66, Type 4/13)

b

Operator Type	
Push, Twist-to-Release‡§	
Code	Type
LMT4	40 mm color cap
LMT6	60 mm color cap
Push-Pull	
Code	Type
LMP3	30 mm color cap
LMP4	40 mm color cap
LMP6	60 mm color cap
Half-Dome Push-Pull	
Code	Type
LMP9	90 mm color cap⌘

c

Lens Cap Color	
Code	Color
3	Green
4	Red
5	Yellow➢
6	Blue♣

∗ LED module required for illumination, can not use incandescent module.
❄ All emergency stop operators are EN ISO 13850 compliant with standard NC, NCLB, or self-monitoring contact blocks.
‡ Only available with red color cap.
§ 60 mm version has black arrows; 30 and 40 mm versions have white arrows.
➢ When using LED for illumination, a white LED is recommended.
♣ Only available with 40 mm Push-Pull color cap (**LMP4** from Table b).
⌘ Half-dome operators only available with red and yellow lens cap colors.

2-Position Non-Illuminated Operators — Mushroom, Key Release (Trigger Action)∗



40 mm Key Release Mushroom
Cat. No. 800FP-MK44

Color	Pkg. Quantity	2-Position (Trigger Action) 40 mm Mushroom Key Release	
		Plastic	Metal
		Cat. No.	Cat. No.
Red	1	800FP-MK44	800FM-MK44

Note: For Ronis replacement keys, see the Industrial Controls catalog. Key release mushroom operators use key no. 3825.

800F **P** – **MK4** **4** ____
a *b* *c* *d*

a

Operator Construction	
Code	Description
P	Round plastic operator (IP66, Type 4/13)
M	Round metal operator (IP66, Type 4/13)

b

Operator Type	
Key Release Mushroom	
Code	Type
MK4	40 mm

c

Lens Cap Color	
Code	Color
4	Red

d

Ronis Key Lock❄‡§	
Code	Key No.
Blank	3825 (Standard)
R	455
01R	3801
02R	3802
03R	3803
04R	3804
05R	3805
06R	3806
27R	4001
28R	4002
29R	4003
30R	4004
31R	4005
32R	4006
33R	4007

∗ All emergency stop operators are EN ISO 13850 compliant with standard NC, NCLB, or self-monitoring contact blocks.
❄ Keyed operators are IP66, Type 4/13.
‡ Not intended for high security applications. Interoperability is possible with certain key/cylinder lock combinations. Consult your local Rockwell Automation sales office or Allen-Bradley distributor for interoperability information.
§ For Ronis replacement keys, see the Industrial Controls catalog.

3-Position Push-Pull Operators, Illuminated & Non-Illuminated — Mushroom♣



Illuminated 3-Position Push-Pull
Cat. No. 800FM-LMP44E3

Target Table and Operator Position✶			
Contact Type✦	Out	Center	In
N.O.	O	O	X
N.C.E.B.	X	O	O
N.C.L.B.	X	X	O

Note: X = Closed/O = Open

✦ Contact selection is limited to the following options, consult your local Rockwell Automation sales office or Allen-Bradley distributor for other options.

Operator Function	Operator Type	Color	Pkg. Quantity	Cat. No.
Momentary Out, Maintained Center, Momentary In	Non-Illuminated	Black§	1	800FM-MM42E3
		Green		800FM-MM43E3
		Red		800FM-MM44E3
	Illuminated❄	Amber‡		800FM-LMM40E3
		Green		800FM-LMM43E3
		Red		800FM-LMM44E3
		Blue‡		800FM-LMM46E3
		Clear‡		800FM-LMM47E3
Momentary Out, Maintained Center, Maintained In	Non-Illuminated	Black§	1	800FM-MP42E3
		Green		800FM-MP43E3
		Red		800FM-MP44E3
	Illuminated❄	Amber‡		800FM-LMP40E3
		Green		800FM-LMP43E3
		Red		800FM-LMP44E3
		Blue‡		800FM-LMP46E3
		Clear‡		800FM-LMP47E3

800F M – L MM 4 4 E3
a b c d e f

a

Operator Construction	
Code	Description
M	Round metal operator (IP66, Type 4/13)

b

Operator Type	
Code	Description
Blank	Non-Illuminated
L	Illuminated❄

c

Operator Function	
Code	Description
MM	Momentary Out, Maintained Center, Momentary In
MP	Momentary Out, Maintained Center, Maintained In

d

Cap Size	
Code	Description
4	40 mm Plastic

e

Cap Color	
Code	Description
0	Amber‡
2	Black§
3	Green
4	Red
6	Blue‡
7	Clear‡

f

Positions	
Code	Description
E3	3-Position

♣ Sold as stand-alone operator only. Not available as a composite catalog number.
✶ Cannot use N.C. or N.O.E.M. contact blocks with 3-position push-pull operators. Must use N.O., N.C.E.B., or N.C.L.B. contact blocks.
❄ Available in integrated LED version only.
‡ Available in illuminated only.
§ Available in non-illuminated only.

Momentary Push Button Operators, Non-Illuminated — Mushroom∗



40 mm Mushroom
Cat. No. 800FP-MM42



60 mm Mushroom
Cat. No. 800FP-MM63



90 mm Mushroom
Cat. No. 800FP-MM94

Color	Pkg. Quantity	40 mm Mushroom		60 mm Mushroom	
		Plastic	Metal	Plastic	Metal
		Cat. No.	Cat. No.	Cat. No.	Cat. No.
Black	1	800FP-MM42	800FM-MM42	**800FP-MM62**	800FM-MM62
Green		800FP-MM43	800FM-MM43	**800FP-MM63**	800FM-MM63
Red		800FP-MM44	800FM-MM44	**800FP-MM64**	800FM-MM64
Yellow		800FP-MM45	800FM-MM45	**800FP-MM65**	800FM-MM65
Blue		**800FP-MM46**	**800FM-MM46**	**800FP-MM66**	800FM-MM66

800F **P** **–** **MM4** **3**
a *b* *c*

a

Operator Construction	
Code	Description
P	Round plastic operator (IP65, Type 4/4X/13)
M	Round metal operator (IP65, Type 4/13)

b

Size and Operator Type	
Mushroom	
Code	Type
MM4	40 mm momentary
MM6	60 mm momentary
MM9	90 mm momentary❄

c

Color Cap	
Code	Color
2	Black
3	Green
4	Red
5	Yellow
6	Blue

∗ Momentary mushroom operators are IP65 rated.
❄ Only available with black, red, and yellow cap colors.

Momentary Push Button Operators, Illuminated — Mushroom∗



40 mm Mushroom
Cat. No. 800FP-LMM43

Color	Pkg. Quantity	40 mm Mushroom	
		Plastic	Metal
		Cat. No.	Cat. No.
Green	1	800FP-LMM43	800FM-LMM43
Red		800FP-LMM44	800FM-LMM44
Yellow		800FP-LMM45	800FM-LMM45
Blue		**800FP-LMM46**	**800FM-LMM46**
Clear		**800FP-LMM47**	**800FM-LMM47**

800F [P] – [LMM4] [3]
a b c

a

Operator Construction	
Code	Description
P	Round plastic operator (IP65, Type 4/4X/13)
M	Round metal operator (IP65, Type 4/13)

b

Size and Operator Type	
Mushroom	
Code	Type
LMM4	40 mm momentary

c

Lens Cap Color	
Code	Color
3	Green
4	Red
5	Yellow❄
6	Blue
7	Clear

∗ Momentary mushroom operators are IP65 rated.
❄ When using LED for illumination, a white LED is recommended.

Back-of-Panel Components

Contact Blocks with Latch — Composite

800F – P X 0 1 E
a b c d e



a

Style	
Code	Description
P	Plastic latch
M	Metal latch

b

Contact Block(s) Termination Style∗	
Code	Description
X	Screw termination
Q	Spring-clamp termination

∗ Six circuits maximum allowable.

c

N.O. (Normally Open) Circuits	
Code	Description
0	No contact
1	1 N.O.
2	2 N.O.
3	3 N.O.
4	4 N.O.
5	5 N.O.
6	6 N.O.

d

N.C. (Normally Closed) Circuits	
Code	Description
0	No contact
1	1 N.C.
2	2 N.C.
3	3 N.C.
4	4 N.C.
5	5 N.C.
6	6 N.C.

e

Specialty Contact Block(s)	
Code	Description
Blank	Standard blocks
V	Low voltage — QuadCONNECT™
E	N.O. early make
L	N.C. late break
B	N.C. early break
S	N.C. self-monitoring

Power Modules

Power Modules with Latch — Composite

800F – M N 3 G
a b c d



a

Style	
Code	Description
P	Plastic latch
M	Metal latch

b

Power Module Type‡§	
Code	Description
D	Incandescent module, screw termination
N	Integrated LED module, screw termination
Q	Integrated LED module, spring-clamp termination

c

Voltage	
Code	Description
0	No bulb♣
1	6V AC/DC♣
2	12V AC/DC♣
3	24V AC/DC
4	48V AC/DC♣
5	120V AC
7	240V AC➢

d

Lamp Color⌘	
Code	Description
C	Incandescent
R	Red LED
G	Green LED
Y	Amber LED
W	White LED
B	Blue LED

‡ LED modules for use with all illuminated operators. Incandescent module for use with pilot lights, momentary push buttons, and momentary mushroom operators only.
§ Four circuits maximum allowable when power module is used. Do not stack contact block on power module.
♣ Only available for incandescent module.
➢ Only available for integrated LED module.
⌘ For best illumination results, LED color should match lens color. For yellow operator, select a white LED.

Back-of-Panel Components, Continued

Power Modules with Contact Blocks and Latch — Composite

800F –	P	N	5	R	X	1	0	E
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*

a

Style	
Code	Description
P	Plastic latch
M	Metal latch

b

Power Module Type✶❄	
Code	Description
D	Incandescent module, screw termination
N	Integrated LED module, screw termination
Q	Integrated LED module, spring-clamp termination

c

Voltage	
Code	Description
0	No bulb‡
1	6V AC/DC‡
2	12V AC/DC‡
3	24V AC/DC
4	48V AC/DC‡
5	120V AC
7	240V AC§

d

Lamp Color♣	
Code	Description
C	Incandescent
R	Red LED
G	Green LED
Y	Amber LED
W	White LED
B	Blue LED

e

Contact Block(s) Termination Style	
Code	Description
X	Screw termination
Q	Spring-clamp termination

f

N.O. (Normally Open) Circuits	
Code	Description
0	No contact
1	1 N.O.
2	2 N.O.
3	3 N.O.
4	4 N.O.

g

N.C. (Normally Closed) Circuits	
Code	Description
0	No contact
1	1 N.C.
2	2 N.C.
3	3 N.C.
4	4 N.C.

h

Specialty Contact Block(s)	
Code	Description
Blank	Standard blocks
V	Low voltage — QuadCONNECT™
E	N.O. early make
L	N.C. late break
S	N.C. self-monitoring

✶ Four circuits maximum allowable when power module is used. Do not stack contact block on power module.
❄ LED modules for use with all illuminated operators. Incandescent module for use with pilot lights, push buttons, and momentary mushroom operators only.
‡ Only available for incandescent module.
§ Only available for integrated LED module.
♣ For best illuminated results, LED should match lens color. For yellow operator, select a white LED.

Back-of-Panel Components, Continued

Other

	Description	Pkg. Quantity	Cat. No.
 *Cat. No. 800F-ALM*	**Metal Mounting Latch** These are zinc-plated, metal die cast mounting latches. **Note:** Sold only in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces.	10	800F-ALM
	Note: Sold only in multiples of 100. Order (quantity of) 100 to receive one package of 100 pieces.	100	800F-ALM-BP
 *Cat. No. 800F-ALP*	**Plastic Mounting Latch** **Note:** Sold only in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces.	10	800F-ALP
	Note: Sold only in multiples of 100. Order (quantity of) 100 to receive one package of 100 pieces.	100	800F-ALP-BP

	Description	Contact Type	Pkg. Quantity	Cat. No.
	**Contact Block** **Note:** Sold only in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces. Latch not included.	N.O.	10	800F-X10
		N.C.		800F-X01
		N.O. low voltage — QuadCONNECT™		800F-X10V
		N.C. low voltage — QuadCONNECT™		800F-X01V
		N.O.L.M.		♣ 800F-X10N
		N.O.E.M.		800F-X10E
		N.O.E.E.M.		➢ 800F-X10M
		N.C.L.B.		800F-X01L
		N.C.E.B.		✶ 800F-X01B
		Self-Monitoring		❄ 800F-X01S
		Dual circuit of 2 N.O.		❄ 800F-X20D
		Dual circuit of 2 N.C.		❄ 800F-X02D
		Dual circuit of 1 N.O.-1 N.C.		❄ 800F-X11D
		N.O. with stab terminals		800F-X10T
		N.C. with stab terminals		800F-X01T
		N.O. spring-clamp		800F-Q10
		N.C. spring-clamp		800F-Q01
		N.O. spring-clamp low-voltage — QuadConnect™		800F-Q10V
		N.C. spring-clamp low-voltage — QuadConnect™		800F-Q01V
		N.O.E.M. spring-clamp		800F-Q10E
		N.C.L.B. spring clamp		**800F-Q01L**
		N.C.E.B. spring-clamp		✶ 800F-Q01B
		Ring lug N.O.		‡§ 800F-R10
		Ring lug N.C.		‡§ 800F-R01
Cat. No. 800F-X10	**Note:** Sold only in multiples of 100. Order (quantity of) 100 to receive one package of 100 pieces. Latch not included.	N.O.	100	800F-X10-BP
		N.C.		800F-X01-BP

♣ For use with **Cat. No. 800FP-CB_** and **Cat. No. 800FP-CC_** operators.
➢ For use with **Cat. No. 800FP-CC_** operators.
✶ Only for use with 4-position selector switch, 4-position toggle switch, or 3-position push-pull operator.
❄ Cannot stack.
‡ Cannot be used in a composite catalog number.
§ Replacement screws are available (**Cat. No. 800F-ARS1**)

Back of Panel Components, Continued

Other

	Description	Volts	Pkg. Quantity	Cat. No.
 *Cat. No. 800F-D3C*	**Incandescent Module** For use with pilot lights, push buttons, and momentary mushroom operators. **Note:** Sold in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces. Latch not included.	No bulb	10	800F-D0C
		6V AC/DC		800F-D1C
		12V AC/DC		800F-D2C
		24V AC/DC		800F-D3C
		48V AC/DC		800F-D4C
		120V AC/DC		800F-D5C
 *Cat. No. 800F-N3G*	**Integrated LED Module** For use with all illuminated devices. For best results, LED should match lens color. For amber operators, use yellow LED. **Note:** Sold in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces. Latch not included.	24V AC/DC	10	✶ 800F-N3x
		120V AC		✶ 800F-N5x
		240V AC		✶ 800F-N7x
		24V AC/DC spring-clamp		✶ 800F-Q3x
		120V AC spring-clamp		✶ 800F-Q5x
		240V AC spring-clamp		✶ 800F-Q7x
		24V AC/DC ring lug		❄‡ 800F-R3x

	Description	Contact Material	Pkg. Quantity	Cat. No.
 *Cat. No. 800F-BX01*	**Base Mounted Contact Block** Base mounted contact blocks can be used in plastic or metal enclosures. **Note:** Sold only in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces. Latch not included.	N.O.	10	800F-BX10
		N.C.		800F-BX01
		N.O. low voltage — QuadCONNECT™		800F-BX10V
		N.C. low voltage — QuadCONNECT™		800F-BX01V
		N.O.E.M.		800F-BX10E
		N.C.L.B.		800F-BX01L
		N.O. spring-clamp		800F-BQ10
		N.C. spring-clamp		800F-BQ01

	Description	Volts	Pkg. Quantity	Cat. No.
 *Cat. No. 800F-BN3R*	**Base Mounted Integrated LED Module** Base mounted modules can be used in plastic or metal enclosures. For best illumination results, LED should match lens color. **Note:** Sold in multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces. Latch not included.	24V AC/DC	10	✶ 800F-BN3x
		120V AC		✶ 800F-BN5x
		240V AC		✶ 800F-BN7x
		24V AC/DC spring-clamp		✶ 800F-BQ3x
		120V AC spring-clamp		✶ 800F-BQ5x
		240V AC spring-clamp		✶ 800F-BQ7x

✶ To complete the cat. no., replace the **x** with one of the following letters for the desired color: **Y** = Amber, **R** = Red, **G** = Green, **B** = Blue, **W** = White.
❄ Cannot be used in a composite catalog number.
‡ Replacement screws are available (Cat. No. 800F-ARS1)

Assembled Stations



Cat. No. 800F-1YP4

1-Hole Yellow Enclosure E-Stop Station

Enclosure Material	Quick Connect		Operator Type	Illumination Voltage	Contact Configuration	Cat. No.	
						PG Knockouts	Metric Knockouts
Plastic	N/A		Twist-to-Release 40 mm	Non-Illuminated	1 N.C.	800F-1YP1	800F-1YM1
					1 N.O. / 1 N.C.	800F-1YP2	800F-1YM2
					2 N.C.	800F-1YP3	800F-1YM3
			Key Release 40 mm		1 N.C.	800F-1YP4	800F-1YM4
					1 N.O. / 1 N.C.	800F-1YP5	800F-1YM5
					2 N.C.	800F-1YP6	800F-1YM6
			Twist-to-Release 60 mm		2 N.C.	800F-1YP7	—
					1 N.O. / 2 N.C.	800F-1YP8	—
			Twist-to-Release 40 mm	24V AC/DC	1 N.C.	—	800F-1YML1
				120V AC		—	800F-1YML2
				240V AC		—	800F-1YML3
	AC Micro∗	5-pin		Non-Illuminated	2 N.C. — Low voltage	—	**800F-1YMQ53V**
		6-pin			1 N.O. / 2 N.C.	—	**800F-1YMQA**
	DC Micro∗	4-pin		Non-Illuminated/EMO/Guard	1 N.C.	—	**800F-NX1**
				Non-Illuminated	1 N.C.	—	**800F-1YMQ1**
					1 N.O. / 1 N.C.	—	**800F-1YMQ2**
					2 N.C.	—	**800F-1YMQ3**
				Non-Illuminated/EMO/Guard		—	**800F-1YMQ3VEG**
		5-pin		Non-Illuminated		—	**800F-1YMQ3V**
	Mini Receptacle∗	4-pin		Non-Illuminated	1 N.C.	—	800F-1YMQ41
				24V AC/DC	1 N.O. / 1 N.C.	—	800F-1YMQ44
		6-pin		24V AC/DC	1 N.O. / 1 N.C.	—	800F-1YMQ4
				120V AC	1 N.O. / 1 N.C.	—	800F-1YMQ5
				240V AC	1 N.O. / 1 N.C.	—	800F-1YMQ6
Metal				24V AC/DC	1 N.O./1 N.C.	—	800F-1MYMQ4
				120V AC	1 N.O./1 N.C.	—	800F-1MYMQ5
				240V AC	1 N.O./1 N.C.	—	800F-1MYMQ6

∗ Please reference Assembled Station Pin Out Chart on page 4-44

1-Hole Grey Enclosure E-Stop Station

Enclosure Material	Quick Connect	Operator Type	Illumination Voltage	Contact Configuration	Cat. No.	
					PG Knockouts	Metric Knockouts
Metal	N/A	Twist-to-Release 40 mm	Non-Illuminated	1 N.C.	—	800F-1MM1
				1 N.O. / 1 N.C.	—	800F-1MM2
				2 N.C.	—	800F-1MM3
		Key Release 40 mm		1 N.C.	—	800F-1MM4
				1 N.O. / 1 N.C.	—	800F-1MM5
				2 N.C.	—	800F-1MM6

Grey Enclosure Assembled Stations

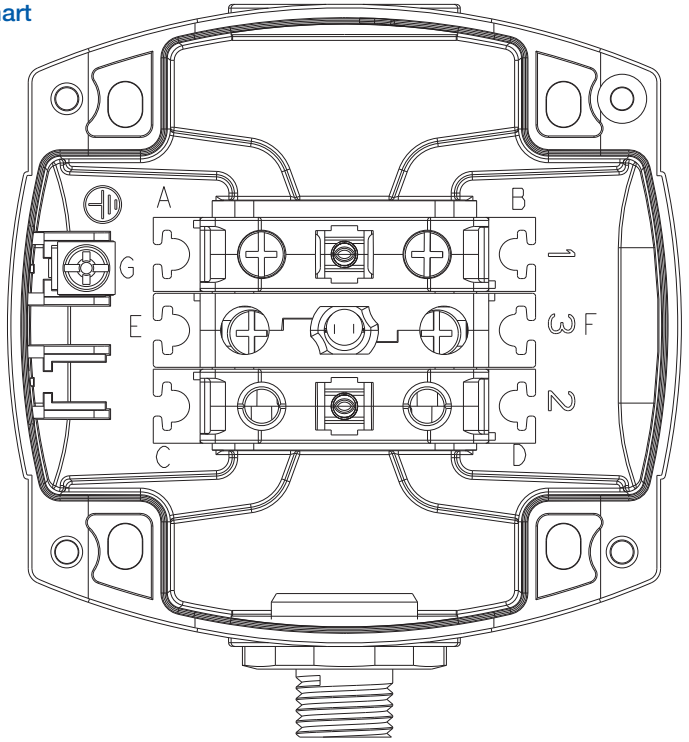
Enclosure Material	Quick Connect	Operator Type	Illumination Voltage	Contact Configuration	Cat. No.	
					PG Knockouts	Metric Knockouts
1-Hole Plastic	N/A	Black Push Button	Non-Illuminated	1 N.O.	800F-1PP1	800F-1PM1
		"0-1" 2-Position Selector Switch		1 N.O.	800F-1PP2	800F-1PM2
		"OFF-ON" 2-Position Selector Switch		1 N.O. / 1 N.C.	800F-1PP3	800F-1PM3
		↔ (Flush Black)		1 N.O.	800F-1PP4	—
2-Hole Plastic		Start and Stop Push Buttons		1 N.O./1 N.C.	800F-2PP1	—
3-Hole Plastic		↑ (Flush Black) O (Extended Red) ↓ (Flush Black)		4 N.O./1 N.C.	800F-3PP1	—

Assembled Stations, Continued

90 mm Enclosed Stations

Enclosure Material	Quick Connect	Operator Type	Illumination Voltage	Contact Configuration	Cat. No.	
					PG Knockouts	Metric Knockouts
1-Hole, Yellow Plastic	N/A	Red half dome	Non-illuminated	1 N.C.	800F-1YP1HD	800F-1YM1HD
				1 N.O./1 N.C.	800F-1YP2HD	800F-1YM2HD
				2 N.C.	800F-1YP3HD	800F-1YM3HD
			24V AC/DC	1 N.C.	—	800F-1YML1HD
			120V AC		—	800F-1YML2HD
			240V AC		—	800F-1YML3HD
		Red 90 mm momentary	Non-illuminated	1 N.C.	800F-1YP1M94	800F-1YM1M94
				1 N.O./1 N.C.	800F-1YP2M94	800F-1YM2M94
				2 N.C.	800F-1YP3M94	800F-1YM3M94
1-Hole, Grey Plastic		Black 90 mm momentary		1 N.O./1 N.C.	800F-1PP2M92	800F-1PM2M92

Assembled Station Pin Out Chart



Cat. No.	Connector Style / No. of Pins	Location 1	A to Pin #	B to Pin #	Location 2	C to Pin #	D to Pin #	Location 3	E to Pin #	F to Pin #	G to Pin #
800F-1YMQ53V	AC Micro / 5-pin	BX01V	1	2	BX01V	4	5	—	—	—	3
800F-1YMQA	AC Micro / 6-pin	BX01	1	5	BX01	2	6	BX10	3	4	—
800F-NX1	DC Micro / 4-pin	BX01	1/4	2/3	—	—	—	—	—	—	—
800F-1YMQ1		BX01	1/4	2/3	—	—	—	—	—	—	—
800F-1YMQ2		BX10V	2	4	BX01V	1	3	—	—	—	—
800F-1YMQ3		BX01V	1	3	BX01V	2	4	—	—	—	—
800F-1YMQ3VEG		BX01V	1	3	BX01V	2	4	—	—	—	—
800F-1YMQ3V	DC Micro / 5-pin	BX01V	1	2	BX01V	4	5	—	—	—	3
800F-1YMQ41	Mini Receptacle / 4-pin	BX01	2	4	—	—	—	—	—	—	—
800F-1YMQ44		BX10	1	J	BX01	2	4	BN3R	3	J	J
800F-1YMQ4	Mini Receptacle / 6-pin	BX10	1	J	BX01	6	5	BN3R	2	J	J
800F-1YMQ5		BX10	1	J	BX01	6	5	BN5R	2	J	J
800F-1YMQ6		BX10	1	J	BX01	6	5	BN7R	2	J	J
800F-1MYMQ4		BX10	1	J	BX01	6	5	BN3R	2	J	J
800F-1MYMQ5		BX10	1	J	BX01	6	5	BN5R	2	J	J
800F-1MYMQ6		BX10	1	J	BX01	6	5	BN7R	2	J	J

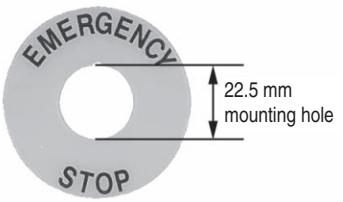
J = Jumper

Guards

	Description	Type	Cat. No.	Pkg. Quantity
 *Cat. No. 800F-AMRG*	**Protective Ring** for use with non-illuminated 2-position momentary and illuminated/non-illuminated 3-position mushroom operators (40 mm only)	Shiny metal	800F-AMRG	1
		Black	800F-AMRGB	
		Yellow Metal	800F-AMRGY	
 *Cat. No. 800F-A6PR5*	**Plastic Guard** for use with the following operators: • 40 mm E-stop (SEMI Standards Compliant) • 40 mm illuminated/non-illuminated alternate action and momentary operators • 60 mm illuminated/non-illuminated momentary operators • Selector switches (standard knob and key operated) • Potentiometers	Yellow, round	800F-A6PR5	
 *Cat. No. 800F-AMEGY*	**Narrow Plastic Guard** for use with the following operators: • Illuminated and non-illuminated momentary mushroom operators (40 mm) only • Bul. 800FD monolithic E-stops (SEMI standards compliant) • Flush/extended/guarded push buttons • Alternate action operators • Selector switches (standard knob and key operated) • Potentiometers	Yellow	800F-AMEGY	
 *Cat. No. 800F-AMMG*	**40 mm Protective Guard** used with illuminated and non-illuminated momentary mushroom operators (40 mm) only.	Shiny Metal	800F-AMMG	

Emergency Stop Legend Plates§

800F –15YS
a *b*



Cat. No. 800F-15YSE112

a

Size/Color (Yellow)	
Code	Description
15Y	60 mm round (30.5 mm mounting hole)
15YS	60 mm round (22.5 mm mounting hole)➢
16Y	90 mm round (22.5 mm mounting hole)➢

b

Text	
Code	Description
Blank	No text
E112	EMERGENCY STOP
F112	ARRÊT D'URGENCE⌘
G112	NOT AUS
T112	ARRESTO EMERGENZA
S112	PARADA DE EMERGENCIA
B112	EMERGENCY STOP, ARRÊT D'URGENCE, PARADA DE EMERGENCIA⌘

b (cont'd)

Text	
Code	Description
M112	NOT AUS, ARRESTO EMERGENZA, ARRÊT D'URGENCE✦
	EMERGENCY STOP, ARRÊT D'URGENCE, NOT AUS❖
D112	NOODSTOP⌘
N112	NÖDSTOPP, EMERGENCY STOP⌘
W112	NØDSTOPP, EMERGENCY STOP⌘
A112	NØDSTOP
L112	NEYÐARSTOPP, NEYÐARSTOPP⌘
H112	NÖD-STOP, HÄTÄ-SEIS, NÖD-STOP⌘

§ Sold only multiples of 10. Order (quantity of) 10 to receive one package of 10 pieces.
➢ Not for use with base mounted contact blocks.
⌘ Not available on 15YS version.
✦ Text printed on the 15Y version only.
❖ Text printed on the 15YS & 16Y versions only.

Push Buttons

Bul. 800T 30.5 mm

Non-Illuminated



2-Pos. Push-Pull
Cat. No. 800T-FX6D4



2-Pos. Push-Pull / Twist
Cat. No. 800H-FRXT6D4



2-Pos. Push-Pull / Twist
Cat. No. 800T-FXT6D4

Illuminated



2-Pos. Push-Pull
Cat. No. 800T-FXP16RA1



2-Pos. Push-Pull/Twist
Cat. No. 800H-FRXTP16RA1



2-Pos. Push-Pull/Twist
Cat. No. 800T-FXTP16RA1

Description

The Bulletin 800T and 800H 30.5 mm Emergency Stop devices provide increased reliability. E-stops with normally closed late break contacts comply with EN418 and IEC 947-5-5 standards. This means the operator will latch when actuated before the contacts will change state.

Application flexibility is offered with 2-position push-pull or 2-position push-pull/twist release configurations. Non-illuminated and illuminated operator options are available. Contact block versions are also available that provide IP2X finger-safe protection.

Rockwell Automation also offers Self-Monitoring™ contact blocks (SMCB) which feature enhanced E-stop safety for critical process control applications. The SMCB monitors whether or not it is properly installed on the operator so that the normally closed contacts will open when the E-stop is actuated. If the SMCB is separated from the operator for any reason, the controlled circuit will automatically open.

Features

- 30.5 mm mounting hole
- Type 4/13 watertight/oiltight (Bul. 800T)
- Type 4/4X/13 corrosion-resistant/watertight/oiltight (Bul. 800H)
- Heavy industrial stations and operators

Specifications

Electrical Ratings		
Contact ratings		Refer to the contact ratings tables below.
Dielectric strength		2200V for one minute, 1300V for one minute (Logic Reed)
Electrical design life cycles		1 000 000 at max. rated load, 200 000 at max. rated load (Logic Reed)
Mechanical Ratings		
Vibration		10…2000 Hz 1.52 mm displacement (peak-to-peak) max./10 G max. (except Logic Reed)
Shock		1/2 cycle sine wave for 11 ms ≥ 25 G (contact fragility) and no damage at 100 G
Degree of protection		Type 1/4/12/13 (Bul. 800T); Type 1/4/4X/12/13 (Bul. 800H); EN/IEC 60529 IP66/65
Mechanical design life cycles (Push-pull/twist-to-release)		250 000 min.
Contact operation		Shallow, mini, and low voltage contact blocks: Slow, double make and break Logic Reed and sealed switch contact blocks: Single break magnetic
Wire gauge/Terminal screw torque		#18…12 AWG / 6…8 lb•in
Typical operating forces 2-position push-pull		7.5 lbs max. push or pull
Twist-to-release or push-pull		9 lbs max. push or pull 30 in oz. max. twist, 6 in oz. minimum return
Contact blocks	Standard	1 lb
	Logic Reed	1 lb max.
	Sealed switch	3 lbs max. at 0.205 in plunger travel
	Stackable sealed switch	1 lb max.
Environment		
Temperature range	Operating	–40…+131 °F (–40…+55 °C)
	Storage	–40…+185 °F (–40…+85 °C)
Note: Operating temperatures below freezing are based on the absence of moisture and liquids. Contact your local Rockwell Automation sales office or Allen-Bradley distributor for use in lower temperature applications.		
Humidity		50…95% RH from 77…140 °F (25…60 °C) per Procedure IV of MIL-STD-BIOC, Method 507.1 cycling test

Standard Contact Ratings

Minimum: 24V 24 mA

Maximum thermal continuous current I^{th} 10 A AC/2.5 A DC. Bulletin 800T and 800H units with Cat. No. 800T-XA contacts have ratings as follows:

Max. Opertnl. Volts Ue	Utilization Category		Rated Operational Currents		
	IEC	NEMA	Volts Ue	Make	Break
AC 600	AC-15	A600	120…600 72…120 24…72	7200VA 60 A 60 A	720VA 720VA 10 A
DC 600	DC-13	Q600	28…600 24…28❄	69VA 2.5 A	

❄ For applications below 24V/24 mA, Pen*TUFF*™ or Logic Reed contacts are recommended.

Self-Monitoring is a trademark of Rockwell Automation, Inc.

2-Position Push-Pull and Push-Pull/Twist Release, Non-Illuminated

Note: A jumbo or large legend plate is recommended, if space allows.

Contact Type	Operator Position: Out	Operator Position: In	Button Color	Type 4/13: Push-Pull Cat. No.	Type 4/13: Push-Pull/Twist Release Cat. No.	Type 4/4X/13: Push-Pull/Twist Release Cat. No.
N.C.L.B.∗	X	O	Red	**800T-FX6D4**	**800T-FXT6D4**	**800H-FRXT6D4**
N.O. - N.C.L.B.∗	O X	X O	Red	**800T-FX6A1**	**800T-FXT6A1**	**800H-FRXT6A1**
N.C.L.B. - N.C.L.B.∗	X X	O O	Red	**800T-FX6A5**	**800T-FXT6A5**	**800H-FRXT6A5**
S.M.C.B.∗❄	X	O	Red	**800TC-FX6D4S**	800TC-FXT6D4S	800HC-FRXT6D4S
N.O. - S.M.C.B.∗❄	O X	X O	Red	800TC-FX6A1S	800TC-FXT6A1S	800HC-FRXT6A1S
S.M.C.B. - S.M.C.B∗❄	X X	O O	Red	**800TC-FX6A5S**	800TC-FXT6A5S	800HC-FRXT6A5S

Note: X = Closed/O = Open
Note: Emergency stop push buttons are compliant with EN 418 and EN/IEC 60947-5-5 Standards when using N.C.L.B. contact blocks.
Note: These caps are only available in plastic.

2-Position Push-Pull and Push-Pull/Twist Release Units, Illuminated

Note: A jumbo or large legend plate is recommended, if space allows.

Type	Lamp Type	Volts	Color	Contacts	Operator Position: Maintained Out	Operator Position: Maintained In	Type 4/13: Push-Pull Release Cat. No.	Type 4/13: Push-Pull/Twist Release Cat. No.	Type 4/4X/13: Push-Pull/Twist Release Cat. No.
Full Voltage	Incandescent	24V AC/DC	Red	N.O. - N.C.L.B. ∗‡	O X	X O	**800T-FXQ24RA1**	**800T-FXTQ24RA1**	**800H-FRXTQ24RA1**
	LED	120V AC					**800T-FXQH10RA1**	**800T-FXTQH10RA1**	800H-FRXTQH10RA1
		24V AC/DC					**800T-FXQH24RA1**	800T-FXTQH24RA1	800H-FRXTQH24RA1
Transformer	Incandescent	120V AC	Red	N.O. - N.C.L.B. ∗‡	O X	X O	**800T-FXP16RA1**	**800T-FXTP16RA1**	**800H-FRXTP16RA1**
		240V AC					**800T-FXP26RA1**	800T-FXTP26RA1	800H-FRXTP26RA1
	LED	120V AC					**800T-FXPH16RA1**	**800T-FXTPH16RA1**	**800H-FRXTPH16RA1**
		240V AC					800T-FXPH26RA1	800T-FXTPH26RA1	800H-FRXTPH26RA1

Note: X = Closed/O = Open
Note: Emergency stop push buttons are compliant with EN 418 and EN/IEC 60947-5-5 Standards when using N.C.L.B. contact blocks.

∗ Normally closed late break contact. When button is pushed from the OUT to IN position, the mechanical detent action of the operator occurs before electrical contacts change state. When the button is pulled from the IN to the OUT position, the electrical contacts change state before the mechanical detent occurs.
❄ The Self Monitoring Contact Block (S.M.C.B.) is composed of a N.C.L.B. contact wired in series with a N.O. monitoring contact. The N.O. monitoring contact automatically closes when the S.M.C.B. is properly installed onto the E-stop operator. If the S.M.C.B. is separated from the E-stop operator, the N.O. monitoring contact will automatically open.
‡ Contact your local Rockwell Automation sales office or Allen-Bradley distributor for availability of illuminated E-stops with Self Monitoring Contact Blocks (S.M.C.B.s).

Accessories

	Type	Style	Color	Cat. No.
	Emergency Stop Legend Plates	For 800T Buttons	Yellow, Blank	**800T-X646**
			Yellow, Emergency Stop	**800T-X646EM**
		For 800H Buttons	Yellow, Emergency Stop	**800H-W690**



General Purpose
Cat. No. 800Z-GF2Q5



General Purpose
Cat. No. 800Z-GL3Q5B



Heavy Industrial
Cat. No. 800Z-HF1



Heavy Industrial
Cat. No. 800Z-HL1Y

Description

Bulletin 800Z Zero-Force Touch Buttons are designed for use by machine control systems requiring the use of two hands. An interlinked sensor surface weaves two capacitive sensors in offset planes for superior product sensitivity.

Bulletin 800Z touch buttons are ergonomically designed for ease of operation. Simply touching the surface of the switch will initiate an output. The Bulletin 800Z line can detect the hand through most industrial gloves.

The contour of Bulletin 800Z touch buttons serves two purposes; it easily conforms to the shape of the hand while helping prevent defeatability when two-hand control is needed.

Two bi-colored diagnostic LEDs provide guidance during operation. The power/fault LED blinks at different rates to provide diagnostic information to the user. The Bulletin 800Z line detects the presence of a hand during power-up, noise, and conductive film build-up over time.

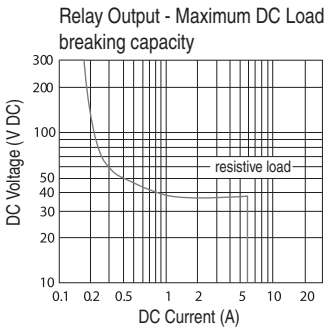
Features

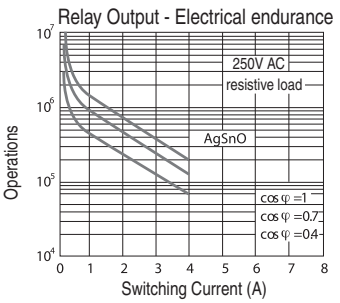
- Internationally rated ergonomic touch buttons
- Zero force to operate
- EMC protection
- Diagnostic LEDs
- Replaceable relays (heavy industrial design)

Specifications

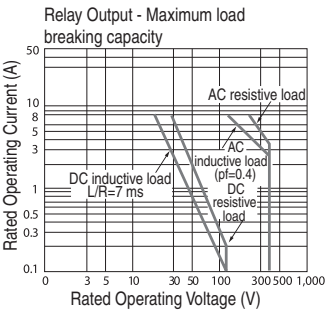
Description	General Purpose Line (Cat. No. 800Z-G)	Heavy Industrial Line (Cat. No. 800Z-H)
Mechanical Ratings		
Vibration Endurance	Tested @ 10 G, 1.52 mm displacement	
Mechanical Shock	Tested @ 100 G (mechanical durability)	
Degree of Protection	Type 4/4X/13 IP66 1200 psi Washdown	Type 4/13 IP66
Operating Force	Zero	
Electrical Ratings		
Input Voltage (Relay type)	Low Voltage: 10…40V DC, 20…30V AC Full Voltage (800Z-GF): 85…264V AC	
Input Voltage (Solid-State type)	Low Voltage (800Z-GN/GP): 10…30V DC	
Electrical Design Life (Relay type)	Relay Output 200,000 Operations @ 2A inductive 4A resistive	Relay Output 150,000 Operations @ 5A inductive 2.5 A resistive
On-delay/Off-delay	Off 60 ms max. On 76 ms max.	
Current Draw (Solid-State type)	100 mA at 24V DC = 2.23 W (no external load)	
Terminal Block Ratings		
Degree of Protection	—	IP2X
Wire Range		#22…12 AWG (0.5…4 mm²)
Tightening Torque		9 lb-in. (1N•m)
Environmental		
Temperature Range (Operating)	–25...+55°C	
Temperature Range (Storage)	–40...+85°C	
Humidity	95% RH from 25...50°C (full operation)	
Materials		
Housing/Guard	Valox 357	
Gasket	BUNA-N	1/16 in. Cork-BUNA-N
Connector	Insulator material (micro connector) = nylon Insulator material (mini connector) = PVC	
Standards and Certifications		
Certifications	$_{c}UL_{us}$, CE, C-TICK, CSA	
Standards Conformity	UL508, CSA 22.2 No. 14, UL50, EN/IEC 60947-5-1, EN50081-2, EN61000-6-2, EN954-1	

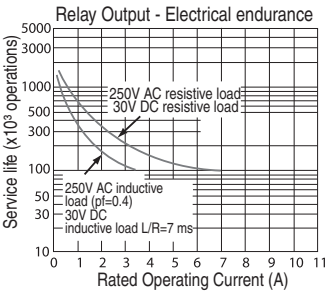
Load Life Curves for General Purpose Product Line





Load Life Curves for Heavy Industrial Line





General Purpose Line — Momentary Touch Buttons

Mounting Hole Size	Input Voltage	Output Type	Electrical Connection	No Guard Cat. No.	Black Guard Cat. No.
30.5 mm	85...264V AC	Relay Output	5-Pin QD	**800Z-GF3Q5**	**800Z-GF3Q5B**
			6 ft Cabled — 5-Wire	**800Z-GF3065**	**800Z-GF3065B**
	10...40V DC and 20...30V AC	Relay Output	5-Pin QD	**800Z-GL3Q5**	**800Z-GL3Q5B**
			6 ft Cabled — 5-Wire	**800Z-GL3065**	800Z-GL3065B
22.5 mm	85...264V AC	Relay Output	5-Pin QD	**800Z-GF2Q5**	**800Z-GF2Q5B**
			6 ft Cabled — 5-Wire	**800Z-GF2065**	**800Z-GF2065B**
	10...40V DC and 20...30V AC	Relay Output	5-Pin QD	**800Z-GL2Q5**	**800Z-GL2Q5B**
			6 ft Cabled — 5-Wire	**800Z-GL2065**	**800Z-GL2065B**
Recommended standard cordset, 2 m (6.5 ft). See *Safety Catalog* for additional lengths.			Mini-Plus Style QD Cordset, 5-Pin	889N-F5AE-6F	889D-F5AC-2

Use the configurator below to build a Bulletin 800Z touch button to suit your application.

800Z – G [L] [3] [065] [B] – [ ]
a *b* *c* *d* *e*

a

Input Voltage and Output Type ‡	
Code	Description
Relay Output	
L	Input: 10…40V DC and 20…30V AC Output: Relay
F	Input: 85…264V AC Output: Relay
Transistor Output	
P	10…30V DC PNP (Sourcing) Output

b

Mounting Hole Size §	
Code	Description
2	22.5 mm
3	30.5 mm

c

Electrical Connection	
Code	Description
Sinking/Sourcing Output ∗	
Q4	4-Pin QD
064	6 ft (1.8 m) Cabled
244	24 ft (7.2 m) Cabled
Relay Output ❄	
Q5	5-Pin QD
065	6 ft (1.8 m) Cabled
245	24 ft (7.2 m) Cabled

d

Guard Option	
Code	Description
Blank	No Guard
B	Black Guard
Y	Yellow Guard

∗ These devices are transistor outputs.
❄ These devices have separate N.O. and N.C. output relays with a shared common.
‡ Safety relays should be used in conjunction with two relay output type Zero-Force Touch Buttons™ in 2-hand control applications. Order separately, safety relay 440R-D23171 for 24V, 440R-D23169 for 120V, 440R-D23168 for 240V.
§ 22.5 mm touch buttons use micro connector, 30.5 mm touch buttons use mini connector.

Heavy Industrial Line — Momentary Touch Buttons

Button Type	Input Voltage	Output Type	Electrical Connection	No Guard Cat. No.	Yellow Guard Cat. No.
Flush Mount	10...40V DC and 20...30V AC	Relay Output	Terminal Block	**800Z-HL1**	**800Z-HL1Y**
	85...264V AC	Relay Output	Terminal Block	**800Z-HF1**	**800Z-HF1Y**

Use the configurator below to build a Bulletin 800Z touch button to suit your application.

800Z – H [L] [1] [Y] - [ ]
a *b* *c* *d*

a

Voltage ❄	
Code	Description
L	Input: 10…40V DC and 20…30V AC Output: Relay
F	Input: 85…264V AC Output: Relay

b

Mounting Type ∗	
Code	Description
1	Flush Mounting

c

Guard Option	
Code	Description
Blank	No Guard
Y	Yellow Guard

∗ Heavy industrial devices have an 8-position terminal block connection. See wiring diagrams on page 4-53 for details.
❄ Safety relays should be used in conjunction with two relay output type Zero-Force Touch Buttons in 2-hand control applications. Order separately, safety relay 440R-D23171 for 24V, 440R-D23169 for 120V, 440R-D23168 for 240V.

Accessories — General Purpose

Heavy Industrial with Guard

	Description		Cat. No.
  ***Cat. No. 800Z-G3AG1*** ***Cat. No. 800Z-G3AG2***	**Guards** These guards help protect against accidental activation of the touch button surface and protect it from damage. Can be used for both the 22.5 mm and 30.5 mm mounted products.	Yellow Plastic	**800Z-G3AG1**
		Black Plastic	**800Z-G3AG2**
 *Plastic Mounting Kit* ***Cat. No. 800Z-G2AH1***	**Mounting Ring Nut for 22.5 mm Holes** Used on 22.5 mm devices.		800Z-G2AH1
 *Plastic Mounting Kit* ***Cat. No. 800Z-G3AH1***	**Mounting Ring Nut for 30.5 mm Hole** Used on 30.5 mm devices.		800Z-G3AH1
 *Swivel Assembly* ***Cat. No. 60-2439***	**30.5 mm Swivel/Tilt Mounting Assembly** This bracket allows you to orient the touch button in any position. It can be mounted on any vertical or horizontal surface. Compatible with 30.5 mm mounting only.	2.25 in. (57 mm)	60-2681
		1.15 in. (29 mm)	60-2439
 ***Cat. No. 800E-AHA1***	**30.5 mm to 22.5 mm Hole Size Adapter** This adapter allows a 22.5 mm push button operator to be installed in a panel with existing 30.5 mm mounting holes.	Metal	800F-AHA1
		Black Metal	800E-AHA2

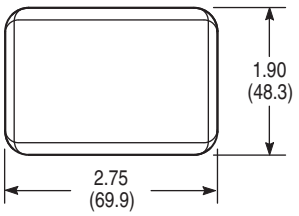
Accessories — Heavy Industrial

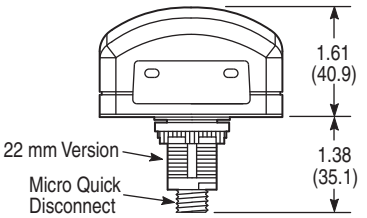
	Description		Cat. No.
 *Cat. No. 800Z-HAG1*	**Guard** This guard helps protects against accidental activation of the touch surface and protects it from damage. Mounting screws are included.	Yellow Plastic	**800Z-HAG1**
 *Single Hub Base* **Cat. No. 800P-B1**  *Double Hub Base* **Cat. No. 800P-B2**	**Mounting Bases** The heavy industrial line products mount directly on these bases. The conduit hub(s) come with a 3/4 inch opening.	1	**800P-B1**
		2	**800P-B2**
 *Cat. No. 800P-N150*	**Adapter** This adapter is used if mounting touch button onto a 4-1/2 in. x 2-3/8 in. (114.3 x 60.3 mm) enclosure pattern.		**800P-N150**
 *Cat. No. 800Z-N12*	**Replacement Relay** **Note:** Package quantity of 2.	10...264V	800Z-N12
 *Cat. No. 800Z-HAH1*	**Replacement Screws**	Guard-to-Base Mounting **Note:** package quantity of 4	800Z-HAH1
		Base Mounting **Note:** package quantity of 4	800Z-HAH2

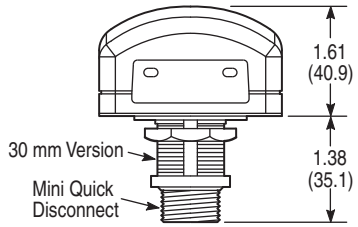
Approximate Dimensions

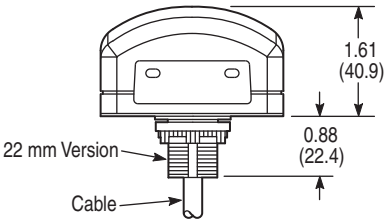
Dimensions in in. (mm). Dimensions are not intended to be used for manufacturing purposes.

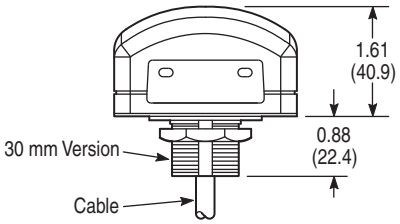
General Purpose



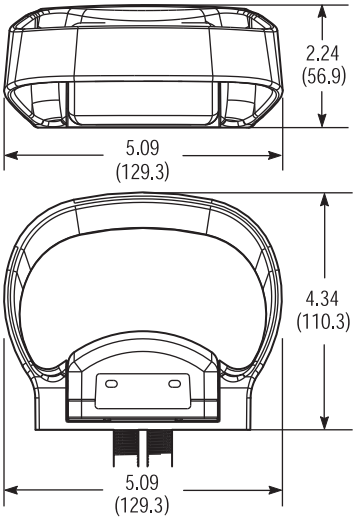




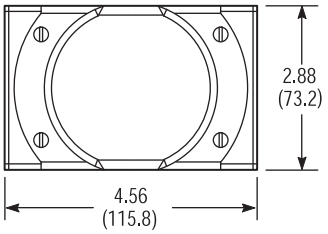


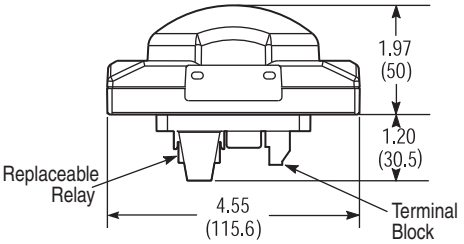


General Purpose With Guard

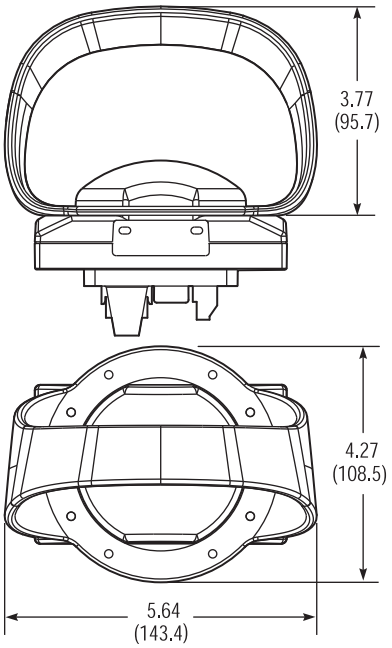


Heavy Industrial

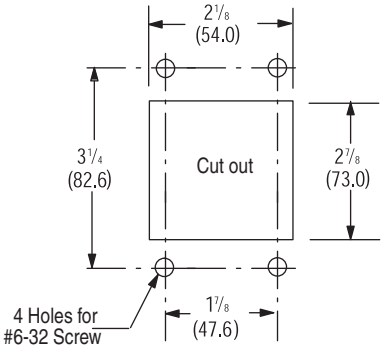




Heavy Industrial With Guard



Cutout and Mounting Screw Locations for a Flush Mounted Cover



Wiring Diagrams — Touch Button Terminations

General Purpose Line

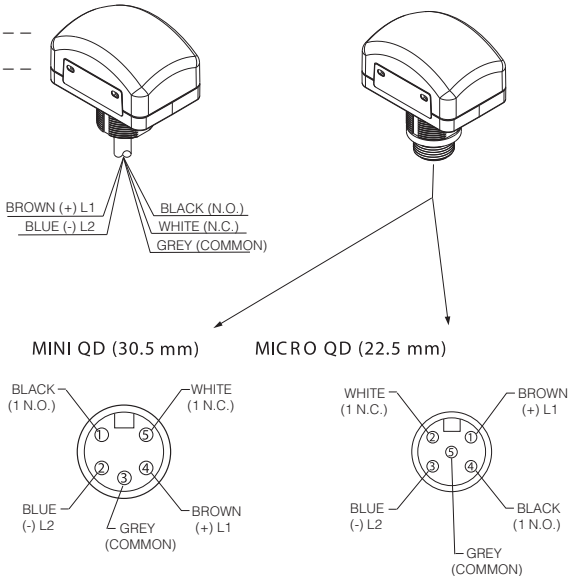
Electrical Connections: 10...40V DC and 20...30V AC Input Voltage (Relay Output); 85...264V AC Input Voltage (Relay Output)

Note: Separate N.O. and N.C. output relays with shared common.

5-Conductor Cabled (Relay Output)

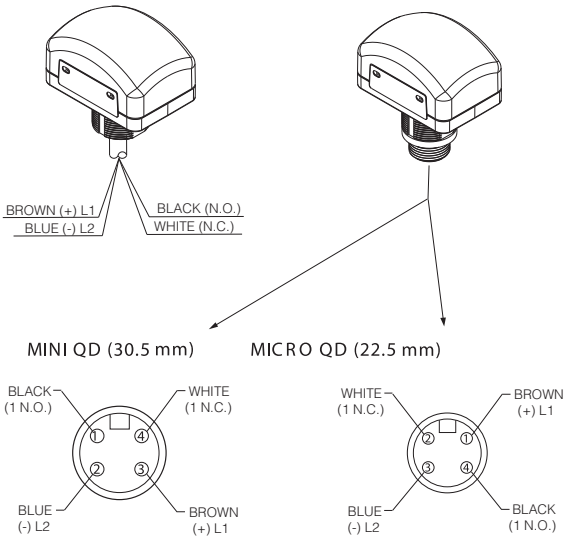
For 800Z-GL_ _ _

For 800Z-GF_ _ _

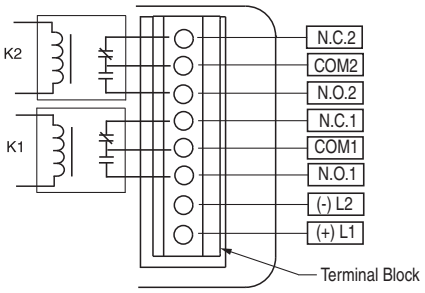


Electrical Connections: 10...30V DC Input Voltage (Transistor Output); 150 mA Max. per Circuit Output

4-Conductor Cabled



Heavy Industrial Line



Applications Detail

LED Blink Rate	Diagnostic	Description
** ** **	Power Up	Device touched during power up. Device will resume 10 seconds after removal of hand.
*** *** ***	Noise Detection	Device detected an unacceptable level of noise (>20 V/m). Device will resume once noise subsides.
**** **** ****	Margin Detection	A conductive film is building up on the sensing surface. Device will resume once cleared.

Notes

Logic

Selection Criteria

Selection Flowchart 5-2
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Selection Navigator 5-4
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Safety Relays

Overview

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Selection Guidelines 5-13
Make the Right Choice 5-13

Single-Function Safety Relays

MSR9T 5-14
MSR30RT/RTP 5-16
MSR33RT/RTP 5-18
MSR41 5-20
MSR117T 5-22
MSR126R/T 5-24
MSR127RP/TP 5-26
MSR131RTP 5-28
MSR142RTP 5-30
MSR144RTP 5-32
With Delayed Outputs
CU4 5-34
MSR38D/DP 5-36
MSR138DP 5-38
MSR178DP 5-40

Specialty Safety Relays

Two-Hand
MSR35H/HP 5-44
MSR125H/HP 5-46
Muting Light Curtain
MSR22LM 5-48
MSR42 5-52
Stop Motion Monitors
CU2 5-56
CU2 Sensor Details 5-58
Speed Monitors
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Note:

E =	Expander	T =	Automatic Reset
D =	Delayed	R =	Manual Reset
H =	Two-Hand Control	M =	Safety Mat
P =	Removable Terminals		

‡ Information for this product line is available on the Safety Products Catalog website: www.ab.com/catalogs.

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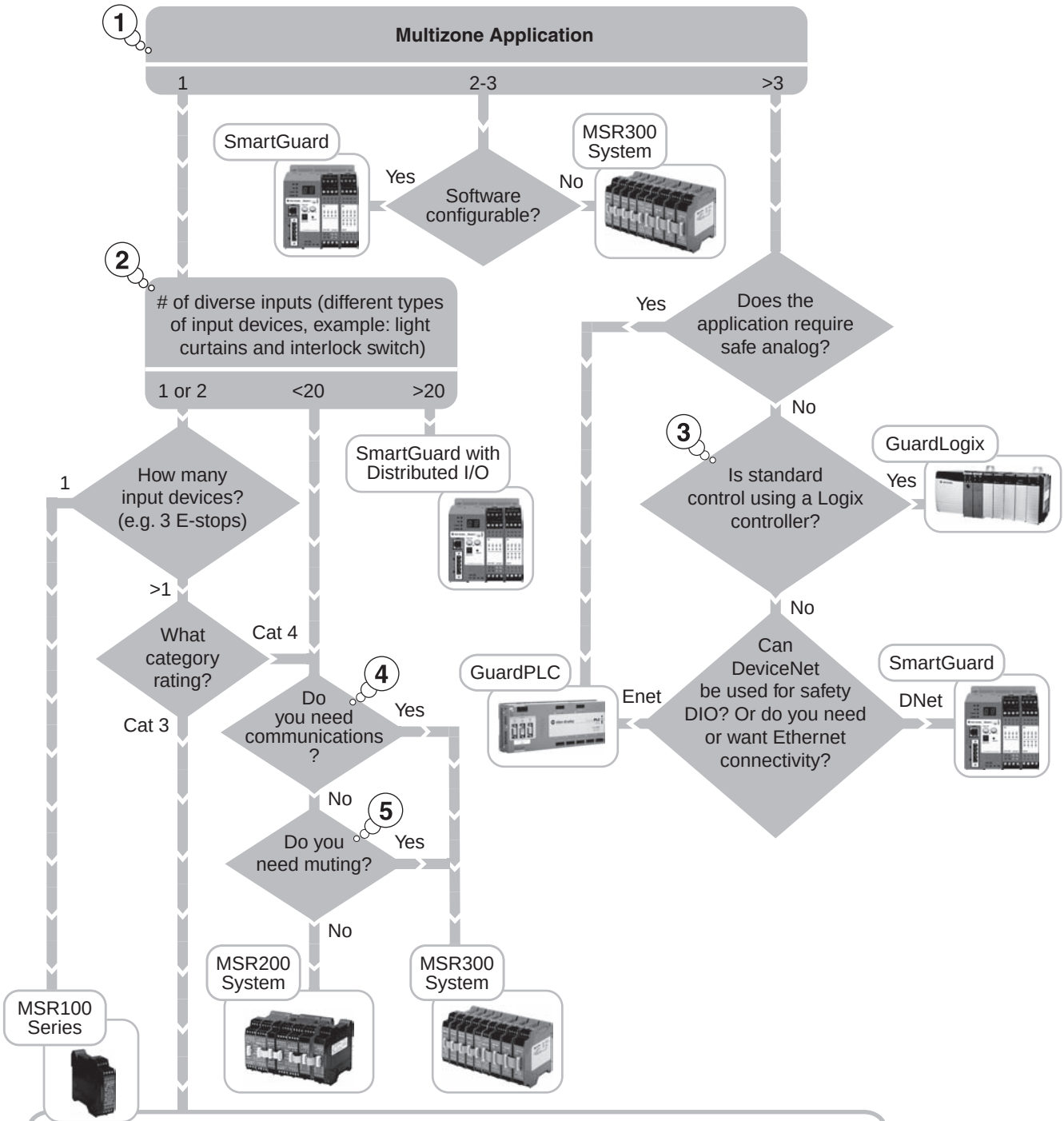
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Selection Flowchart



RECOMMENDED PRODUCTS

E-stop/Safety Switch	Light Curtain	Muting & Blanking	Time Delay	Two-Hand Control	Safety Mat
MSR126 **MSR127**	**MSR127** **MSR131**	**MSR42**	**MSR138**	**MSR125**	**MSR131**

Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

1 Is This a Multizone Application?

In order to comply with safety standards and remain productive, machine builders have begun building functional safety features into machines using what has been termed the “Zone Concept.” The Zone Concept increases both safety and productivity by allowing a portion of the production line to slow or stop while the rest of the line remains active. The safety hazard, whether a minor malfunction of line equipment or an obstruction, can be removed or corrected without taking the entire line down, eliminating lengthy production shut downs and worker downtime. When the hazard is cleared, the line can quickly return to normal operation. Single function and/or expandable relays systems are suited only for single-zone control, while multizone control for 2…3 zones is best served through a configurable system such as MSR300 relays or a SmartGuard packaged controller. Any applications involving control of more than three zones (and therefore more complex logic) is better suited for a programmable safety controller—SmartGuard, GuardPLC or GuardLogix.

2 Diverse Inputs—Number and Type

For single- and multizone applications (≤ 3 zones), the number and type of inputs (e.g. interlock switches, safety mats, light curtains) will dictate the use of either safety relays (MSR100, MSR200 and MSR300) or a small packaged safety controller such as SmartGuard. For 1…2 inputs, dedicated standalone relays (MSR100) are a simple and cost effective solution, but for applications involving a high number of input devices, the hard wiring associated with individual relays can be restrictive. Therefore, in applications requiring a moderate input device count (20 or less), an expandable relay system with modular design and plug-in connections (MSR200, MSR300) is an ideal solution. In any case with safety relays, the types of input devices used will dictate the relay modules that must be selected; thus relay selection for a wide range of input devices can be complex. Applications requiring greater than 20 diverse inputs and a degree of complex logic lend themselves to the SmartGuard Controller in combination with Distributed I/O. Larger installations—those with a high number and wide variety of input device types—are best served with a safety PLC system as their programmable nature allows safety applications to be solved in software rather than hard-wiring large, cascaded relay systems.

3 Is Standard Control Using a Logix Controller?

A safety control system can be a dedicated (safety only) system or integrated, where standard and safety control are combined to maximize the re-use of components and tools.

GuardLogix brings together the benefits of a Logix platform—common programming environment, common networks, and common control engine—with integrated safety control in an easy-to-use environment while providing Safety Integrity Level (SIL) 3 control. By partnering with the Logix5000™ processor, GuardLogix users can benefit from common programming software, controller and I/O to help reduce development time and application cost.

GuardPLC and SmartGuard are the recommended platforms for applications requiring safety to be physically separated from standard control.

4 Do You Need Communications?

On-board communications allow the relay to deliver output and error status over an RS232/RS485 or fieldbus network (such as DeviceNet) to an HMI or other device. While the MSR200 series of modular safety relays does offer communications compatibility, it is not the most economical solution—MSR300 configurable safety relays are the best choice for applications requiring communications. Programmable safety controllers offer network connectivity and a high level of diagnostics, with SmartGuard and GuardPLC having DeviceNet and Ethernet capabilities, respectively.

5 Do You Need Muting?

Sometimes the process requires that the machine stop when personnel enters the area, yet remains running when automatically-fed material enters or exits—this is a situation where a muting function is necessary. Muting requires the combination of a light curtain, two or four muting sensors and a control unit to process the signals and determine if and when to activate the muting function. Muting sensors are mounted in front of and behind the light curtain and only a specific sequence of sensor outputs will initiate the muting function. For example, when the two sensors in front of the light curtain change state within a predetermined timeframe, the light curtain is “muted” and will not send a stop signal to the machine as the material enters. The MSR300 modular safety monitoring relay offering includes a module specifically designed to control the muting function in applications that do not require a specific sequence or timing requirement. Muting of the MSR42 can be conveniently set up using configuration software. If sequence and timing is required, then the MSR22LM may be better suited for your application.

Safety Relay Overview

Safety Relay Selection Navigator

Relay Model	Cat. per EN 954-1	1 NC	2 NC	1 NC & 1 NO	THC	SM	LC/ SG	SE	Immediate Outputs					Delayed Outputs					
									Safety		Auxiliary			Safety			Auxiliary		
									EM NO	SS NO	EM NC	SS NC	SS NO	EM NO	EM NC	SS NO	EM NC	SS NC	SS NO
Single Function Safety Relays																			
MSR9T	3	—	—	1	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—
MSR30RT/RTP	4	1	1	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—
MSR33RT/RTP	4	—	—	1	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—
MSR41	4	—	—	—	—	—	1	—	—	2	—	2	—	—	—	—	—	—	—
MSR117	4	1	—	—	—	—	—	—	3	—	1	—	—	—	—	—	—	—	—
MSR126R/T	4	1	1	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	—
MSR127RP/TP	4	1	1	—	—	—	1	—	3	—	1	—	—	—	—	—	—	—	—
MSR131RP/TP	4	1	1	—	—	1	1	—	3	—	2	2	—	—	—	—	—	—	—
MSR142RTP	4	1	1	—	—	1	1	—	7	—	4	2	—	—	—	—	—	—	—
MSR144RTP	4	1	1	—	—	1	1	—	2	—	2	2	—	—	—	—	—		—
Delayed Outputs																			
CU4	3	—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	—
MSR38D/DP	4	1	1	—	—	1	—	—	—	—	—	—	1	—	—	2	—	—	—
MSR138DP	4/3	1	1	—	—	—	1	—	2	—	—	—	—	3	—	—	—	—	—
MSR138.1DP	4/3	1	1	—	—	—	1	—	2	—	—	—	—	2	1	—	—	—	—
MSR178DP	4	1	1	—	1	—	1	—	—	—	—	—	—	3	—	—	2	—	—
Specialty Safety Relays																			
Two-Hand Control																			
MSR35H/HP	4	—	—	2	1	—	—	—	—	2	—	—	1	—	—	—	—	—	—
MSR125H/HP	4	—	—	2	1	—	—	—	2	—	—	—	—	—	—	—	—	—	—
Muting LIght Curtain																			
MSR22LM	4	—	—	—	—	—	3	—	2	—	1	2	—	—	—	—	—	—	—
MSR42	4	—	1	—	—	—	3	—	—	2	—	2	—	—	—	—	—	—	—
Stop Motion Monitors																			
CU2	1	—	—	1	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—
Speed Monitors																			
MSR57P	4	1	1	1	—	1	1	—	—	6	—	—	—	—	—	—	—	—	—
Back EMF Monitors																			
CU3	1	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—
Mat Controllers																			
MSR23	3	—	—	—	—	1	—	—	2	—	1	—	—	—	—	—	—	—	—
440F-C4000P	3	—	—	—	—	1	—	—	2	—	1	—	—	—	—	—	—	—	—
440F-C4000S	3	—	—	—	—	1	—	—	2	—	1	—	—	—	—	—	—	—	—
Mat Manager																			
C280**	3	—	—	—	—	8✶	—	—	6❄	—	1	—	—	—	—	—	—	—	—
Safedge™ Controllers																			
251D	3	—	—	—	—	—	—	1‡	2	—	1	—	—	—	—	—	—	—	—
252D	3	—	—	—	—	—	—	1‡	1	—	1	—	—	—	—	—	—	—	—
C251P	3	—	—	—	—	—	—	1‡	2	—	1	—	—	—	—	—	—	—	—
Sipha Controllers																			
Sipha 1	3	—	—	1	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—
Sipha 2	3	—	—	6	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—
Sipha 6	4	—	—	6	—	—	—	—	2	—	1	—	—	1	—	—	—	—	—

Note: THC= Two-hand Control, SM = Safety Mat, LC = Light Curtain, SG = SensaGuard, SE = Safedge, EM = Electromechanical, SS = Solid State, and • = included

✶ Up to eight mats can be monitored.

❄ Up to six mats can be monitored.

‡ Can support more than one edge in series or parallel.

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Allen-Bradley
GuardMaster®

Operating Voltage				Reset❄		Output Switching Current, A		Housing Width (mm)	Removable Terminals	Additional Information	Relay Model
24 DC	24 AC	115 AC	230 AC	Auto./ Man.	Mon. Man.	250V AC	24V DC				
•	•	•	•	•	—	4	3	45.5	—	5-14	MSR9T
•	—	—	—	•	•	—	2	22.5	•	5-16	MSR30RT/RTP
•	—	—	—	•	•	—	2	22.5	•	5-18	MSR33RT/RTP
•	—	—	—	•	—	—	4	22.5	•	5-22	MSR41
•	•	—	—	•	—	5	3	22.5	—	5-22	MSR117
•	•	•	•	•	•	6	3	22.5	—	5-24	MSR126R/T
•	•	•	•	•	•	5	3	22.5	•	5-26	MSR127RP/TP
•	•	•	•	•	•	6	3	45.0	•	5-28	MSR131RP/TP
—	•	•	•	•	•	6	3	67.5	•	5-30	MSR142RTP
•	—	—	—	•	•	5	3	45.0	•	5-32	MSR144RTP
•	•	—	—	•	—	5	3	22.5	—	5-34	CU4
•	—	—	—	•	•	—	2	22.5	•	5-36	MSR38D/DP
•	•	•	•	•	•	6	3	45.0	•	5-38	MSR138DP
•	•	•	•	•	•	6	3	45.0	•	5-38	MSR138.1DP
•	•	•	•	•	—	4	2	35.0	•	5-40	MSR178DP
•	—	—	—	—	—	—	2	22.5	•	5-44	MSR35H/HP
•	—	•	•	—	—	6	3	22.5	•	5-46	MSR125H/HP
•	—	—	—	—	•	3	3	45.0	•	5-48	MSR22LM
•	—	—	—	•	•	—	4	22.5	•	5-48	MSR42
•	•	•	•	•	—	4	3	45	—	5-56	CU2
•	—	—	—	•	•	—	2	67.5	•	5-60	MSR57P
•	•	•	•	•	—	4	3	45	—	5-64	CU3
•	•	•	—	•	•	3	3	22.5 & 45.0	•	5-66	MSR23M
•	•	•	•	•	•	4	2	210	—	5-66	440F-C4000P
•	•	•	•	•	•	4	2	210	—	5-66	440F-C4000S
•	•	•	•	•	•	4	2	210	—	5-70	C280
•	•	•	•	•	—	2	1	45	—	5-72	251D
•	•	—	—	•	—	2	1	22.5	—	5-72	252D
•	•	•	•	•	—	2	1	130	—	5-72	C251P
•	•	—	—	•	—	4	2	22.5	—	5-74	Sipha 1
•	•	•	•	•	—	4	2	45	—	5-74	Sipha 2
•	•	•	•	•	—	4	2	90	—	5-74	Sipha 6

Note: Auto./Man. = Automatic/Manual and Mon. Man. = Monitored Manual, and • = included

Safety Relay Overview

Relay Model	Cat. per EN 954-1	 1 NC	2 NC	 1 NC & 1 NO	 THC	 SM	 LC/ SG	SE	Immediate Outputs					Delayed Outputs					
									Safety		Auxiliary			Safety			Auxiliary		
									EM NO	SS NO	EM NC	SS NC	SS NO	EM NO	EM NC	SS NO	EM NC	SS NC	SS NO
Expansion Relays																			
MSR45E	4	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—
MSR132E/EP	4	1	1	—	—	—	—	—	4	—	2	—	—	—	—	—	—	—	—
Delayed Outputs																			
MSR132ED/EDP	3	1	1	—	—	—	—	—	—	—	—	—	—	4	—	—	2	—	—
Modular Safety Relays (Series 200)																			
MSR210P	4	2	2	2	—	2	—	—	2	—	1	—	2	—	—	—	—	—	—
MSR211P	4	2	2	—	—	—	2	—	2	—	1	—	2	—	—	—	—	—	—
MSR220P	4	2	2	2	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—
MSR221P	4	2	2	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
MSR230P	4	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—
MSR238P	3	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1	—	—
MSR240P	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MSR241P	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—
MSR245P	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Configurable Safety Relays (Series 300)																			
MSR310P	4	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—
MSR312P	4	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—
MSR320P	4	2	2	2	1	2	2	—	—	—	—	—	2	—	—	—	—	—	—
MSR329P	4	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—
MSR330P	4	—	—	—	—	—	—	—	3	—	1	—	—	—	—	—	—	—	—
MSR338DP	3	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	1	—	—

Note: THC= Two-hand Control, SM = Safety Mat, LC = Light Curtain, SG = SensaGuard, SE = Safedge, EM = Electromechanical, and SS = Solid State

Operating Voltage				Reset❄		Output Switching Current, A		Housing Width (mm)	Removable Terminals	Additional Information	Relay Model
24 DC	24 AC	115 AC	230 AC	Auto./Man.	Mon. Man.	250V AC	24V DC				
—	—	—	—	—	—	3	6	22.5	•	5-78	MSR45E
•	•	—	—	—	—	6	3	22.5	•	5-78	MSR132E/EP
•	—	—	—	—	—	6	3	22.5	•	5-78	MSR132ED/EDP
•	—	—	—	•	•	3	2.5	45.0	•	5-82	MSR210P
•	—	—	—	•	•	3	2.5	45.0	•	5-84	MSR211P
•	—	—	—	—	—	—	—	17.5	•	5-86	MSR220P
•	—	—	—	—	—	—	—	17.5	•	5-88	MSR221P
•	—	—	—	—	—	3	2.5	22.5	•	5-90	MSR230P
•	—	—	—	—	—	5	3	22.5	•	5-92	MSR238P
•	—	—	—	—	—	—	—	17.5	•	5-94	MSR240P
•	—	—	—	—	—	—	2	45	•	5-96	MSR241P
•	—	—	—	—	—	—	—	144	•	5-98	MSR245P
•	—	—	—	•	•	—	—	35	•	5-102	MSR310P
•	—	—	—	•	•	—	—	35	•	5-104	MSR312P
•	—	—	—	—	—	—	50 mA	17.5	•	5-106	MSR320P
•	—	—	—	—	—	—	30…200 mA	17.5	•	5-108	MSR329P
•	—	—	—	—	—	6	3	22.5	•	5-110	MSR330P
•	—	—	—	—	—	5	3	22.5	•	5-112	MSR338DP

Note: Auto./Man. = Automatic/Manual and Mon. Man. = Monitored Manual, and • = included

MSR100 Single Function Safety Relays



Features/Benefits

A simple and cost-effective solution for a wide variety of applications, MSR100 single function safety relays support a wide variety of input devices and output configurations. Ideal for relatively small safety applications and single zone control, MSR100 relays are designed in a compact package with removable terminal for ease of installation and maintenance. These relays are also available in electromechanical versions, or solid-state models for applications involving high cycle rates.

Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling
- OEM machines

Common Misapplications

- Complex safety solutions
- Applications requiring a high level of diagnostics
- Driving high current loads
- Electromechanical relays used for high cycle rates

MSR200 Modular Safety Relays



Features/Benefits

Using plug-and-play digital I/O expansion modules, the MSR200 expandable modular relay system supports up to 22 diverse inputs (mats, light curtains, switches, etc.) to allow safety control of larger, more complex manufacturing equipment with a single relay system. The MSR200 family's microprocessor-based design offers enhanced diagnostic and communication functionality over multiple protocols. It also allows the relay to deliver output and error status over a fieldbus network to an HMI. Simple plug-in connectivity between modules provides simple system expansion with reduced wiring. Offering SIL3, delayed output support and an optional dedicated display module, the MSR200 system provides substantial cabinet space savings over dedicated single-function relays.

Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling
- PLC controlled applications
- Medium size machines

Common Misapplications

- Dedicated input connections for input devices
- Not economical when communication is needed (MSR300 recommended)

MSR300 Configurable Safety Relays



Features/Benefits

The MSR300 family of expandable modular safety relays handles larger, more complicated safety systems by allowing connection of multiple input modules to a single base unit. It offers a logic configuration with multiple inputs and the control of multiple independent outputs. The system supports up to 20 diverse inputs and can control up to 3 zones, performing simple function block logic configurations through rotary switch settings as opposed to software configuration. Modules can be mixed and matched to work with various input device types, reducing the need for multiple single-purpose relays, simplifying setup, wiring, maintenance and saving valuable panel space. The MSR300's diagnostic capabilities over multiple protocols provide input, output and error status. Offering SIL3, two-hand control support and monitoring through HMI, the MSR300 is easily customized and expanded thanks to plug-in connections that reduce wiring for the addition of inputs and outputs.

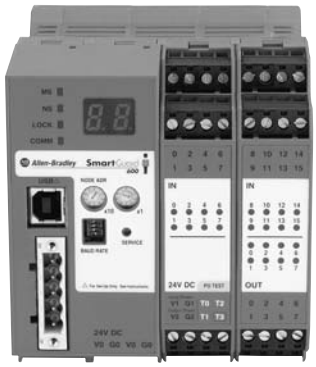
Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling
- Wide variety of input types
- Reduced inventory

Common Misapplications

- Single zone applications with no communications requirements

SmartGuard™ 600



Features/Benefits

The SmartGuard 600 controller is designed for SIL3 applications that require some complex logic. It is a “packaged safety controller” that includes the CPU, 16 Safety Inputs and 8 Safety Outputs and an embedded DeviceNet communications port. Using the DeviceNet communications port, the SmartGuard 600 controller can control additional safety I/O modules including the 1791DS CompactBlock Guard I/O and 1732DS ArmorBlock Guard I/O, as well as 1734 POINT Guard I/O modules via a 1734-PDN module. In addition, the SmartGuard controller can also communicate with standard PLCs and HMIs on DeviceNet or EtherNet/IP networks. SmartGuard 600 systems are programmed using RSNetworx software.

Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling

Common Misapplications

- Simple applications (MSR300 recommended)

Guard I/O™



Features/Benefits

Guard I/O is the name for the Rockwell Automation family of Safety I/O modules that communicate via CIP Safety on EtherNet/IP and DeviceNet networks. CompactBlock Guard I/O modules on EtherNet/IP and DeviceNet networks are available in IP20 (in-cabinet) form-factor ArmorBlock Guard I/O modules on DeviceNet networks are available in IP67 (on-machine) form-factors. POINT Guard I/O modules provide EtherNet/IP and Devicenet connectivity in a maximum density in-cabinet I/O solution.

Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling

Common Misapplications

- Simple applications (MSR300 recommended)

GuardPLC™



Features/Benefits

GuardPLC refers to a family of SIL3 safety controllers that are programmed with the RSLogix Guard software package. Like the SmartGuard 600, the GuardPLC 1600 and GuardPLC 1800 Safety PLCs are “packaged safety controllers” with a CPU, safety I/O and embedded communication networks. In the case of the GuardPLC 1600 and 1800 the embedded communication network is Ethernet for communication to GuardPLC Safety I/O modules as well as EtherNet/IP for communications to standard controllers and HMIs. The GuardPLC 1600 includes 20 safety inputs and 8 safety outputs. The GuardPLC 1800 includes 24 safety inputs, 8 safety outputs, 8 analog safety inputs and 2 safety rated high speed counters.

Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling

Common Misapplications

- Simple applications with low I/O counts

GuardLogix®



Features/Benefits

The GuardLogix system is a SIL3 Logix5000™ controller that in addition to running all standard control functions like sequential, motion, etc., also has the ability to run a Safety Task and control safety DIO. This enables both safety and standard applications to run simultaneously in a single application project. This significantly reduces integration, spares and training and improves the flow of data to HMI and information systems. A GuardLogix controller communicates to Safety I/O via a standard communication modules. It is programmed with RSLogix 5000, just like a Logix5000 processor.

Applications

- Wide range of general purpose applications
- Automotive
- Packaging
- Food and beverage
- Semiconductor
- Material handling

Common Misapplications

- Simple applications with low I/O counts

Safety Relay Overview

Why Use a Minotaur?

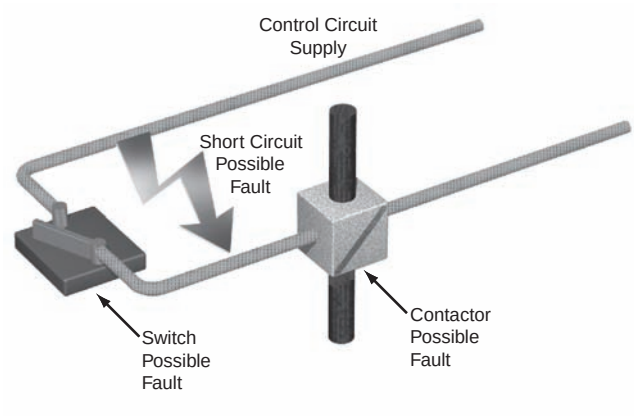
Control units provide functions such as time delays, motion sensing and two hand control supervision.

The functional requirements for monitoring safety relay units, such as the Guardmaster Minotaur range, will depend on their use in the system.

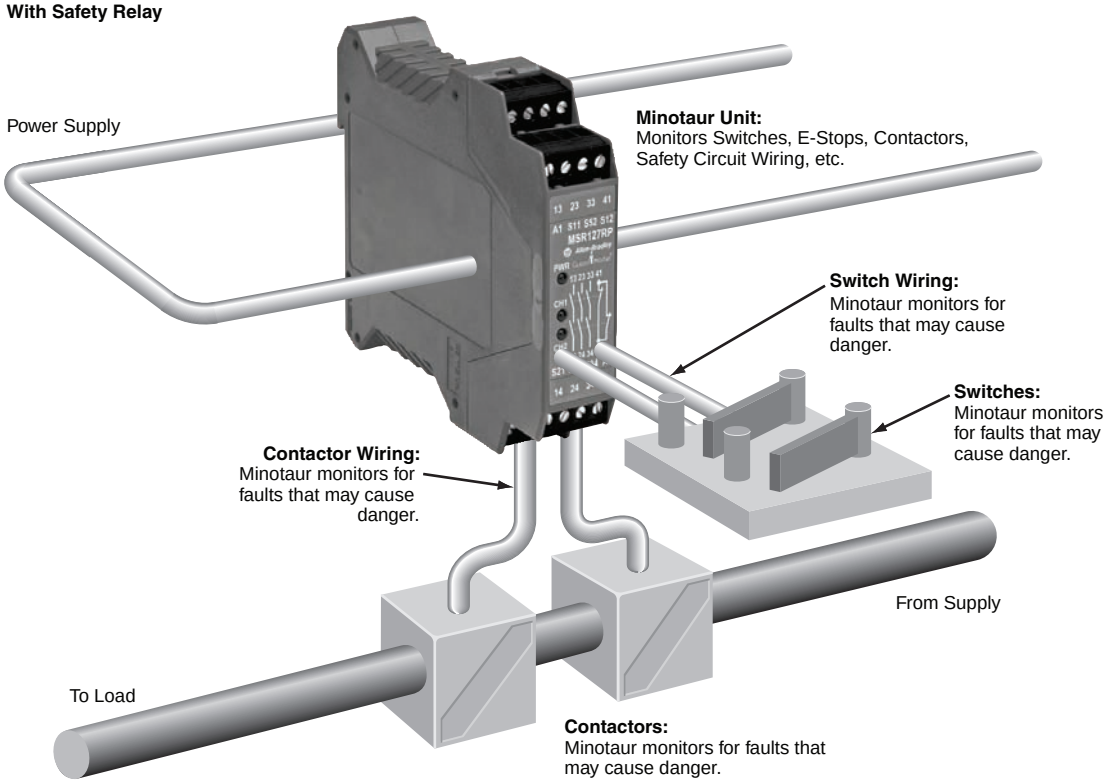
Their basic tasks are:

1. To detect faults on safety-related electrical control circuits, e.g. faults in sensors, wiring, contactors, etc.
2. To provide an ensured switching action, e.g. to act as an intermediate relay to amplify a signal or distribute it to multiple devices.
3. To provide a manual reset facility. They achieve their function by using internal redundancy (e.g. duplication) and monitoring.

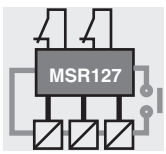
With Safety Relay



With Safety Relay



Applications



- Contactor monitoring circuit
- Contactor switching circuit
- Supply inclusive of switching circuit
- Contactor
- Monitored by Minotaur

Selection Guidelines

There are four safety system architectures available from Rockwell Automation. They are as follows:

1. Component systems: At the lowest level, a safety function can be accomplished with an actuating device and a control device. For example, an e-stop button that opens up the coil of a safety control relay performs a simple safety function. Component system architectures are typically used in low risk applications.

2. Dedicated safety monitoring relay systems: Dedicated safety relays are used for specific applications. These systems utilize packaged control modules that are designed to interface to common safety devices such as e-stops, safety gates, light curtains, and safety mats. Some dedicated relays provide special functions like timing, two-hand control, muting, and presence sensing device initiation. Since there are many different types of input devices and functions, there are many different types of dedicated safety monitoring relays. Dedicated safety monitoring relays have the ability to provide basic diagnostics in the form of LEDs on their front panels and auxiliary contacts that may be connected to a PLC or indicator lamp. Dedicated safety relays system architectures are typically used in medium to high-risk applications.

3. Expandable safety monitoring relay systems (MSR200): It provides the unique ability to easily add input and output modules to a "basic" safety relay module. Since the modular system is microprocessor based, it also has the ability to provide enhanced diagnostics over a communication connection. For instance, the I/O and error status can be communicated over a field bus network. Being a relatively new architecture, it currently accepts inputs from common types of safety devices: e-stops, safety gates, light curtains and safety mats. Modular safety relay system architectures are typically used in medium- to high-risk applications.

4. Configurable safety monitoring relay systems (MSR300): The MSR300 family of expandable modular safety relays handles larger, more complicated safety systems by allowing connection of multiple input modules to a single base unit. It offers the ability for a logic configuration with multiple inputs and the control of multiple independent outputs. The system can control up to three independent groups of outputs and perform simple function block logic configurations through rotary switch settings—no software needed. Mix and match modules to work with various input device types, reduces the need for multiple single-purpose relays, simplifies setup, wiring, maintenance and saves valuable panel space. The MSR300s diagnostic capabilities and communication functionality also reduces maintenance time by providing input, output and error status.

5. Safety PLC systems: Safety PLCs bring programmability, high I/O counts, distributed control and a high level of communications to safety architectures. They also bring some special functions not previously available in dedicated systems: high speed counters and analog signals. Safety PLC architectures are often applied in a variety of complex, high-risk applications.

Making the Right Choice

Begin the selection process by evaluating the needs of your application. The *Quick Guide* below can be used to direct you towards the best solution. Some of the guidelines will clearly point you to one type of architecture or another. Some will require further analysis before making a final decision. Due to the diverse nature of machine guarding, it is possible to create a hybrid system or a combination of architectures to provide adequate safeguarding of a particular machine or manufacturing system.

Quick Guide

Characteristics	Architecture
Application Complexity	
Low	Dedicated Relays
Medium	Dedicated or Expandable Relays
High	Safety PLCs
Communication	
Status	Expandable Relays
Control	Safety PLCs
Diagnostics	
Low	Dedicated Relays
Medium	Expandable Relays
High	Safety PLCs
Expandability	
Low	Dedicated Relays
Medium	Expandable Relays
High	Safety PLCs
Input Types	
Special	Dedicated Relays or Safety PLCs
Common	Dedicated or Expandable Relays
I/O Count	
Low	Dedicated Relays
Medium	Expandable Relays
High	Safety PLCs
I/O Location	
Contained	Dedicated or Expandable Relays
Spread Out	Safety PLCs
Sequential Shutdown	
None	Dedicated or Expandable Relays
Yes	Safety PLCs
Zone Control	
Few	Dedicated or Expandable Relays
Many	Safety PLCs

Single-Function Safety Relays

MSR9T



Description

The MSR9T has one normally closed and one normally open dual-channel input for use with gate interlocks and emergency stop buttons in higher risk applications. The MSR9T is typically used for gate interlocks incorporating the diversity of one positive opening and one non-positive opening interlock.

The MSR9T has output monitoring that can accommodate an automatic/manual reset. Automatic/manual reset can use a jumper or can be used to check operation of the contacts.

The MSR9T has two normally open safety outputs and one normally closed auxiliary output. The safety outputs have independent and redundant internal contacts to support the safety function. The auxiliary contact is a nonsafety output intended to provide an external signal about the status of the safety outputs.

Features

- Category 3 per EN 954-1
- Stop category 0
- One N.C. and one N.O. dual channel input
- Two N.O. safety outputs
- One N.C. auxiliary output
- Automatic reset
- 45 mm wide housing

LED Indicators

Green	Power On
Green	Output On

Specifications

Safety Ratings			
Standards		EN 954-1, ISO13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification		Cat. 3 per EN 954-1 (ISO 13849-1)	
Certifications		CE Marked for all applicable directives, cULus, and c-Tick	
Power Supply			
Input Power Entry		24V AC/DC, 115/230V AC, 50/60 Hz	
Power Consumption		<4V A	
Inputs			
Safety Inputs		1 N.C. & 1 N.O.	
Input Simultaneity		0.5 seconds	
Input Resistance, Max.		500 Ω	
Reset		Auto./Manual	
Response Time		50 ms	
Outputs			
Safety Contacts		2 N.O.	
Auxiliary Contacts		1 N.C.	
Thermal Current I_{th}		4 A (nonswitching)	
Rated Impulse withstand Voltage		2500V	
Switching Current @ Voltage, Min.		10 mA @ 10V	
Fuses, Output		5 A quick acting (external)	
Electrical Life		220V AC/4A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7A/375VA cosϕ = 0.6…0.5 M 30V DC/2A/60W = 1 M 10V DC/0.01A/0.1W = 2 M	
Mechanical Life		2,000,000 operations	
Utilization Category			
A300/AC-15	(Ue)	240V	120V
	(Ie)	3 A	6 A
A300/DC-13	(Ue)	24V	
	(Ie)	3 A	
Environmental and Physical Characteristics			
Enclosure Type Rating/ Terminal Protection		IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]		-10…+55 ° (14…131 °)	
Vibration		0.75 mm (0.30 in.) peak, 10…55 Hz	
Shock		30 g, 11 ms half-sine	
Mounting		35 mm DIN Rail	
Weight [g (lbs)]		210 (0.46)	
Conductor Size, Max.		1 x 2.5 mm² (14 AWG) stranded, 1 x 4 mm² (12 AWG) solid	

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

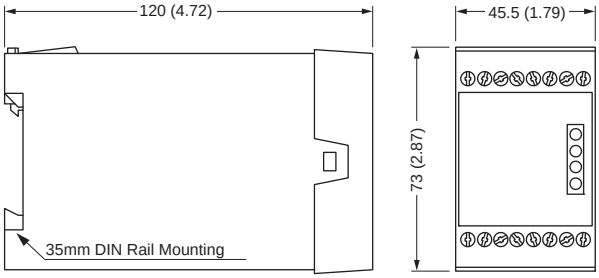
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C. & 1 N.O.	2 N.O.	1 N.C.	Fixed	Auto./Manual	24V AC/DC	440R-F23027
					110/230V AC	440R-F23028

Accessories

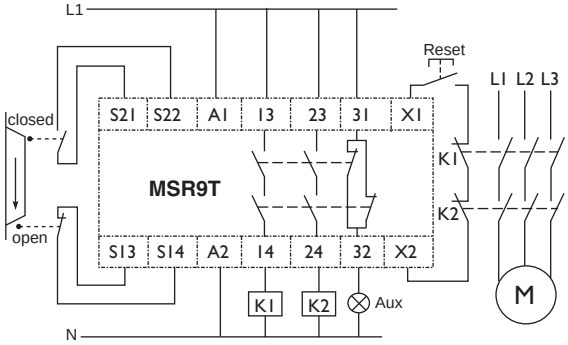
Description	Cat. No.
500 mA Fuse—Bussmann Cat. No. ETF-500 mA	440R-A31562

Approximate Dimensions

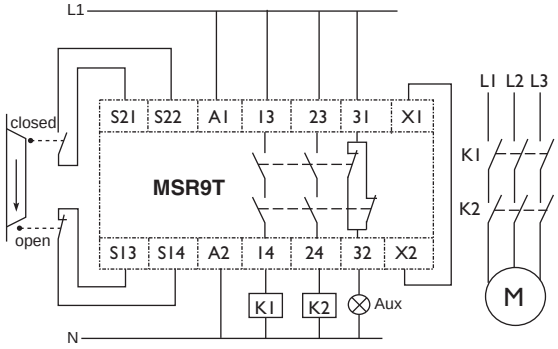
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Typical Wiring Diagrams

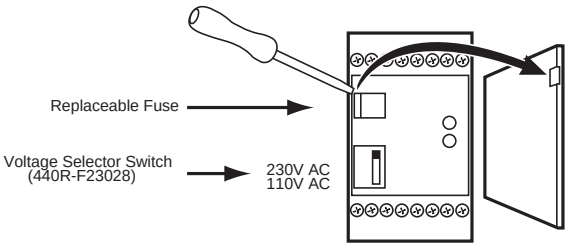


Dual-Channel Safety Gate, Manual Reset, Dual-Channel Output, Monitored Output



Dual-Channel Safety Gate, Automatic Reset, Dual-Channel Output, No Monitored Output

Application Details



Single-Function Safety Relays

MSR30RT/RTP



Housing with removable terminals shown.

Description

The Minotaur MSR30RT/RTP is a microprocessor based, monitoring safety relay, with safety-rated, solid-state outputs.

The versatility of the MSR30RT/RTP inputs allows it to be connected to gate interlocks, e-stop devices and four-wire safety mats. The gate interlocks and e-stops can be either single channel or dual channel normally-closed circuits.

The reset capability of the MSR30RT/RTP allows it to set up for manual or automatic start and restart.

The outputs include two normally-open safety-rated outputs that can be connected to loads up to 2 A at 24V DC. These outputs can be used to send a safety stop signal to a machine or manufacturing system.

The MSR30RT/RTP also has one solid-state normally-closed auxiliary output, which must only be used to indicate the status of the MSR30RT/ RTP.

Features

- Category 4 per EN954-1
- Stop Category 0
- Two solid-state safety outputs
- One solid-state auxiliary output
- One N.C., two N.C or safety mat input
- Monitored manual or automatic/manual reset

LED Indicators

Green	Power (Pwr)
Green	K1 Closed
Green	K2 Closed

Wiring Terminations

S11 & S21	Pulse train output
S12 & S22	Input contacts
A1 – S34	Reset switch
S11 – S34	Automatic reset, start-up test disabled
S21 – S34	Automatic reset, start-up test enabled
A1 – Y2	Monitoring circuit
A1 – Y41	Cross-fault monitoring disabled

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC EN 60204-1, ANSI B11.19, AS 4024.5
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 9.2 x 10^{-10} MTTFd: > 631 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL CL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC SELV
Power Consumption	3 W
Inputs	
Safety Inputs	1 N.C., 2 N.C.
Input Simultaneity	Infinite
Input Resistance, Max.	200 Ω
Reset	Auto./Manual or Monitored Manual
Power On Delay/ Recovery Time	3 seconds/20 ms
Response Time	15 ms
Outputs	
Safety Contacts	2 N.O. Solid State
Auxiliary Contacts	1 N.O. Solid State
Fuses, Output	External 6 A slow blow or 10 A fast acting
Power LED Diagnostics	3 s Blink: Initialization Constant: Normal Operation 2 Blinks: Configuration change during operation 3 Blinks: Cross-fault after reset 4 Blinks: Solid-state output switch fault Continuous blinking: Internal fault 5 Blinks: Reset switch closed after reset
Utilization Category	
DC-13	2 A @ 24V DC
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1) DIN 0470/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	130 (0.287)
Conductor Size, Max.	0.2…2.5 mm^2 (24…14 AWG)

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

Product Selection

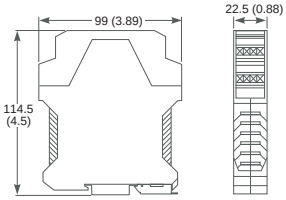
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C.	2 N.O. Solid State	1 N.O. Solid State	Fixed	Auto./Manual or Monitored Manual	24V DC SELV	440R-N23197
			Removable		24V DC	440R-N23198

Accessories

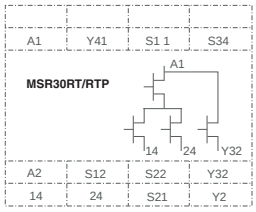
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

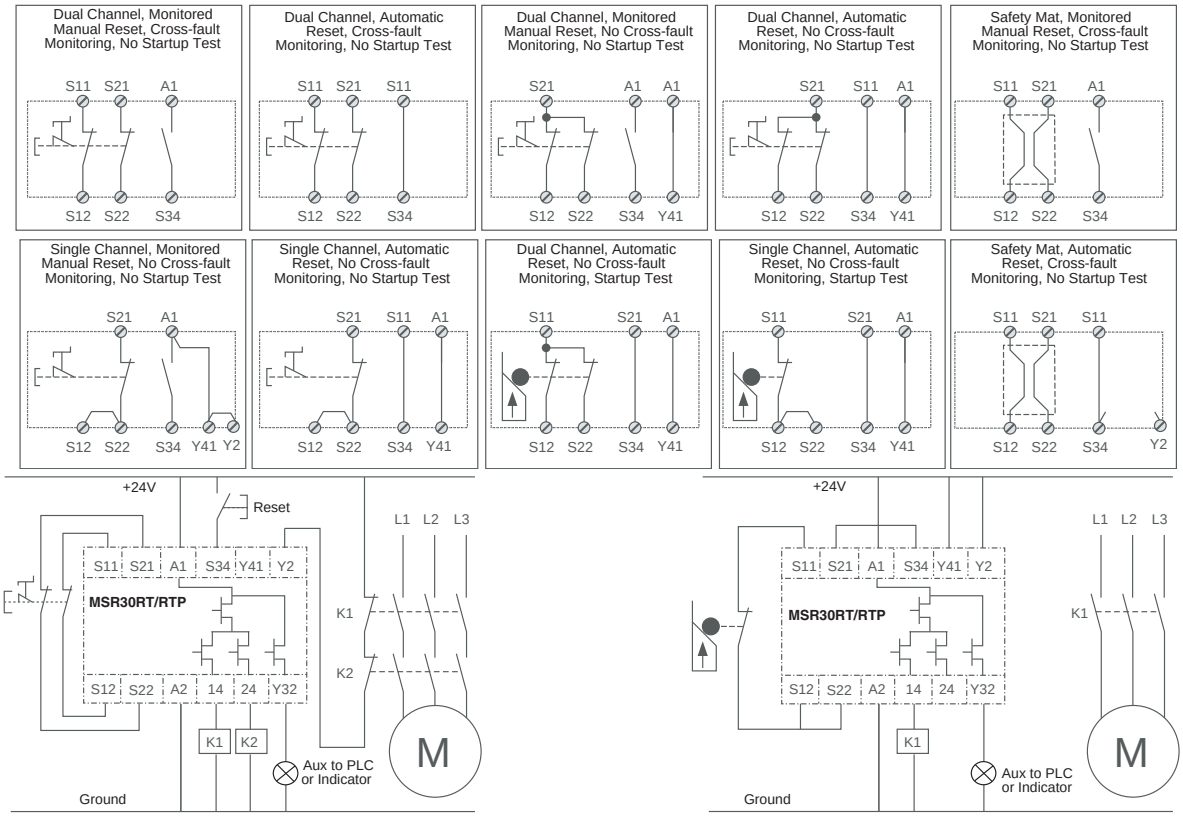
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Dual Channel E-Stop, Dual Channel Outputs, Monitored Manual Reset, Output Monitoring

Single Channel Gate Interlock, Single Channel Output, Automatic Reset, No Output Monitoring

Single-Function Safety Relays

MSR33RT/RTP



Housing with removable terminals shown.

Description

The Minotaur MSR33RT/RTP is a microprocessor-based, monitoring safety relay, with safety-rated, solid-state outputs.

The MSR33RT/RTP is designed to operate with dual channel inputs where one channel is normally closed and the other is normally open. The Sipha sensors can be connected to the MSR33RT/RTP inputs.

Test pulses are used to dynamically check the input circuits. All inputs and outputs are short-circuit protected.

The reset capability of the MSR33RT/RTP allows it to set up for monitored manual or automatic reset. A start-up test can be enabled if automatic reset is used. The start-up test requires the inputs to be cycled before energizing the outputs. The reset and start-up test is determined by the connection wiring.

The outputs include two normally-open safety-rated outputs that can be connected to loads up to 2 A at 24V DC. These outputs can be used to send a safety stop signal to a machine or manufacturing system.

The MSR33 also has one solid-state, normally-open auxiliary output, which must only be used to indicate status of the MSR33RT/RTP.

Features

- Category 4 per EN954-1
- Stop Category 0
- Two solid-state N.O. safety outputs
- One solid-state N.O. auxiliary output
- One N.O. and one N.C. input

LED Indicators

Green	Power (Pwr)
Green	CH1 Energized
Green	CH2 Energized

Wiring Terminations

S11 & S21	Pulse checking dynamic output
S12 & S22	Input contacts
A1 – S34	Reset switch
S11 – S34	Automatic reset, start-up test disabled
S21 – S34	Automatic reset, start-up test enabled
A1 – Y2	Monitoring circuit

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, ANSI B11.19, AS 4024.5
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 9.2 x 10^{-10} MTTFd: > 631 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL CL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC SELV
Power Consumption	3 W
Inputs	
Safety Inputs	1 N.C. + 1 N.O.
Input Simultaneity	Infinite
Input Resistance, Max.	200 Ω
Reset	Auto. or Monitored Manual
Power On Delay/ Recovery Time	3 seconds/20 ms
Response Time	15 ms
Outputs	
Safety Contacts	2 N.O. Solid State
Auxiliary Contacts	1 N.O. Solid State
Power LED Diagnostics	3 s Blink: Initialization Constant: Normal Operation 2 Blinks: Configuration change during operation 4 Blinks: Solid state output switch fault Continuous blinking: Internal fault
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN VDE 0470-1/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	In panel enclosure (IP54); 35 mm DIN Rail
Weight [g (lbs)]	130 (0.287)
Conductor Size, Max.	0.2…2.5 mm^2 (24…14 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

Product Selection

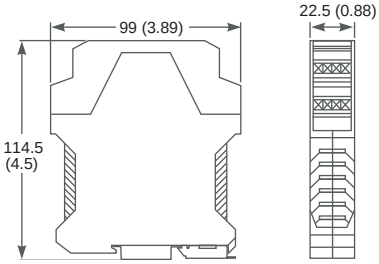
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C. & 1 N.O.	2 N.O. Solid State	1 N.O. Solid State	Fixed	Auto. or Monitored Manual	24V DC SELV	440R-F23199
			Removable			440R-F23200

Accessories

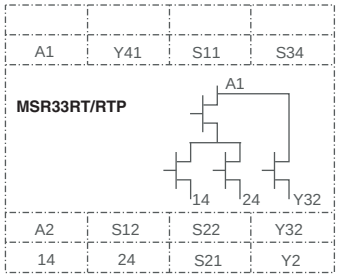
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

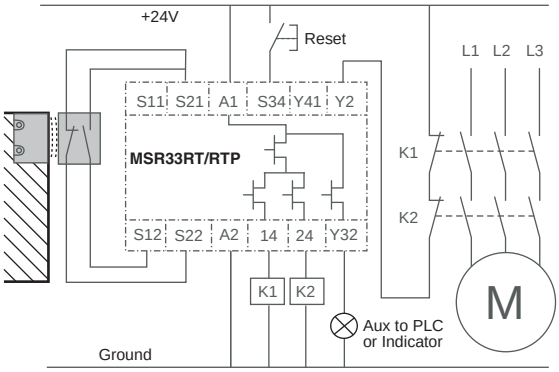
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



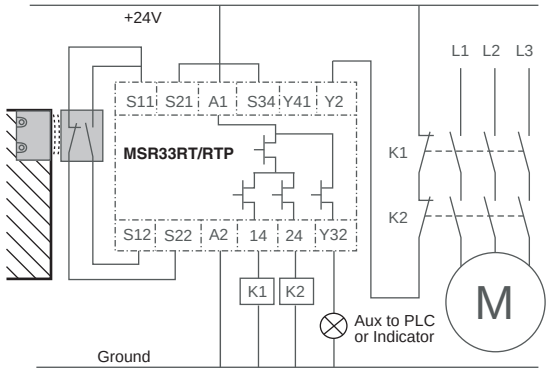
Block Diagram



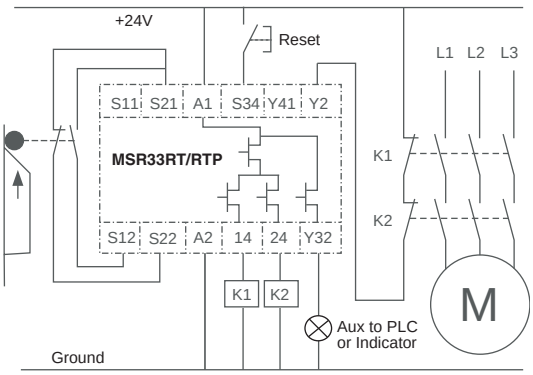
Typical Wiring Diagrams



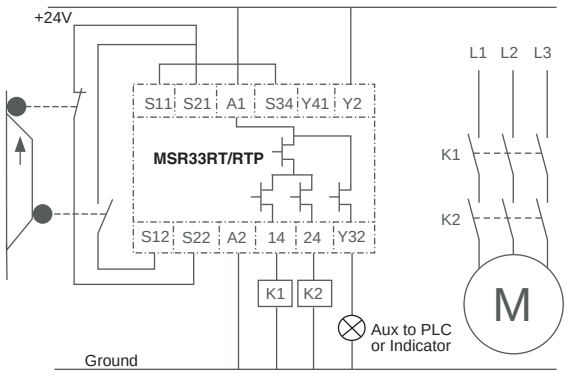
Sipha Sensor Inputs, Dual Channel Outputs, Monitored Manual Reset, Output Monitoring Start-up Test Disabled



Sipha Sensor Inputs, Dual Channel Outputs, Automatic Reset, No Output Monitoring Start-up Test Enabled



Dual Channel Inputs, Dual Channel Outputs, Monitored Manual Reset, Output Monitoring Start-up Test Disabled



Dual Independent Inputs, Dual Channel Outputs, Automatic Reset, No Output Monitoring Start-up Test Disabled

Single-Function Safety Relays

MSR41



Description

The MSR41 safety relay is a simple on/off control module for the GuardShield Micro 400 safety light curtain. This Category 4, SIL CL3 safety device has a pair of PNP solid state, 400 mA OSSDs for direct connection to the final switching device. When safety relay outputs are required, the MSR41 easily accommodates the interconnection of up to three MSR45E safety relay expansion modules, each providing a pair of safety relay outputs. Simply connect ribbon cable connectors from the back of the MSR41 to each of the MSR45E modules for a series of interconnections for two PNP OSSDs, and six N.O. relay outputs.

This 22.5 mm DIN mount safety relay can only be configured through hard-wired configurations. This relay module does not support configuration through the software but can be used for diagnostics only. The removable spring terminal connectors on the MSR41 allow for ease of wiring of the device as well as hard-wired operating mode configuration.

Manual/automatic reset and start/restart can be configured by simply changing the wiring (see examples).

Features

- Category 4 per EN 954-1
- SIL CL3 IEC 61508, IEC 62061
- 22.5 mm housing
- Stop category 0
- 24V DC supply voltage
- Manual or automatic reset
- Eight diagnostic LEDs
- Unique design allows for easy addition of relay expansion modules
- Removable terminal blocks
- Two auxiliary and standard outputs
- RJ45 connections for Micro 400 safety light curtain
- Supports up to three MSR45E expander units

LED Indicators (Default Configuration)

LED	Green	Red
OSSD2	Output active	Output inactive
OSSD1	Output active	Output inactive
Info2 (LED)	System OK	Lockout
Info1 (LED)	Safety Outputs ON	Safety Outputs OFF
IN2	Reset OK	Waiting for reset signal
IN1	—	—
0V	—	—
+24V	Power connected	No power connected

Specifications

Safety Ratings	
Standards	EN 954-1, IEC/EN 60204-1, IEC 61496-1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 61508, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFD: 2.92E-09 (w LC) SFF: 96.40% (w LC) For use in SIL3 systems (according to IEC 61508) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	24V DC
Power Consumption	2.4 W (semi-conductor outputs unloaded)
Inputs	
Safety Inputs	GuardShield Micro 400 Light Curtain
Input Resistance, Max.	—
Reset	Auto./manual
Power On Delay Time	Determined by configuration
Response Time	Determined by configuration
Outputs	
Safety Contacts	2 PNP, 400 mA each
Auxiliary Contacts	2 PNP
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP20/ IP20
Operating Temperature [C (F)]	0…55 ° (32…131 °)
Vibration	0.35 mm 10…55 Hz
Mounting	35 mm DIN Rail
Weight [g (lbs)]	130 (0.287)
Conductor Size, Max.	1 x 2.5 mm2 (14 AWG) stranded

∗ Usable for IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

Product Selection

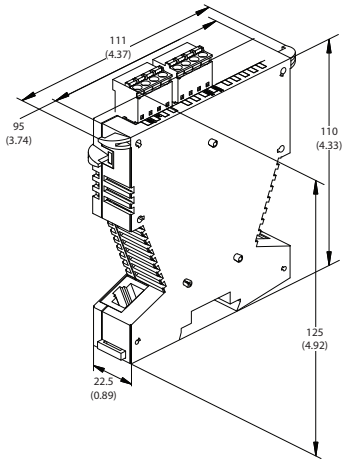
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
GuardShield Micro 400	2 PNP	2 PNP	Removable	Auto./manual	24V DC	**440R-P221AGS**

Accessories

Description	Cat. No.
MSR45E—expander for MSR41 and MSR42	440R-P4NANS
Ribbon cable—for one MSR45E	**440R-ACABL1**
Ribbon cable—for two MSR45Es	440R-ACABL2
Ribbon cable—for three MSR45Es	440R-ACABL3
Replacement terminal block kit—MSR41	440R-ATERM1P
Replacement terminal block kit—MSR45E	440R-ATERM2C

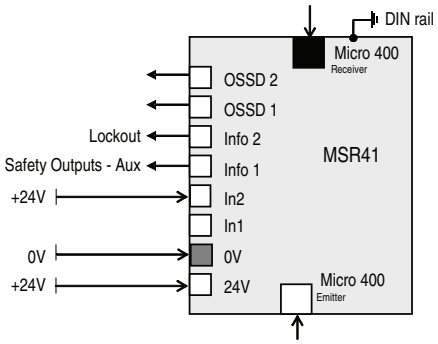
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

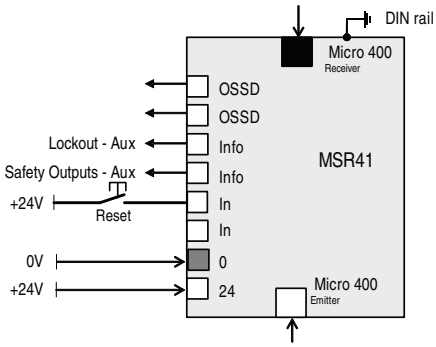


Typical Wiring Diagrams

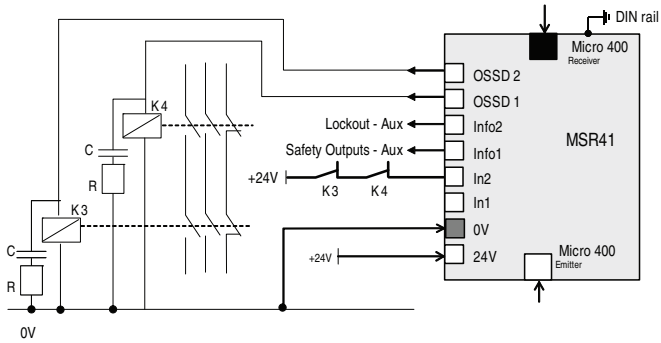
Default Configurations (No Software)



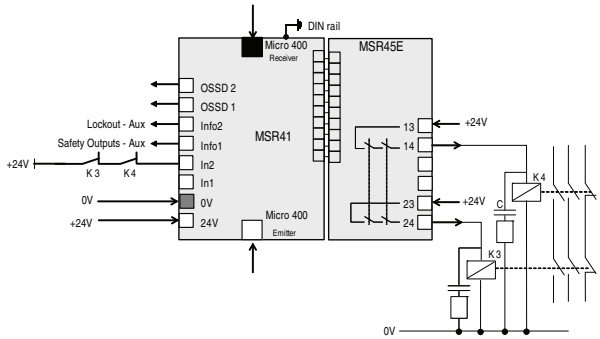
Micro 400 Light Curtain, Automatic Reset, No Output Monitoring



Micro 400 Light Curtain, Manual Reset, No Output Monitoring



Micro 400 Light Curtain, Manual Reset, Output Monitoring



Micro 400 Light Curtain, Automatic Reset, Output Monitoring

Single-Function Safety Relays

MSR117T



Description

The MSR117T has one normally closed single-channel input for use with gate interlocks and emergency stop buttons in lower risk applications. The MSR117T has output monitoring that can accommodate an automatic/manual reset function. Automatic/manual reset can use a jumper or can be used to check operation of the contacts.

The MSR117T has three normally open safety outputs and one normally closed auxiliary output. The safety outputs have independent and redundant internal contacts to help ensure the safety function. The auxiliary contact is a nonsafety output intended to provide an external signal about the status of the safety outputs.

The MSR117T can be activated via the terminals A1-A2 and the feedback/reset loop X1-X2. Then the safety outputs 13-14, 23-24 and 33-34 close and enable operation.

Features

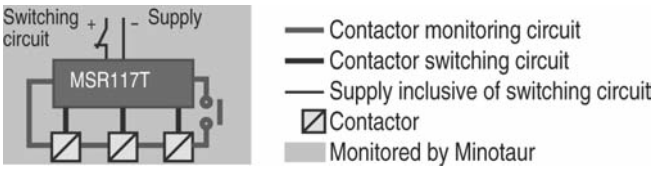
- Category 4 per EN 954-1
- Stop category 0
- Single channel input
- Three N.O. safety outputs
- One N.C. auxiliary output
- 22.5 mm wide housing

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISO 12100, ISO 13849-1 (EN 954-1)
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.53 x 10^{-9} MTTFd: > 425 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	24V AC/DC
Power Consumption	2 W
Inputs	
Safety Inputs	1 N.C.
Input Resistance, Max.	25 ohms
Reset	Auto./Manual or Monitored Manual
Power On Delay/ Recovery Time	1 sec/110 ms
Response Time	30 ms
Outputs	
Safety Contacts	3 N.O.
Auxiliary Contacts	1 N.C.
Thermal Current/$_{Ith}$	2 x 5 A or 3 x 4 A
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	6 A slow blow or 10 A quick blow (external)
Electrical Life	230V AC/4 A/880V A cosϕ=0.35…0.1 M 230V AC/1.7 A/375V A cosϕ=0.6…0.5 M 30V DC/2 A/60 = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	2,000,000 cycles
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	180 (0.37)
Conductor Size, Max.	0.2…4 mm² (24…12 AWG) wire size only

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Applications



Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

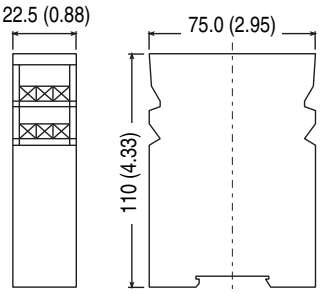
Allen-Bradley
GuardMaster®

Product Selection

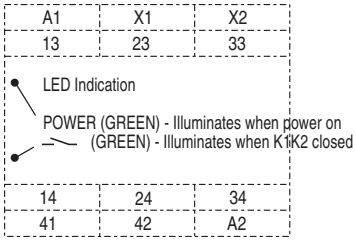
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C.	3 N.O.	1 N.C.	Fixed	Auto./Manual or Monitored Manual	24V AC/DC	440R-B23211

Approximate Dimensions

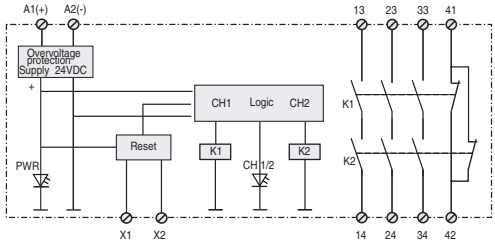
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



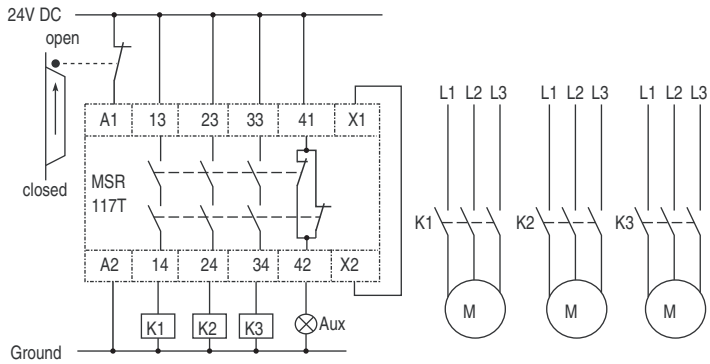
Connections



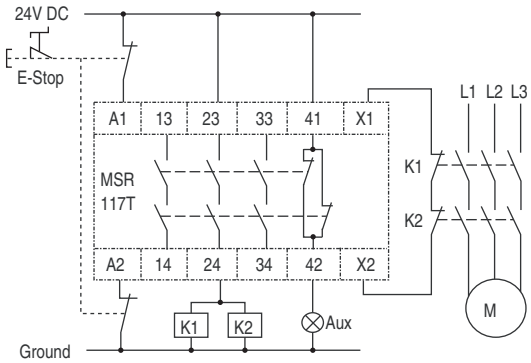
Block Diagram



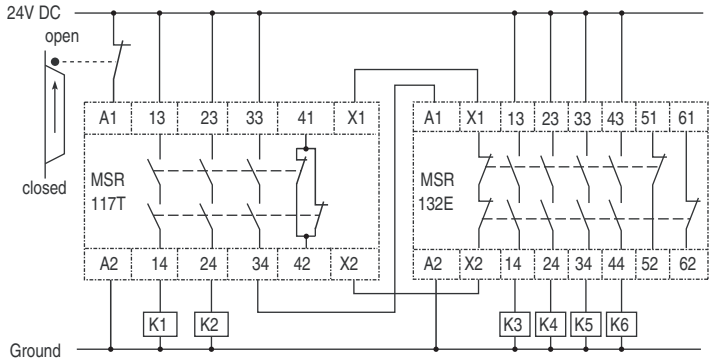
Typical Wiring Diagrams



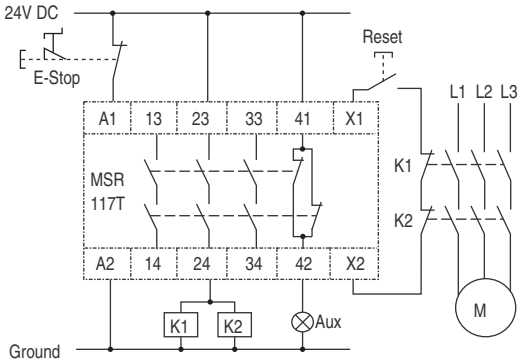
Single Channel Gate Interlock, Automatic Reset, Single Channel Output, No Monitored Output



Dual Channel E-Stop, Automatic Reset, Single Channel Output, Monitored Output



Single Channel Gate Interlock, Automatic Reset, Single Channel Output Expansion



Single Channel E-Stop, Manual Reset, Single Channel Output, Monitored Output

Single-Function Safety Relays

MSR126RT



Description

The Allen-Bradley Guardmaster Minotaur MSR126R/T is a safety monitoring relay that provides the very basics for safety control systems in a 22.5 mm package.

The MSR126R/T is designed for connection to a single channel safety gate, a single channel e-stop or a light curtain that provides cross fault detection. The MSR126.1R/T is designed for connection to a dual channel safety gate or e-stop, as it performs cross fault detection across the inputs.

The MSR126R and MSR126.1R are designed for applications where a monitored manual reset is required. Monitored manual reset requires the use of a momentary normally open switch to activate the outputs.

The MSR126T and MSR126.1T are designed for applications where automatic/manual reset is required.

The outputs are only two normally open safety-rated outputs. The safety outputs have independent and redundant internal contacts to support the safety function.

Features

- Category 4 per EN 954-1
- Stop category 0
- Two safety contacts N.O.
- Single/dual channel operation
- Cross fault monitoring
- Monitored or automatic reset
- E-stop, safety gate or light curtain applications

LED Indicators

Green	Power On
Green	K1 Closed
Green	K2 Closed

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI B11.19, AS 4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 1.45 x 10^{-9} MTTFd: > 398 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and BG	
Power Supply		
Input Power Entry	24V AC/DC, 115/230V AC	
Power Consumption	4 W	
Inputs		
Safety Inputs	1 N.C., 2 N.C., or LC	
Input Simultaneity	Infinite	
Input Resistance, Max.	90 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay/ Recovery Time	300 ms/100 ms	
Response Time	15 ms	
Outputs		
Safety Contacts	2 N.O.	
Thermal Current I_{th}	Max 6 A in one current path (nonswitching)	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 1…0.1 M 250V AC/2.5 A/625VA cosϕ = 1…0.5 M 250V AC/1.5 A/375VA cosϕ = 0.35…0.3 M 250V AC/5 A/1250VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category	UL: B300, 5 A/250V AC, 24V AC, 6 A/24V DC	
Resistive: AC-1	6 A/250V AC	
Resistive: DC-1	6 A/24V DC	
Inductive: AC-15	6 A/250V AC	6 A/125V AC
Inductive: DC-13	3 A/24V DC	6 A/24V DC @ 6 ops/min
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	24V DC: 160 (0.35); 115/230V AC: 215 (0.47)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

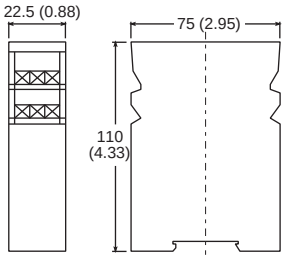
✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

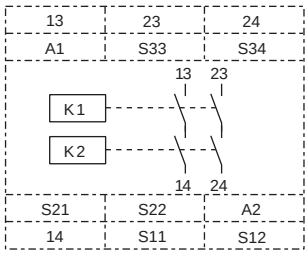
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
Light Curtain or Single Channel (MSR126T)	2 N.O.	None	Fixed	Auto./Manual	24V AC/DC	**440R-N23117**
					115V AC	440R-N23116
					230V AC	440R-N23115
Dual Channel 2 N.C. (MSR126.1T)					24V AC/DC	**440R-N23114**
					115V AC	440R-N23113
					230V AC	440R-N23112
Light Curtain or Single Channel (MSR126R)				Monitored Manual	24V AC/DC	440R-N23123
					115V AC	440R-N23122
					230V AC	440R-N23121
Dual Channel 2 N.C. (MSR126.1R)					24V AC/DC	440R-N23120
					115V AC	440R-N23119
					230V AC	440R-N23118

Approximate Dimensions

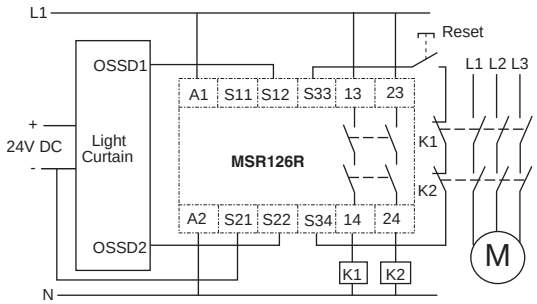
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



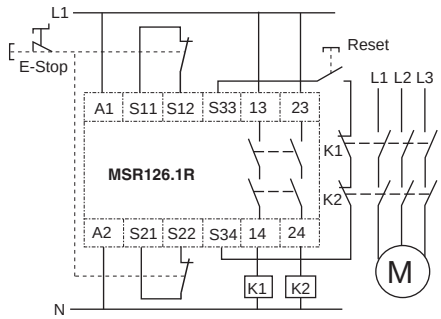
Block Diagram



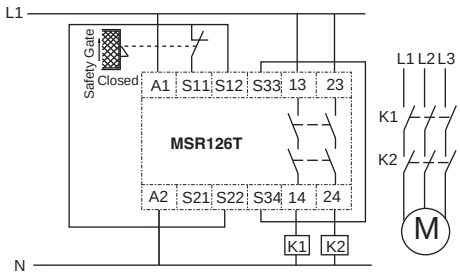
Typical Wiring Diagrams



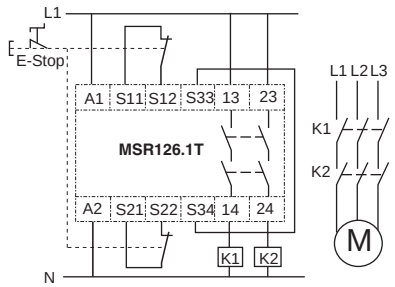
115/230V Supply, 24V DC Light Curtain, Monitored Manual Reset, Monitored Output



Dual Channel E-Stop Input, Monitored Manual Reset, Monitored Output



Single Channel Safety Gate, Automatic Reset, No Output Monitoring



Dual Channel E-Stop, Automatic Reset, No Output Monitoring

Single-Function Safety Relays

MSR127RTP



Description

The MSR127RTP can be connected in three different input wiring configurations: one normally closed, two normally closed, or with two PNP connections from a light curtain. When connected in the two normally closed fashion, the MSR127RTP checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross fault detection.

The MSR127RP has a monitored manual reset. The MSR127TP has an automatic/manual reset. Models with automatic/manual reset can have the reset jumpered or can be converted to an unmonitored manual reset by adding a normally open switch in the monitoring loop. Models with monitored manual reset provide checking of the output monitoring circuit.

The outputs include three normally open safety-rated outputs as well as one normally closed auxiliary output. The safety outputs have independent and redundant internal contacts to support the safety function. The auxiliary output is a nonsafety output intended to provide an external signal about the status of the safety outputs.

Features

- Category 4 per EN 954-1
- Stop category 0
- Three safety contacts
- One auxiliary contact
- Cross fault monitoring
- Monitored or automatic reset
- Removable terminals
- Light curtain, E-stop or safety gate applications

LED Indicators

Green	Power On
Green	CH1 Closed
Green	CH2 Closed

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 1.45 x 10^{-9} MTTFd: > 398 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus and BG	
Power Supply		
Input Power Entry	24V AC/DC, 115V AC or 230V AC 50/60 Hz	
Power Consumption	2 W	
Inputs		
Safety Inputs	1 N.C. or 2 N.C. or LC	
Input Simultaneity	Infinite (ch2 before ch1) with Auto Reset	
Input Resistance, Max.	110 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay/ Recovery Time	1 second/100 ms	
Response Time	15 ms	
Outputs		
Safety Contacts	3 N.O.	
Auxiliary Contacts	1 N.C.	
Thermal Current/$_{Ith}$	Units with 24V AC/DC supply: 3 x 4 A or 2 x 5 A nonswitching Units with 115/230V AC supplies: 3 x 3 A or 2 x 4 A or 1 x 5 A nonswitching	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA/10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 1…0.1 M 250V AC/2.5 A/625VA cosϕ = 1…0.5 M 250V AC/1.5 A/375VA cosϕ = 0.35…0.3 M 250V AC/5 A/1250VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category	UL: B300, R300 5 A/250V AC, 24V DC	
Resistive: AC-1	5 A/250V AC	
Resistive: DC-1	5 A/24V DC	
Inductive: AC-15	5 A/250V AC	
Inductive: DC-13	3 A/24V DC	5 A/24V DC @ 6 ops/min
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	24V DC: 210 (0.46), 115/230V AC: 260 (0.57)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

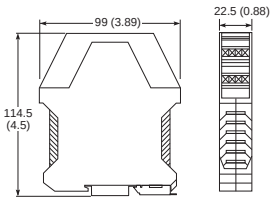
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., Light Curtain	3 N.O.	1 N.C.	Fixed	Auto./Manual	24V AC/DC	**440R-N23126**
				Monitored Manual		440R-N23129
				Auto./Manual	115V AC	440R-N23125
				Monitored Manual		440R-N23128
				Auto./Manual	230V AC	440R-N23124
				Monitored Manual		440R-N23127
			Removable (Screw)	Auto./Manual	24V AC/DC	**440R-N23132**
				Monitored Manual		**440R-N23135**
			Removable (Spring Clamp)	Auto./Manual	24V AC/DC	440R-N23132S
				Monitored Manual		440R-N23135S
			Removable (Screw)	Auto./Manual	115V AC	**440R-N23131**
				Monitored Manual		440R-N23134
				Auto./Manual	230V AC	440R-N23130
				Monitored Manual		440R-N23133

Accessories

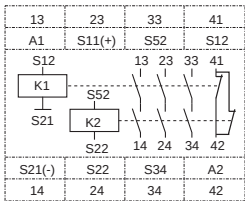
Description	Cat. No.
4 Replacement 4-pin Terminals (screw)	440R-A23209
4 Replacement 4-pin Terminals (spring clamp)	440R-A23228

Approximate Dimensions

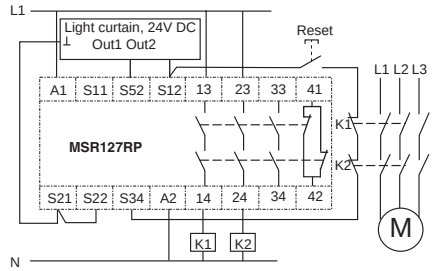
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



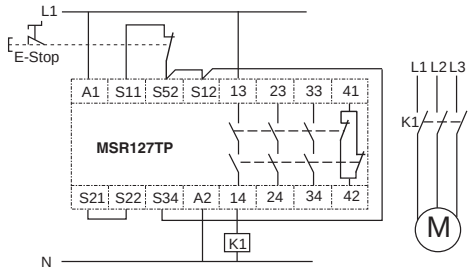
Block Diagram



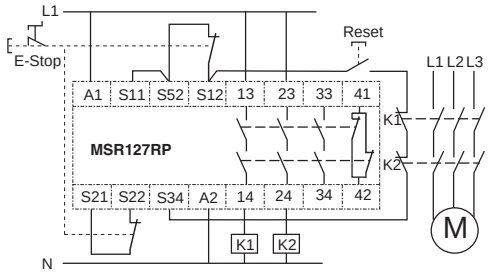
Typical Wiring Diagrams



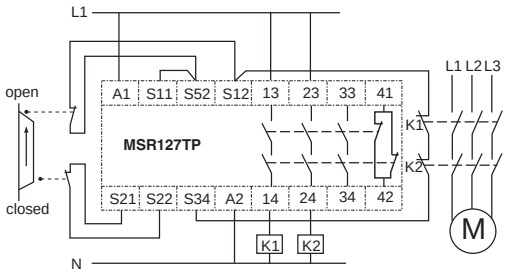
Light Curtain, Monitored Manual Reset, Monitored Output



Single Channel E-Stop, Automatic Reset, No Output Monitoring



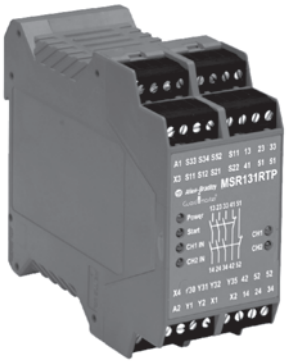
Dual Channel E-Stop, Monitored Manual Reset, Monitored Output



Dual Channel Safety Gates, Automatic Reset, Monitored Output

Single-Function Safety Relays

MSR131RTP



Description

The MSR131RTP is a versatile monitoring safety relay. It can be connected in four different input wiring configurations: one normally closed, 2 normally closed, 2 PNP connections from a light curtain, or a four-wire safety mat. When connected in the two normally closed fashion, the MSR131RTP checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross-fault detection.

The MSR131RTP has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR131RTP can have the reset terminals S33-S34 jumpered or can be converted to an unmonitored manual reset by adding a normally open switch in the monitoring loop (S33-S34). When configured to monitored manual reset, the MSR131RTP checks the output monitoring circuit through the manual application of the reset switch.

The outputs include three normally open safety rated outputs, two normally closed auxiliary outputs, and two solid-state outputs. One solid-state output indicates that the inputs are closed. The second solid-state output indicates that the safety outputs are active.

The safety outputs have independent and redundant internal contacts to help ensure the safety function. The auxiliary output is a nonsafety output intended to provide an external signal about the status of the safety outputs.

Features

- Category 4 per EN 954-1
- Stop category 0
- Light curtain, safety mat, E-stop inputs
- Three safety contacts
- Two auxiliary contact
- Two solid-state outputs
- Cross fault monitoring
- Monitored or automatic reset
- Removable terminals

LED Indicators

Green	Power
Green	Start
Green	CH1 Input Closed
Green	CH2 Input Closed
Green	CH1 Output Active
Green	CH2 Output Active

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 1.67 x 10^{-9} MTTFd: > 389 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, BG, and c-Tick	
Power Supply		
Input Power Entry	24V AC/DC, 115V AC or 230V AC	
Power Consumption	4 W	
Inputs		
Safety Inputs	1 N.C., 2 N.C., LC or SM	
Input Simultaneity	Infinite	
Input Resistance, Max.	45 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay/ Recovery Time	1 second/100 ms	
Response Time	15 ms	
Outputs		
Safety Contacts	3 N.O.	
Auxiliary Contacts	2 N.C.; 1 SS PNP inputs closed; 1 SS PNP outputs active; 30V DC/20 mA solid state	
Thermal Current/I_{th}	1 x 6 A or 3 x 5 A nonswitching	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 1…0.1 M 250V AC/2.5 A/625VA cosϕ = 1…0.5 M 250V AC/1.5 A/375VA cosϕ = 0.35…0.3 M 250V AC/5 A/1250VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category		
Resistive: AC-1	6 A/250V AC	
Resistive: DC-1	6 A/24V DC	
Inductive: AC-15	6 A/250V AC	6 A/125V AC
Inductive: DC-13	3 A/24V DC	6 A/24V DC @ 6 ops/min
UL	B300, R300, 1 x 6 A or 2 x 5 A resistive/250V AC, 24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms 100 shocks	
Mounting	45 mm housing, 35 mm DIN Rail	
Weight [g (lbs)]	24V DC: 320 (0.71) 115/230V AC: 450 (0.99)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

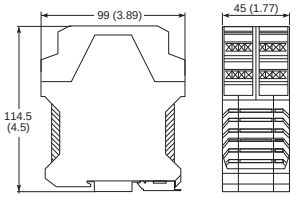
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., Light Curtain, Safety Mat	3 N.O.	2 N.C., 2 PNP Solid State	Removable (Screw)	Auto./Manual or Monitored Manual	24V AC/DC	**440R-C23139**
			Removable (Spring Clamp)			440R-C23139S
			Removable (Screw)		115V AC	440R-C23137
					230V AC	440R-C23136

Accessories

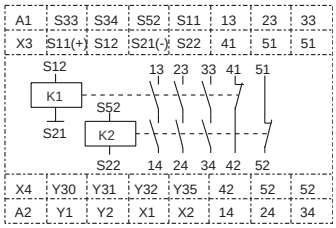
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

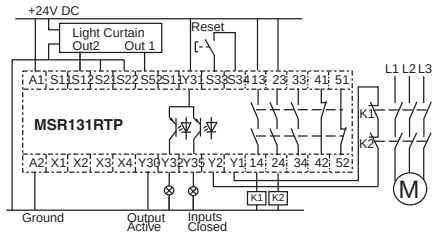
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



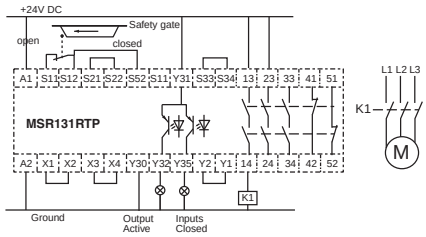
Block Diagram



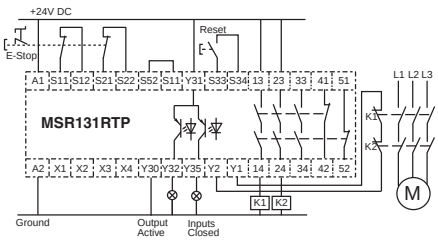
Typical Wiring Diagrams



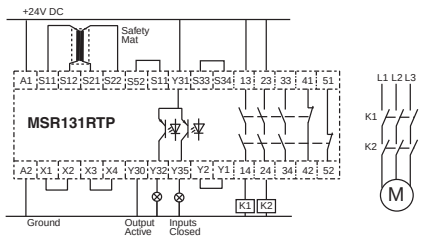
Light Curtain, Monitored Manual Reset, Monitored Output



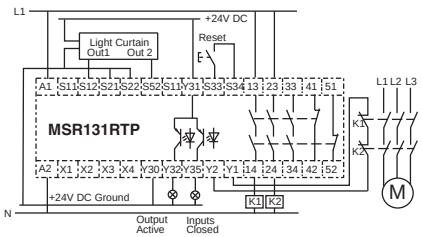
Single Channel Safety Gate, Automatic Reset, No Output Monitoring



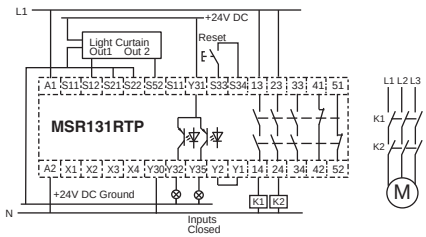
Dual Channel E-Stop, Monitored Manual Reset, Monitored Output



Safety Mat, Automatic Reset, No Output Monitoring



115/230V AC Supply, 24V DC, Light Curtain, Monitored Manual Reset, Monitored Output



115/230V AC Supply, 24V DC, Light Curtain, Monitored Manual Reset, No Output Monitoring

Single-Function Safety Relays

MSR142RTP



Description

The MSR142RTP is a versatile monitoring safety relay. It can be connected in four different input wiring configurations: one normally closed, two normally closed, two PNP connections from a light curtain, or a four-wire safety mat. When connected in the two normally closed fashion, the MSR142RTP checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross-fault detection.

The MSR142RTP has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR142RTP can have the reset terminals S33-S34 jumpered or can be converted to an unmonitored manual reset by adding a normally open switch in the monitoring loop (S33-S34). When configured to monitored manual reset, the MSR142RTP checks the output monitoring circuit through the manual application of the reset switch.

The outputs include seven normally open safety-rated outputs, four normally closed auxiliary outputs, and two solid-state outputs. One solid-state output indicates that the inputs are closed. The second solid-state output indicates that the safety outputs are active. The safety outputs have independent and redundant internal contacts to support the safety function. The auxiliary outputs are nonsafety outputs intended to provide an external signal about the status of the safety outputs.

Features

- Category 4 per EN 954-1
- Stop category 0
- Light curtain, safety mat, E-stop inputs
- Seven electromechanical N.O. state safety outputs
- Four electromechanical N.C. auxiliary outputs
- Two solid-state auxiliary outputs
- Cross-fault monitoring
- Monitored or automatic reset
- Removable terminals

LED Indicators

Green	Power
Green	Start
Green	CH1 IN
Green	CH2 IN
Green	CH1 output energized
Green	CH2 output energized

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, AS 4042.1, ISOTR 12100, B11.19
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 1.92 x 10^{-9} MTTFd: > 210 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, TÜV, and c-Tick
Power Supply	
Input Power Entry	24V AC/DC, 115V AC or 230V AC 50/60 Hz
Power Consumption	5 W
Inputs	
Safety Inputs	1 N.C., 2 N.C., Light Curtain or 4-Wire Safety Mat
Input Simultaneity	Infinite
Input Resistance, Max.	45 ohms
Reset	Auto./Manual or Monitored Manual
Power On Delay/ Recovery Time	1 s/100 ms
Response Time	15 ms
Outputs	
Safety Contacts	7 N.O.
Auxiliary Contacts	4 N.C., 2 PNP
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V DC
Fuses, Output	6 A slow blow or 10 A quick blow (external)
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A/375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	2,000,000 operations
Utilization Category	
Inductive: Safety & Aux.: AC-15	6 A/250V AC
Inductive: AC-13	3 A/24V DC
Resistive: DC-13	20 mA/30V DC short-circuit protected
UL	4 x B300 or 7 x 4 A Resistive
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN VDE 0470-1/ IP20
Operating Temperature [C (F)]	-5…+55 ° (14…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	24V: 470 (1.04); 115/230V AC: 607 (1.34)
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

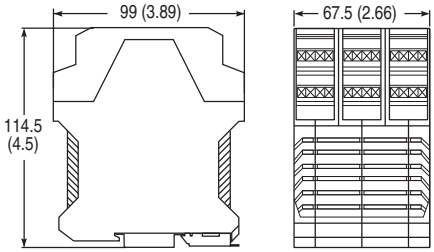
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., Light Curtain, Safety Mat	7 N.O.	4 N.C., 2 PNP, Solid-state	Removable	Monitored Manual or Auto/Manual	24V AC/DC	**440R-G23216**
					115V AC	440R-G23215
					230V AC	440R-G23214

Accessories

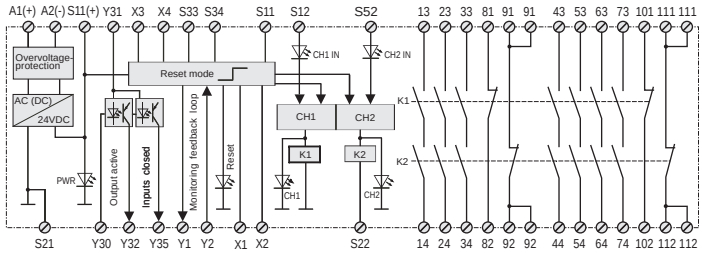
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

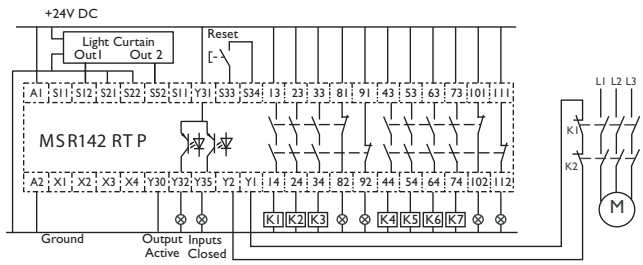
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



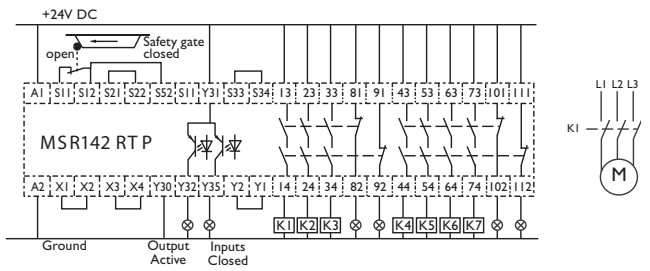
Block Diagram



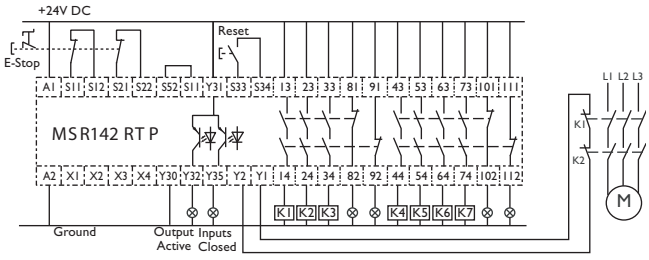
Typical Wiring Diagrams



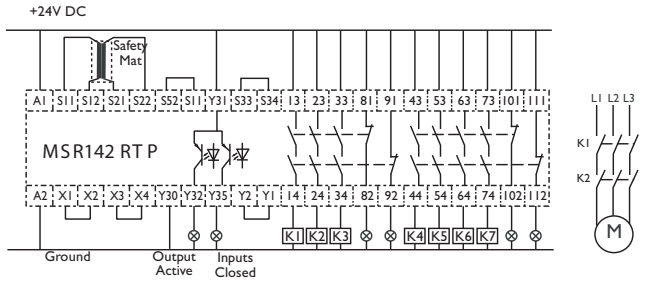
LIght Curtain, Monitored Manual Reset, Monitored Output



Single Channel Safety Gate, Auto Reset, No Output Monitoring



Dual Channel E-Stop, Monitored Manual Reset, Monitored Output



Safety Mat, Automatic Reset, No Output Monitoring

Single-Function Safety Relays

MSR144RTP



Description

The MSR144RTP is a versatile monitoring safety relay. It can be connected in four different input wiring configurations: one normally closed, two normally closed, two PNP connections from a light curtain, or a four-wire safety mat. When connected in the two normally closed fashion, the MSR144RTP checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross-fault detection.

Any combination of up to five MSR230 and MSR238 output modules can be easily connected to the MSR144RTP by removing the terminator, inserting a ribbon cable from the expander and then placing the terminator into the last expansion module.

The MSR144RTP has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR144RTP can have the reset terminals S33-S34 jumpered or can be converted to an unmonitored manual reset by adding a normally open switch in the monitoring loop (S33-S34). When configured to monitored manual reset, the MSR144RTP checks the output monitoring circuit through the manual application of the reset switch.

The outputs include two normally open safety rated outputs, two normally closed auxiliary outputs, and two solid-state auxiliary outputs. One solid-state output indicates the inputs are closed. The second solid-state output indicates the safety outputs are active.

The safety outputs have independent and redundant internal contacts to help ensure the safety function. The auxiliary outputs are nonsafety outputs intended to provide an external signal about the status of the safety outputs.

Features

- Category 4 per EN 954-1
- Stop category 0 or 1 (with MSR238)
- Light curtain, safety mat, E-stop inputs
- Two N.O. safety outputs
- Two N.C. auxiliary outputs
- Two solid-state auxiliary outputs
- Cross-fault monitoring
- Monitored manual or automatic/manual
- Removable terminals
- Expansion for up to five modules

LED Indicators

Green	Power
Green	Start
Green	CH1 IN
Green	CH2 IN
Green	CH1 output energized
Green	CH2 output energized

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, AS 4024.1, ISOTR 12100
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 1.67 x 10^{-9} MTTFd: > 389 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, TÜV, and c-Tick
Power Supply	
Input Power Entry	24V DC
Power Consumption	4 W + expanders
Inputs	
Safety Inputs	1 N.C., 2 N.C., LC or 4-wire safety mat
Input Simultaneity	Infinite
Input Resistance, Max.	45 ohms
Reset	Auto./Manual or Monitored Manual
Power On Delay/ Recovery Time	1 s/100 ms
Response Time	15 ms
Outputs	
Safety Contacts	2 N.O.
Auxiliary Contacts	2 N.C., 2 PNP
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V DC
Fuses, Output	6 A slow blow or 10 A quick blow (external)
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A/375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	2,000,000 operations
Utilization Category	
Inductive: Safety & Aux.: AC-15	5 A/250V AC
Inductive: Safety & Aux.: DC-13	3 A/24V DC
UL	B300, R300, 1 x 6 A or 2 x 5 A resistive/250V AC, 24V DC
Solid State:	20 mA/30V DC short circuit protection
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN VDE 0470-1/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	315 (0.71)
Conductor Size, Max.	0.2…4 mm² (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

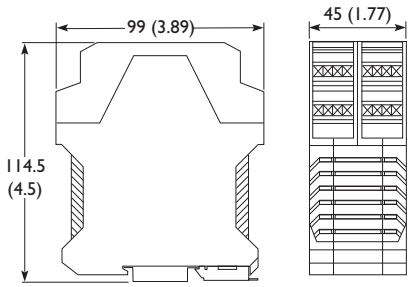
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., Light Curtain, Safety Mat	2 N.O.	2 N.C. 2 PNP solid-state	Removable	Monitored Manual or Auto/Manual	24V DC	440R-C23205

Accessories

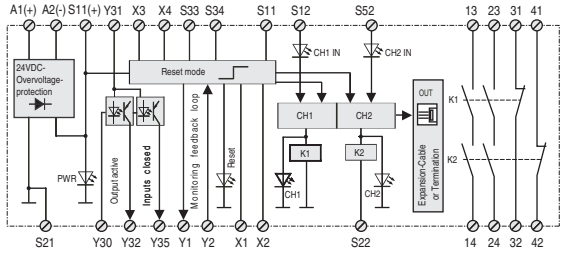
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

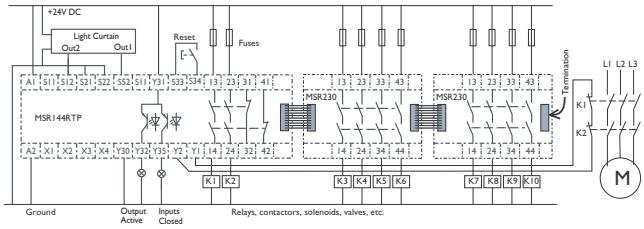
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



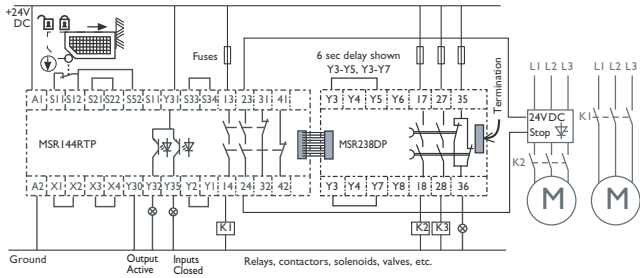
Block Diagram



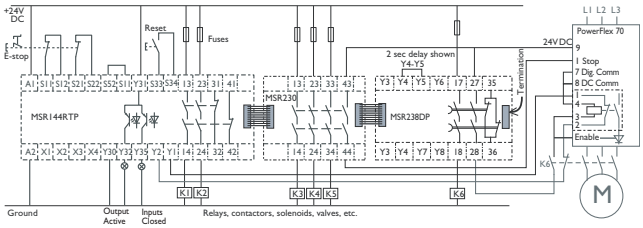
Typical Wiring Diagrams



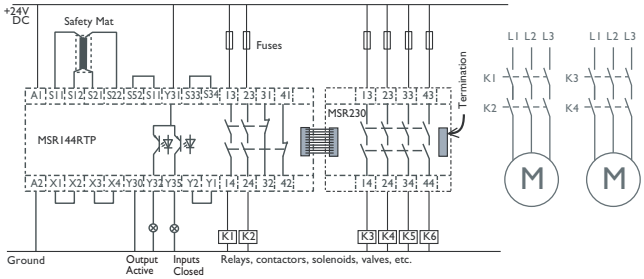
Light Curtain, Manual Reset with Manual Reset



115V/230V AC Supply, 24V DC, Dual Channel, Automatic Reset, Monitored Output



Dual Channel E-Stop, Monitored Manual Reset, Monitored Output



Safety Mat, Automatic Reset, No Output Monitoring

Single-Function Safety Relays with Delayed Outputs

CU4



Description

The CU4 is an off-delay timing unit which can be operated standalone or as an extension of a host relay. The timed outputs are used in applications where power must be maintained for a fixed duration after an input signal is received. For example, driving a power to lock TLS2-GD2 to maintain a guard door in the locked position for a fixed duration after a stop button is pressed. Another example would be maintaining the connection of a drive to a motor until the braking function is achieved, and then dropping out a contactor to remove power to the motor.

The inputs can be connected in either a single channel or dual channel configuration. The inputs must remain open during the complete timing cycle. Closing the contacts before the timing cycle completes causes the timer to be reset to zero.

The CU4 has a redundant structure with two independent safe timer circuits. The outputs include two normally open safety delayed outputs as well as one normally closed auxiliary output. The safety outputs have independent and redundant internal contacts to support the safety function. When used as an extension of a host relay, the normally closed contacts should be used in the feedback loop of the host relay. If used in standalone application, the normally closed contacts can be used to signal an auxiliary device or PLC.

A typical operation starts with power applied to A1/A2 and the input circuits open.

1. Close the B11/B12 and B21/B22 circuits.
   a. The safety outputs (17/18 & 27/28) close immediately.
2. Open the B11/B12 or B21/B22 circuits.
   a. The timing process starts.
   b. The safety outputs (17/18 & 27/28) open after the time expires.
3. Go to Step 1.

Features

- Category 3 per EN 954-1
- Stop category 1
- Timed off-delay 0.15…30 s
- Two safety contacts
- One auxiliary contact

LED Indicators

Green	Power
Green	CH1 t1 Active
Green	CH2 t2 Active

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 3 per EN 954-1 (ISO 13849-1), SIL CL2 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.16 x 10^{-9} MTTFd: > 345 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and BG	
Power Supply		
Input Power Entry	24V AC/DC, 50/60 Hz; 0.85…1.1 x rated voltage	
Power Consumption	2.5 W	
Inputs		
Safety Inputs	1 N.C. or 2 N.C.	
Input Simultaneity	Infinite	
Reset	Automatic	
Response Time	30 ms	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C.	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA/10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A/375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category		
AC-15	5 A @ 250V AC	5 A @ 125V AC
DC-13	3 A/24V DC	
UL:	B300, 5 A/250V AC, 24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40, DIN 0470/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	165 (0.36)	
Conductor Size, Max.	0.2…4 mm² (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Single-Function Safety Relays with Delayed Outputs

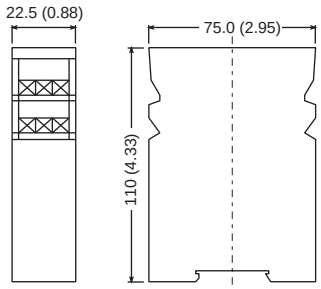
CU4

Product Selection

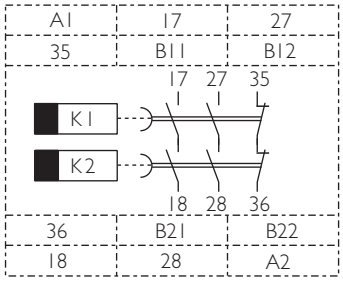
Inputs	Safety Outputs	Auxiliary Outputs	Time Range	Reset Type	Power Supply	Cat. No.
1 N.C. or 2 N.C.	2 N.O.	1 N.C.	0.15…3s	Automatic	24V AC/DC, 50/60 Hz 0.85…1.1 x rated voltage	440R-S23173
			0.5…10s			440R-S23174
			1.5…30s			440R-S23175

Approximate Dimensions

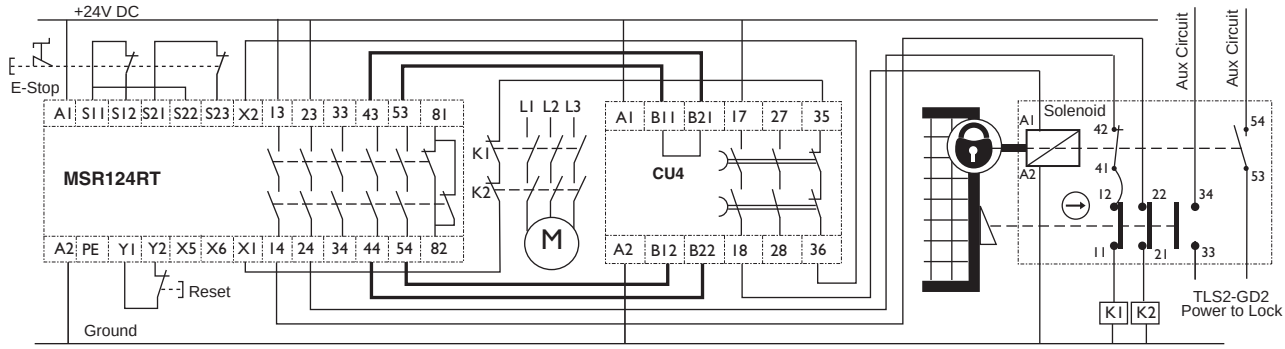
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



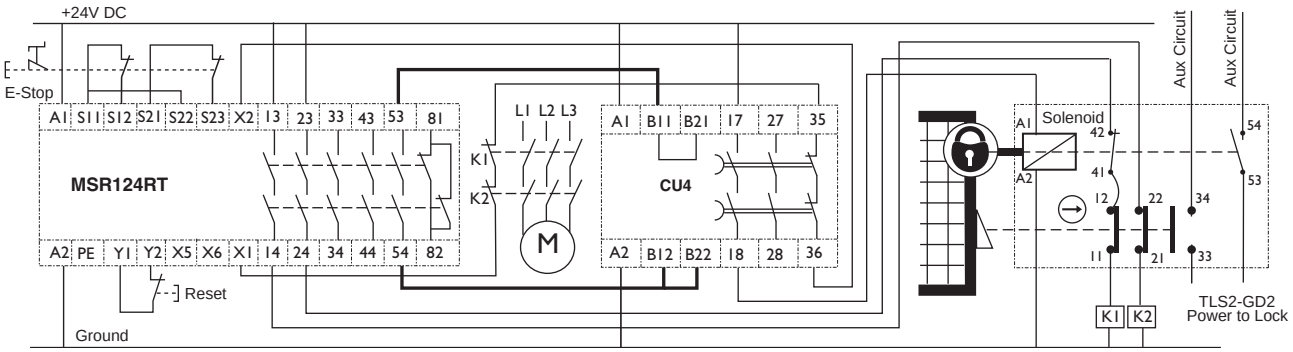
Block Diagram



Typical Wiring Diagrams



Dual Channel Wiring to CU4 Inputs



Single Channel Wiring to CU4 Inputs

Single-Function Safety Relays with Delayed Outputs

MSR38D/DP



Housing with removable terminals shown.

Description

The Minotaur MSR38D/DP is a microprocessor-based, monitoring safety relay, with delayed, safety-rated, solid-state outputs.

The inputs of the MSR38D/DP are the same as the MSR30. They can be connected to gate interlocks, e-stop devices or four-wire safety mats. The gate interlocks and e-stops can be either single channel or dual channel normally-closed circuits.

The reset capability of the MSR38D/DP allows it to set up for monitored manual or automatic/manual reset.

The outputs include two delayed normally-open safety rated outputs that can be connected to loads up to 2 A at 24V DC. These outputs can be used to send a safety stop signal to a machine or manufacturing system. The delay is accomplished by the configuration of jumpers on the terminals. The delay can be easily adjusted by reconfiguring the jumpers.

The MSR38D/DP also has one solid-state normally-closed auxiliary output, which must only be used to indicate the status of the MSR38D/DP. The auxiliary output responds immediately to the change in input status; it is not delayed.

Features

- Category 4 per EN 954-1
- Stop Category 0 or 1
- Two delayed solid-state safety outputs
- One solid-state auxiliary output
- One N.C., two N.C. or safety mat input
- Monitored manual or automatic/manual reset

LED Indicators

Green	Power (Pwr)
Green	K1 Closed
Green	K2 Closed

Wiring Terminations

S11 & S21	Pulse train output
S12 & S22	Input contacts
A1 – S34	Reset switch
S11 – S34	Automatic reset, start-up test disabled
S21 – S34	Automatic reset, start-up test enabled
A1 – Y2	Monitoring circuit
A1 – Y41	Cross-fault monitoring disabled

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, ANSI B11.19, AS4024.1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 9.2 x 10^{-10} MTTFd: > 631 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC SELV
Power Consumption	3 W
Inputs	
Safety Inputs	1 N.C. or 2 N.C. or SM
Input Resistance, Max.	200 Ω
Reset	Auto./Manual or Monitored Manual
Power On Delay/ Recovery Time	3 seconds/20 ms
Response Time	15 ms
Outputs	
Safety Contacts	2 N.O. SS, 2 A @ 24V DC
Auxiliary Contacts	1 N.O. SS, 50 mA @ 24V DC
Fuses, Output	External 6 A slow blow or 10 A fast acting
Power LED Diagnostics	3 s Blink: Initialization Constant: Normal Operation 2 Blinks: Configuration change during operation 4 Blinks: Solid state output switch fault 5 Blinks: Reset switch closed after reset Continuous blinking: Internal fault
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	130 (0.287)
Conductor Size, Max.	0.2…2.5 mm^2 (24…14 AWG)

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

Single-Function Safety Relays with Delayed Outputs

MSR38D/DP

Product Selection

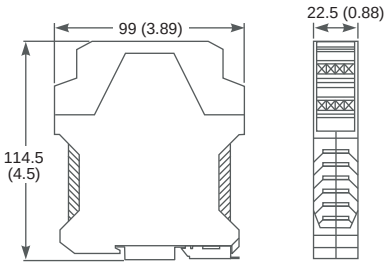
Inputs	Delayed Safety Outputs	Instantaneous Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., Safety Mat	2 N.O. Solid State	1 N.O. Solid State	Fixed	Auto./Manual or Monitored Manual	24V DC SELV	440R-M23203
			Removable			440R-M23204

Accessories

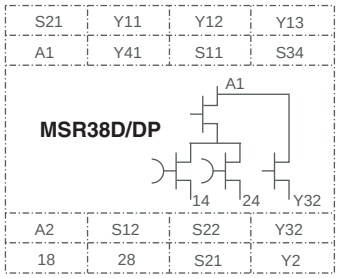
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

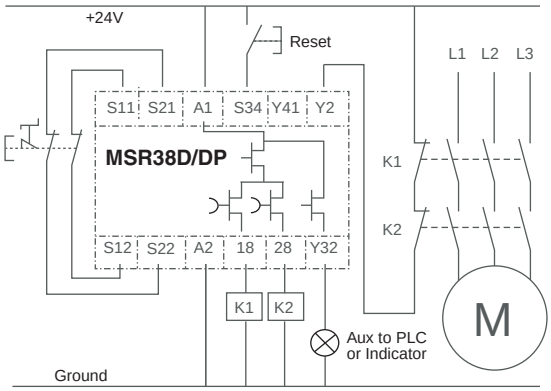


Block Diagram

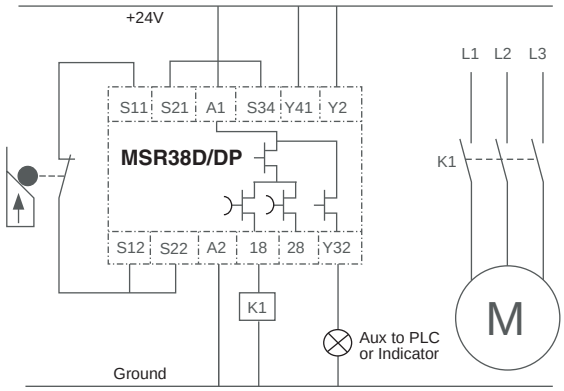


Typical Wiring Diagrams

See MSR30 on 5-16 for additional input wiring configurations.



Dual Channel E-Stop, Dual Channel Delayed Outputs, Monitored Manual Reset, Output Monitoring



Single Channel Gate Interlock, Single Channel Delayed Output, Automatic Reset, No Output Monitoring

Apply jumpers (links) on the terminals identified to achieve the desired off delay.

Delay(s)	Y11	Y12	Y13	Delay(s)	Y11	Y12	Y13	Delay(s)	Y11	Y12	Y13
0	—	—	—	8	S21	S11	—	50	—	S21	S21
0.5	S11	—	—	10	—	S11	S21	60	S11	S11	S11
1	—	S11	—	12	S21	—	S11	80	S11	S11	S21
1.5	—	—	S11	15	—	S21	S11	100	S11	S21	S11
2	S21	—	—	18	S11	S11	—	120	S11	S21	S21
3	—	S21	—	21	S11	—	S11	160	S21	S11	S11
4	—	—	S21	26	—	S11	S11	200	S21	S11	S21
5	S11	S21	—	30	S21	S21	—	250	S21	S21	S11
6	S11	—	S21	40	S21	—	S21	300	S21	S21	S21

Single-Function Safety Relays with Delayed Outputs

MSR138DP



Description

The MSR138DP can be connected in 3 different input wiring configurations: 1 normally closed, 2 normally closed, or 2 OSSD. When connected in the two normally closed fashion, the MSR138DP checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross-fault detection.

The MSR138DP has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR138DP can have the reset terminals S33-S34 jumpered or can be converted to an unmonitored manual reset by adding a normally open switch in the monitoring loop (S33-S34). When configured to monitored manual reset, the MSR138DP checks the output monitoring circuit through the manual application of the reset switch. The unit cannot be reset until the timing function has completed.

The outputs of the MSR138DP include two normally open immediate safety outputs and three normally open delayed safety outputs. The outputs of the MSR138.1DP include two normally open immediate safety rated outputs, two normally open delayed safety outputs and one normally closed delayed safety output. The safety outputs have independent and redundant internal contacts to support the safety function. If a reset request is made during the time cycle, it will cause a lockout condition. Cycle inputs after timing has completed and reset after the delay time has expired to clear lockout. Connecting contacts 55-56 of the MSR138.1DP in series to Y1-Y2 can avoid this lockout.

A normally closed timer reset switch can be added to force the delayed contacts open prior to the completion of the timing cycle.

Features

- Category 4/3 per EN 954-1
- Stop category 0 and 1
- Light curtain, E-stop, safety gate inputs
- Two immediate safety outputs
- Delayed outputs: 3 N.O. safety or 2 N.C. safety and 1 N.C. aux.
- Cross fault monitoring
- Monitored or automatic reset
- Removable terminals

LED Indicators

Green	Power—Illuminates when power on
Green	Start—Illuminates when S33-S34 is closed
Green	CH1 IN—Illuminates when channel 1 input is closed
Green	CH2 IN—Illuminates when channel 2 input is closed
Green	CH1—Illuminates when K1 is closed
Green	CH2—Illuminates when K2 is closed
Green	CHT1—Illuminates during timing period
Green	CHT2—Illuminates during timing period

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.38 x 10^{-9} MTTFd: > 195 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV	
Power Supply		
Input Power Entry	24V AC/DC, 115V AC or 230V AC	
Power Consumption	4 W	
Inputs		
Safety Inputs	1 N.C., 2 N.C. or LC	
Input Simultaneity	Infinite	
Input Resistance, Max.	135 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay/ Recovery Time	1 second/100 ms	
Response Time	15 ms	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	Delayed 3/2 N.O.	
Thermal Current/$_{Ith}$	5 x 2.5 A or 3 x 3.5 A nonswitching	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 1…0.1 M 250V AC/2.5 A/625VA cosϕ = 1…0.5 M 250V AC/1.5 A/375VA cosϕ = 0.35…0.3 M 250V AC/5 A/1250VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 cycles	
Utilization Category		
Resistive: AC-1	7 A@ 250V AC	
Resistive: DC-1	7 A/24V DC	
Inductive: AC-15	6 A@ 250V AC	6 A @ 125V AC
Inductive: DC-13	3 A/24V DC	6 A/24V DC @ 6 ops/min
UL	B300, 5 A/250V AC, 24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	24V DC: 350 (0.77); 115/230V AC: 490 (1.08)	
Conductor Size, Max.	0.2…4 mm² (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Single-Function Safety Relays with Delayed Outputs

MSR138DP

Product Selection

Inputs	Safety Outputs	Delayed Safety Outputs	Delayed Auxiliary Outputs	Time Delay	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., Light Curtain	2 N.O.✶	3 N.O.❄ (MSR138DP)	—	1.0 seconds, fixed	Removable	Auto./Manual or Monitored Manual	115V AC	440R-M23080
				0.15…3 s			24V AC/DC	**440R-M23143**
					Spring Clamp			440R-M23143S
				0.15…3 seconds	Removable		115V AC	440R-M23141
							230V AC	440R-M23140
				0.5…10 s			24V AC/DC	**440R-M23147**
					Spring Clamp			440R-M23147S
				0.5…10 seconds	Removable		115V AC	440R-M23145
							230V AC	440R-M23144
				1.5…30 seconds			24V AC/DC	440R-M23151
							115V AC	440R-M23149
							230V AC	440R-M23148
		2 N.O.❄ (MSR138.1DP)	1 N.C.	0.15…3 seconds			24V AC/DC	**440R-M23084**
							115V AC	440R-M23082
							230V AC	440R-M23081
				0.5…10 seconds			24V AC/DC	**440R-M23088**
							115V AC	440R-M23086
							230V AC	440R-M23085
				1.5…30 seconds			24V AC/DC	440R-M23092
							115V AC	440R-M23090
							230V AC	440R-M23089

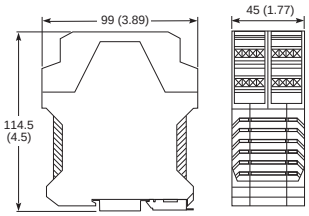
✶ Instantaneous safety outputs Cat. 4
❄ Delayed safety outputs are Cat. 3

Accessories

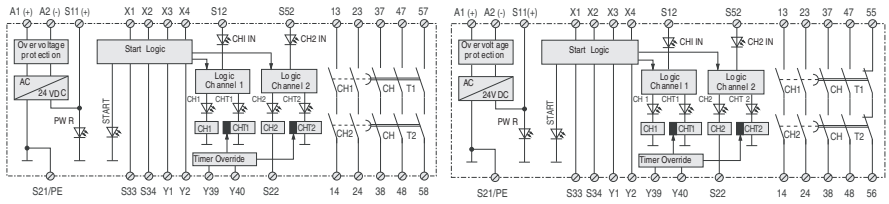
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



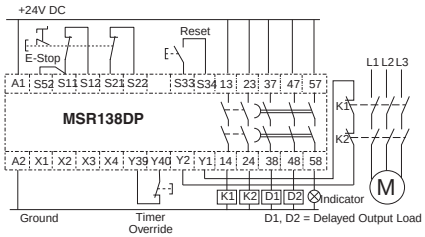
Block Diagram



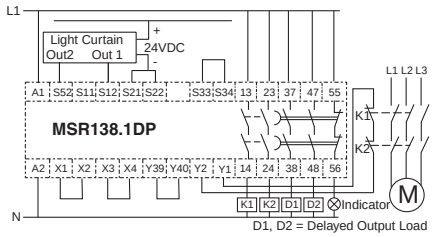
MSR138DP **MSR138.1DP**

In applications with 24V AC supply: terminal S21 must not be connected to PE.

Typical Wiring Diagrams



24V DC Supply Dual Channel E-Stop, Monitored Manual Reset, Monitored Output



115/230V AC Supply, 24V DC Light Curtain, Automatic Reset, Monitored Output

Single-Function Safety Relays with Delayed Outputs

MSR178DP



Description

The MSR178DP is a multi-function time-delay relay for use in safety circuits. It can be configured by the user to perform on-delay, off-delay or single-pulse modes. It is used for applications such as delayed unlocking of safety gates, delayed de-energizing of variable speed controlled motors, or jogging (single pulse) in teaching or setup mode.

The MSR178DP can be used e.g. in conjunction with a power to release or power to lock guard locking switch to time out high inertia machines with significant run down in potentially dangerous equipment. The single-pulse mode enables implementation of two-hand control by use of two normally open contacts. It also can be used as a preset time limited mute dependent bypass in order to clear a blockage in the muting sensor area.

The operating function is selected by external jumpers to Y21 and Y22. The delay time is selected by a combination of external jumpers to Y31 and Y32 and the potentiometer located on the front face.

The input to the MSR178DP can be connected in five different configurations: one normally closed, two normally closed, one normally open, two normally open, or two PNP connections from a light curtain. The normally closed connections are used for off-delay timing. The normally open inputs are used for on-delay timing and the single-pulse function. To generate the single pulse both inputs must be closed within 0.5 seconds. Thus a two-hand control arrangement in accordance with EN 574 Cat. IIIA can be used to trigger the single pulse.

The MSR178DP has three normally open redundant safety outputs. The two normally closed outputs can be connected in series to achieve redundant safety or connected in parallel for auxiliary signaling. External devices can be monitored by the Y11 terminal. Power to the MSR178DP can be either 24V AC/DC (24V/GND terminals) or 115V AC (A3/A2 terminals), or 230V AC (A1/A2 terminals).

The MSR178DP can be used as a standalone control module or in combination with an MSR safety relay to combine instant and delayed safety outputs, as needed.

Features

- Category 4 per EN 954-1
- SIL3 per IEC 61508
- Stop category 1
- On-/off-delayed, or single-pulse (one shot) operation
- Four time ranges up to 30 mins.
- Pulsed or static input monitoring
- Three N.O. safety outputs
- One N.C. safety or two N.C. auxiliary outputs
- Eight diagnostic LEDs
- Automatic reset
- Removable terminals

Specifications

Safety Ratings	
Standards	EN 954-1, IEC 61508, EN IEC 62061, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, EN 61812-1, AS 4024.1, ISOTR 12100, B11.19
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.74 x 10^{-9} MTTFd: > 285 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V AC/DC, 115/230V AC 50/60 Hz
Power Consumption	4 W
Inputs	
Safety Inputs	1 or 2 N.O., 1 or 2 N.C., Light Curtain
Input Simultaneity	Infinite for On-/Off-delay, 0.5 s for single pulse function
Input Resistance, Max.	900 Ω
Reset	Automatic
Power On Delay/ Recovery Time	500 ms/300 ms single pulse only
Response Time	<±0.5% (at constant temp)
Outputs	
Safety Contacts	3 N.O.
Auxiliary Contacts	2 N.C.
Thermal Current/I_{th}	6 A
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V DC
Fuses, Output	External 6 A slow blow or 10 A quick blow
Electrical Life (Operations)	230V AC/4 A/880VA cosϕ = 0.35…0.1 M 230V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	2,000,000 operations
Utilization Category	
Inductive: AC-15	6 A/250V AC
Inductive: DC-13	3 A/24V DC
UL:	B300, 6 A/250V AC, 3 A/24V DC
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN VDE 0470-1/ IP20
Operating Temperature [C (F)]	-5…+55 ° (14…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	325 (0.72)
Conductor Size, Max.	0.2…4 mm^2 (24… 12 AWG)

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Single-Function Safety Relays with Delayed Outputs

MSR178DP

Product Selection

Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 or 2 N.O., 1 or 2 N.C., Light Curtain, Two-Hand Control, Enabling Switch	3 N.O.	2 N.C.	Removable	Automatic	24V AC/DC, 115V AC or 230V AC	440R-M23227

Accessories

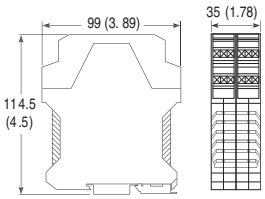
Description	Cat. No.
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

LED Indicators

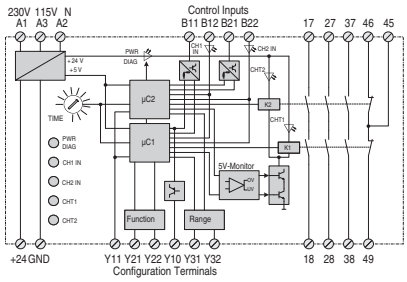
PWR: Green	Power on
Flashing Green/Red	Faillure
CH1/2 IN: Static Green	Input closed
Flashing Green	Time lapse
CHT1: Green	Output CH1 Active
CHT2: Green	Output CH2 Active

Approximate Dimensions

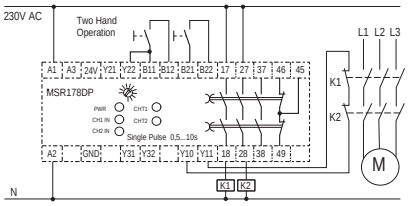
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

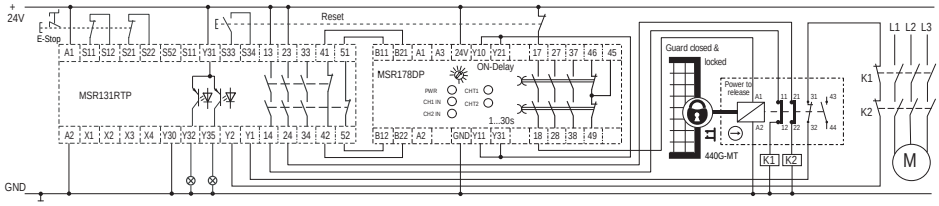


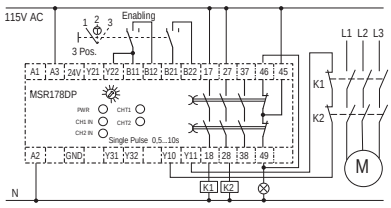
Block Diagram

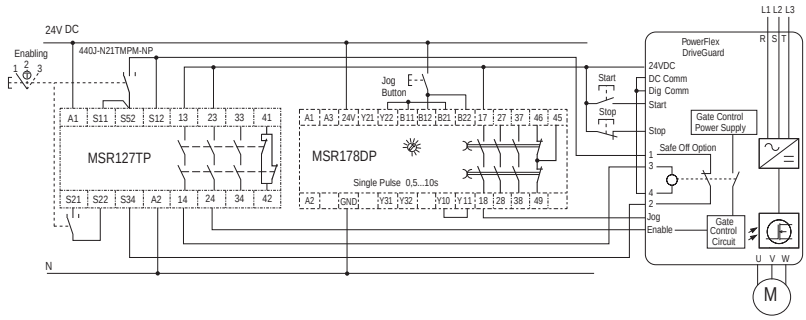


Typical Wiring Diagrams





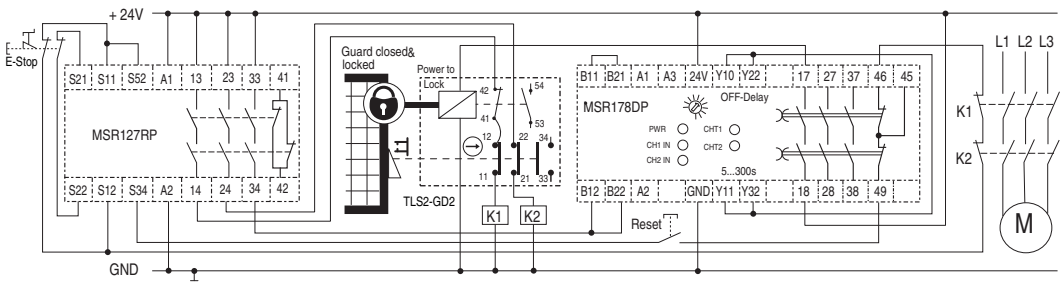




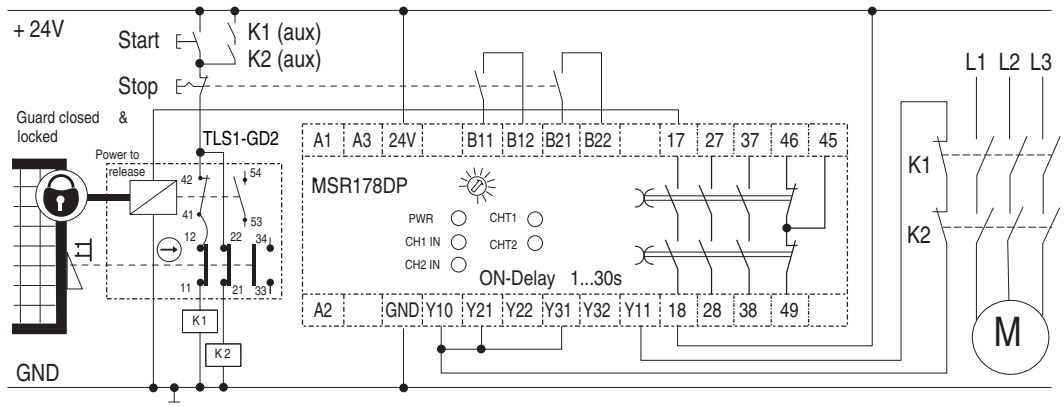
Single-Function Safety Relays with Delayed Outputs

MSR178DP

Typical Wiring Diagrams (continued)



MSR178DP generates OFF-delayed solenoid release after E-Stop on MSR127

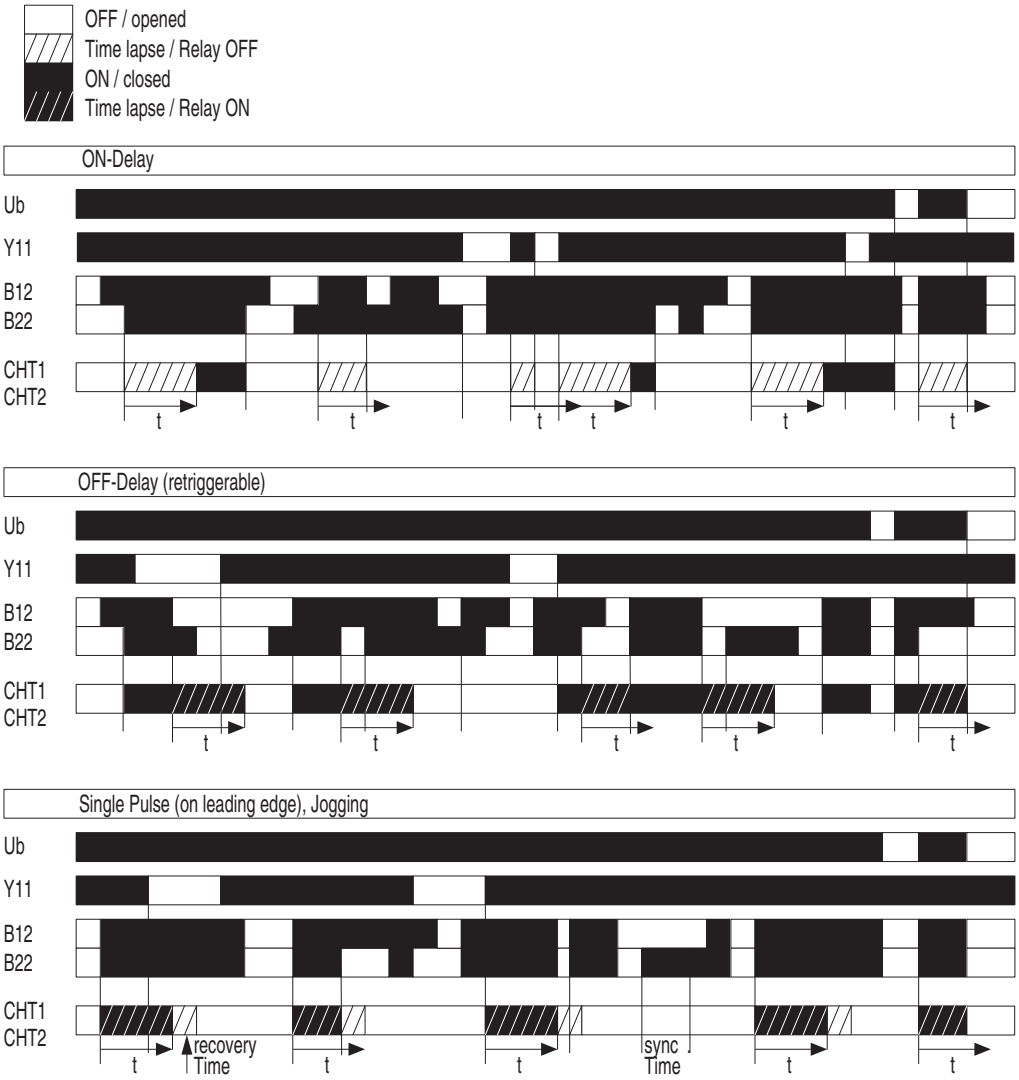


MSR178DP ON-delayed unlocking the Gate after maintained stop switch pressed

Jumper Configuration

Operating Function	
Y10…Y21	ON Delay
Y10…Y22	OFF Delay
B11…Y22	Single Pulse
Time Range	
—	0.5…10 s
Y10…Y31	1…30 s
Y10…Y32	5…300 s
Y10…Y31…Y32	1…30 min
Cross Fault Detection on Inputs	
—	Enabled
B11…B21	Disabled
Feedback Loop	
Y10…Y11	Close before reset

Time Function Diagrams



Specialty Safety Relays

MSR35H/HP Two-Hand Control



Housing with removable terminals shown.

Description

The Minotaur MSR35H/HP is a microprocessor-based, two-hand control monitoring safety relay, with safety-rated, solid-state outputs.

The input of the MSR35H/HP accepts two switches, each containing one normally open and one normally closed. Both switches must be actuated within 0.5 seconds of each other.

The MSR35 can alternatively be wired with two switches with normally open contacts to a Category IIIA application per EN 574.

The reset capability of the MSR35H/HP allows it to be set up for manual or automatic reset.

The outputs include two normally-open safety-rated outputs that can be connected to loads up to 2 A at 24V DC. These outputs can be used to send a safety stop signal to a machine or manufacturing system.

The MSR35H/HP also has one solid-state normally-closed auxiliary output, which must only be used to indicate the status of the MSR35H/HP.

Features

- Category 4 per EN 954-1
- Category IIIC or IIIA per EN 574
- Two solid-state safety outputs
- One solid-state auxiliary output
- Two-hand control input

LED Indicators

Green	Power (Pwr)
Green	K1 Energized
Green	K2 Energized

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, EN 574, IEC/EN 60204-1, ANSI B11.19, AS4024.1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 9.2 x 10^{-10} MTTFd: > 631 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC SELV
Power Consumption	3 W
Inputs	
Safety Inputs	1 N.C. & 1 N.O. or 2 N.O.
Input Simultaneity	0.5 s
Input Resistance, Max.	200 Ω
Reset	Automatic
Power On Delay/ Recovery Time	3 seconds/20 ms
Response Time	15 ms
Outputs	
Safety Contacts	2 N.O., 2 A @ 24V DC
Auxiliary Contacts	1 N.O., 50 mA @ 24V DC
Fuses, Output	External 6 A slow blow or 10 A fast acting
Power LED Diagnostics	3 s Blink: Initialization Constant: Normal Operation 2 Blinks: Configuration change during operation 4 Blinks: Solid state output switch fault Continuous blinking: Internal fault
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	130 (0.287)
Conductor Size, Max.	0.2…2.5 mm^2 (24…14 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

Product Selection

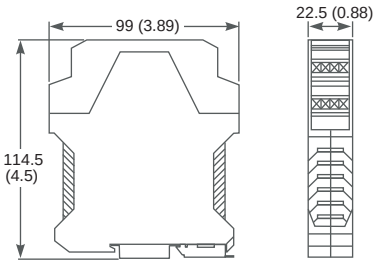
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
2 x 1 N.C. + 1 N.O. (Two-Hand Control) or 2 x N.O.	2 N.O. Solid State Safety; 1 N.O. Solid State Auxiliary	1 N.O. Solid State	Fixed	Automatic	24V DC SELV	440R-D23201
			Removable			440R-D23202

Accessories

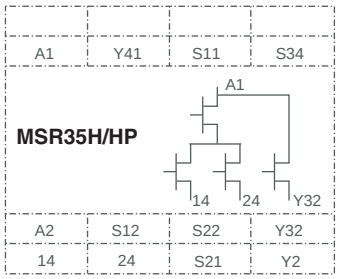
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

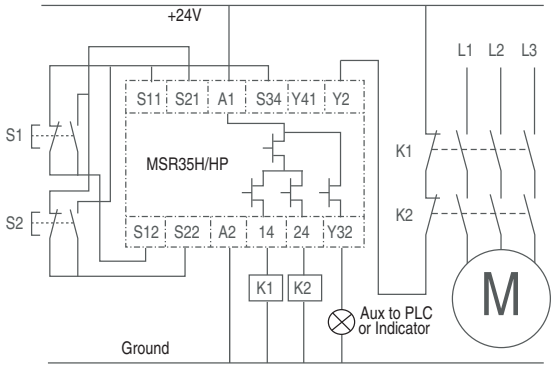
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



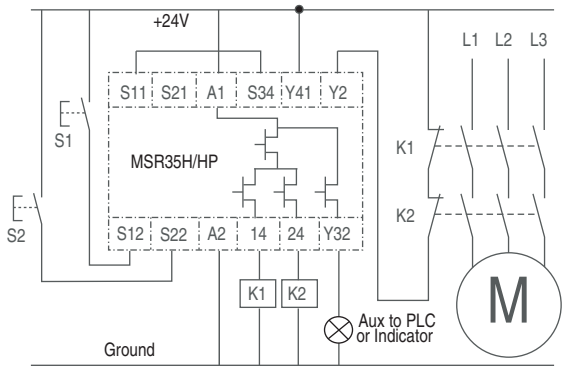
Typical Wiring Diagrams



Switch connection to pulsed signals from S11 and S21, connection between S11 and S34.

Two-Hand Control, Dual Channel Outputs, Output Monitoring

Note: EN 574 IIIC when wired with two sets of N.O./N.C., EN 574 IIIA when wired with two sets of N.O. contacts.



Switch connection direct to 24V DC supply, Y41 to +24V DC, connection between S11 and S34.

Two-Hand Control, Dual Channel Outputs, Output Monitoring

Note: Connect Y41 to +24V to disable pulse testing.

Specialty Safety Relays

MSR125H/HP Two-Hand Control



Description

The Allen-Bradley Guardmaster Minotaur MSR125H/HP is a logic unit for monitoring and interfacing two-hand control devices with a safety-related circuit. The MSR125H/HP is for use with mechanical switches and the Rockwell Automation Bulletin 800Z Zero-Force Touch Buttons.

The MSR125H/HP has two normally open safety outputs. The safety outputs have independent and redundant internal contacts to support the safety function.

The MSR125H/HP requires the two switches to be operated within 0.5 seconds of each other and will only authorize the ON state while both switches are held down. If one of the switches is released, the output goes to the OFF state and the machine cannot be restarted until both buttons are released and then operated simultaneously.

The MSR125H/HP conforms to EN 574 Category IIIC, which gives specific requirements for two-hand control units and logic devices.

The MSR125H has fixed terminals and the MSR125HP has removable terminals.

Features

- Category 4 per EN 954-1
- Safety category IIIC per EN 574
- Two-hand control unit
- Two N.O. safety outputs
- Fixed or removable terminals
- 22.5 mm wide housing

LED Indicators

Green	Power on
Green	CH1 Output Active
Green	CH2 Output Active

Specifications

Safety Ratings		
Standards	EN 574, EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI B11.19, AS 4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 1.44 x 10^{-9} MTTFd: > 385 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and BG	
Power Supply		
Input Power Entry	24V DC, 24V AC, 115V AC, 230V AC	
Power Consumption	2 W	
Inputs		
Safety Inputs	1 N.C. + 1 N.O.	
Input Simultaneity	<0.5 sec	
Input Resistance, Max.	40 Ω	
Reset	Automatic	
Power On Delay/ Recovery Time	1 second/500 ms	
Response Time	20 ms	
Outputs		
Safety Contacts	2 N.O.	
Thermal Current/$_{Ith}$	1 x 6 A or 2 x 4 A nonswitching	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA/10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 0.35…0.1 M 250V AC/2.5 A/625VA cosϕ = 0.6…0.5 M 250V AC/1.5 A/375VA cosϕ = 0.35…0.3 M 250V AC/5 A/1250VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category		
Resistive: AC-1	8 A @ 250V AC	
Resistive: DC-1	6 A/24V DC	
Inductive: AC-15	6 A @ 250V AC	6 A @ 125V AC
Inductive: DC-13	3 A/24V DC	6 A/24V DC @ 6 ops/min
Resistive UL:	B300, R300, 8 A/250V AC, 6 A/24V DC, 30V DC Resistive	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	24V DC: 210 (0.46); 115/230V AC: 260 (0.57)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

Product Selection

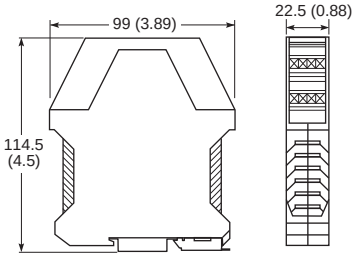
Inputs	Button Type	Safety Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C. + 1 N.O. (Two-Hand Control)	Mechanical or Bulletin 800Z	2 N.O.	Removable (MSR125HP)	Automatic	24V DC	**440R-D23171**
					24V AC	440R-D23170
					115V AC	440R-D23169
					230V AC	440R-D23168
			Fixed (MSR125H)		24V DC	440R-D23166
					115V AC	440R-D23164
					230V AC	440R-D23163

Accessories

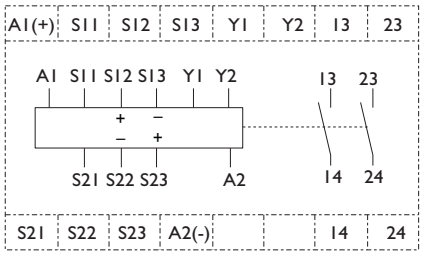
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

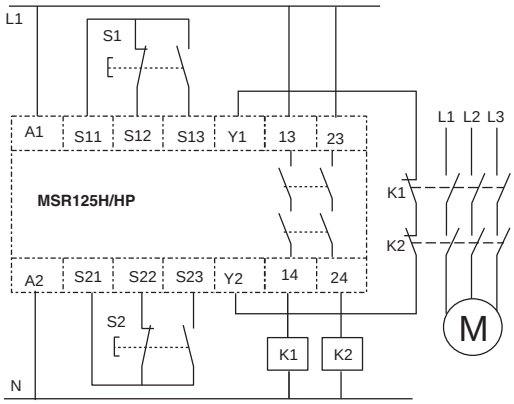
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



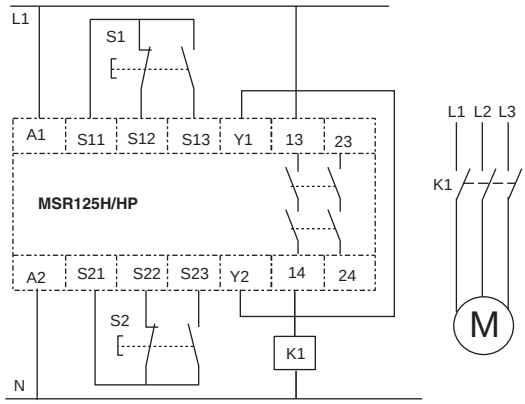
Block Diagram



Typical Wiring Diagrams



Two-Hand Control, Dual Channel, Auto Reset, Output Monitoring



Two-Hand Control, Dual Channel, Auto Reset, No Output Monitoring

Specialty Safety Relays

MSR22LM Muting Light Curtain



Description

The MSR22LM safety monitoring relay is designed to monitor light curtains with the added features of muting and presence sensing device initiation (PSDI). It provides an output to a machine control system when the light curtain is clear. When the inputs to the MSR22LM are closed (conducting), the output relays are closed if the monitoring circuit is satisfied.

The MSR22LM has three sets of dual channel inputs. This allows it to operate in four different configurations:

1. Monitors up to three light curtains in guard only mode.
2. Monitors up to two light curtains with two muting sensors (only one curtain muted).
3. Monitor one light curtain with four muting sensors.
4. Monitors up to three light curtains with PSDI (only one curtain initiated).

The MSR22LM uses microprocessor based technology to offer a wide variety of advanced safety solutions in a small 45 mm DIN rail mounted housing. Internal selector switches provide for easy selection of up to ten different applications. Four LEDs give operational status as well as diagnostic information. Removable terminals reduce wiring and installation costs when replacement is necessary.

Features

- Category 4 per EN 954-1
- Stop category 0
- Light curtain muting—two or four sensors
- Presence sensing device initiation—up to three breaks
- 45 mm housing
- Removable terminals
- 24V DC supply voltage
- Start/restart interlock

LED Indicators

Power: Green	Ready
K1: Green	K1 Closed
If K1 alone is lit, check for short across reset button	
K2: Green	K2 Closed

Specifications

Safety Ratings		
Standards	EN 954-1, ISO13849-1, IEC/EN 60204-1, IEC 60947-5-1, IEC 61496-1, ANSI B11.19, AS4024.3	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < See website MTTFd: > See website Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives and BG	
Power Supply		
Input Power Entry	24V DC	
Power Consumption	4 W	
Inputs		
Safety Inputs	2 N.C. Symmetric or Asymmetric, Switch Selectable	
Input Simultaneity	0.5 seconds	
Input Resistance, Max.	S12-S14: 300 Ω S21-S22: 200 Ω S33-S34: 250 Ω	
Reset	Auto./Manual	
Power On Delay Time	40 ms (Manual Reset); 200 ms (Auto Reset)	
Response Time	15 ms	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C.	
Thermal Current/I_{th}	5 A nonswitching	
Switching Current @ Voltage, Min.	1 mA @ 10V	
Fuses, Output	6 A fast acting (external)	
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	10,000,000 operations	
Utilization Category (Inductive)		
B500: AC-15	3 A @ 250V AC	3 A @ 120V AC
P300 DC-13	3 A/24V DC	
B300 AC-15	2 A @ 250V AC	2 A @ 120V AC
DC-13	2 A/24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]	-15…+55 ° (5…131 °)	
Vibration	0.35 mm 10…55 Hz	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	220 (0.485)	
Conductor Size, Max.	1 x 2.5 mm² (14 AWG) stranded, 1 x 4 mm² (12 AWG) solid	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

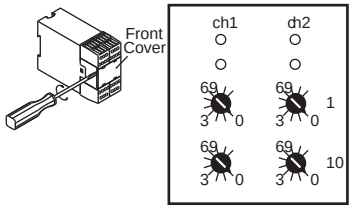
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
3 x 2 N.C.	2 N.O.	1 N.C.	Removable	Auto./Manual	24V DC	**440R-P23071**

Accessories

Description	Cat. No.
70 mm Tower Light Clear LED Module—Black Enclosure	855T-B24YL7
70 mm Tower Light Clear LED Module—Grey Enclosure	855T-G24YL7

Application Details

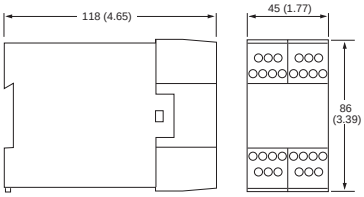
Disconnect power. Use a screwdriver to pop open cover to reveal internal switches.



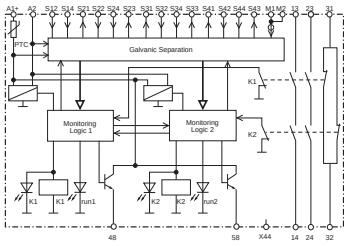
Inside View

Approximate Dimensions

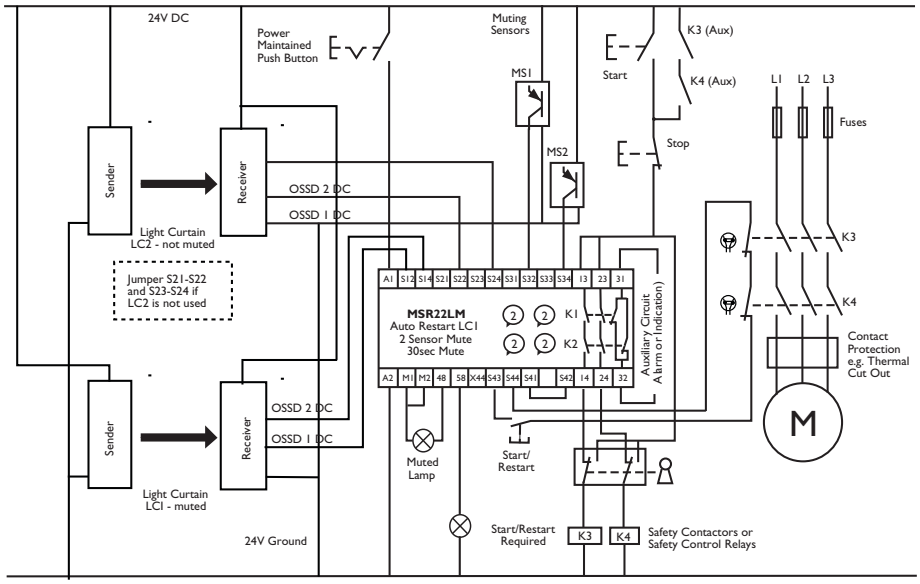
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



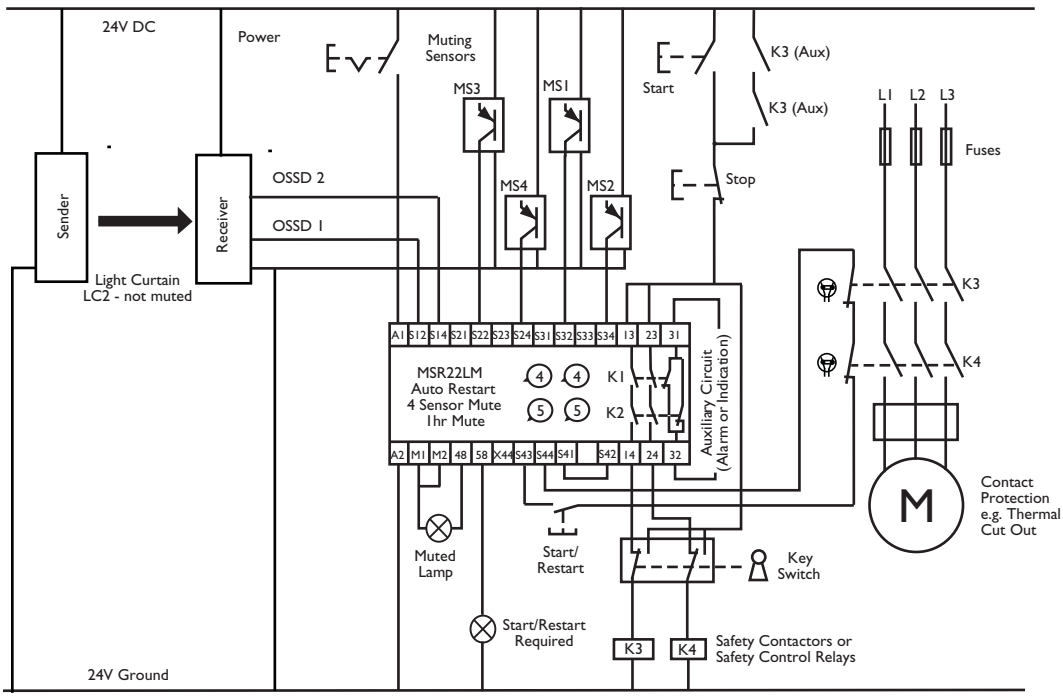
Block Diagram



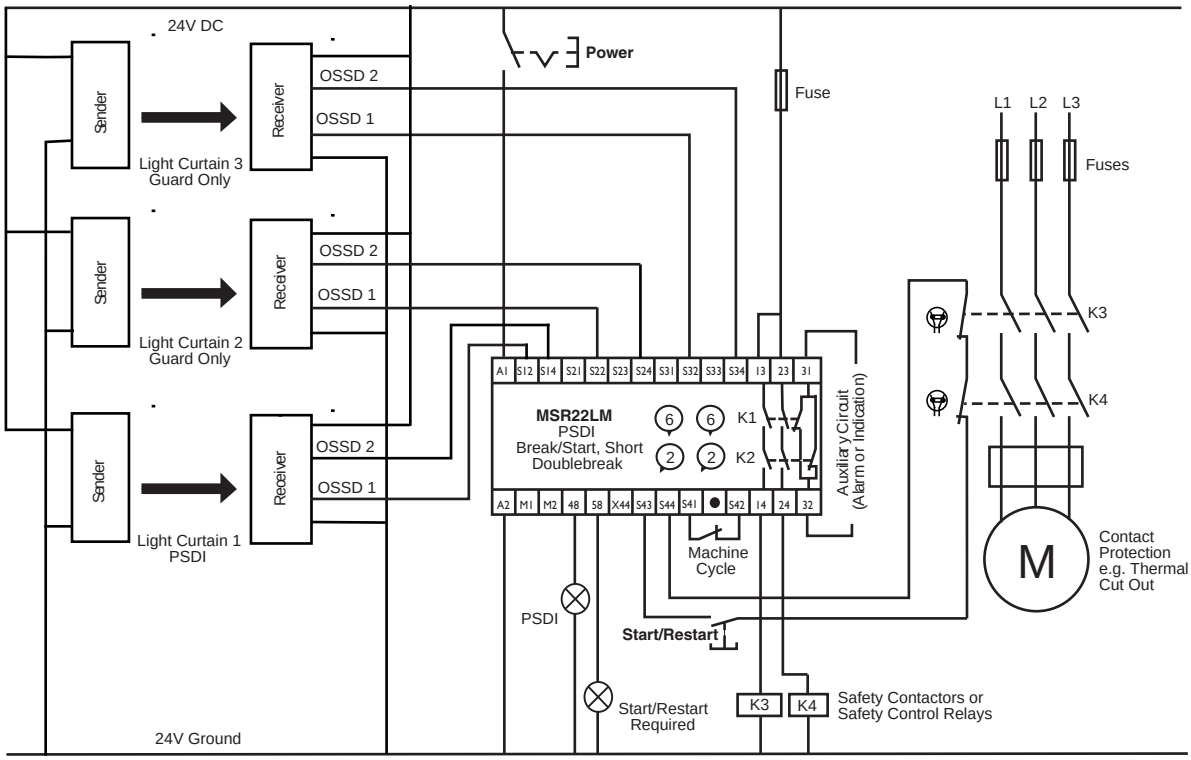
Typical Wiring Diagrams



Note: Two light curtains with two-sensor muting and Auto Restart LC1.



Note: Typical one light curtain with four-sensor muting and Auto Restart LC1.



Note: Light curtain inputs, Presence Sensing Device Initiation (on LC1) Start/Restart Interlock, Dual Channel Output, Output Monitoring.

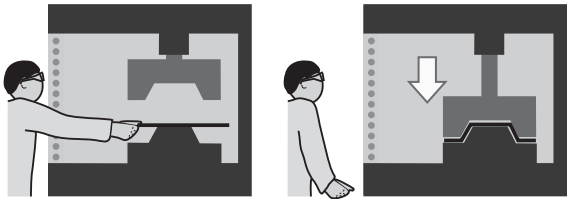
Application Details

MSR22LM—Shown connected to a safety light curtain.

Multiple settings are available offering a variety of advantages. Below are the three most common settings.

Protective Mode

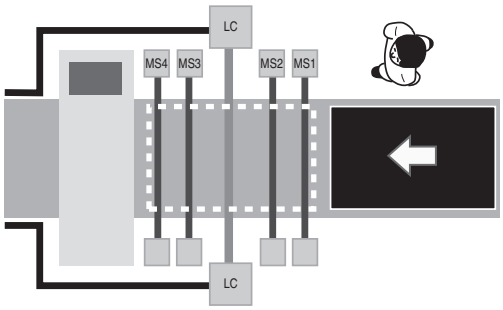
Example shows a press protected by a safety light curtain connected to the MSR22LM.



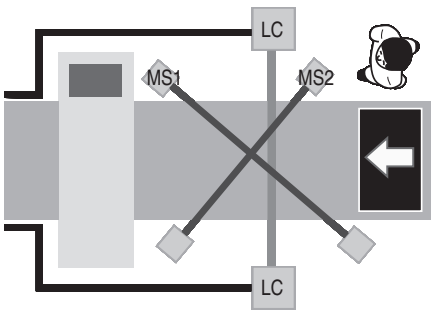
In machine operation, whenever the light curtain beams are broken the press immediately stops to help avoid danger to the operator. Once the beams are cleared the machine can then be started.

Muting Mode

Two examples are shown, both conveyor applications with a safety light curtain protecting the dangerous area. In-line and cross beam muting is used to allow the material to pass through the light curtain without stopping the machine. Any other object or person will be detected by the light curtain which will initiate machine stop.



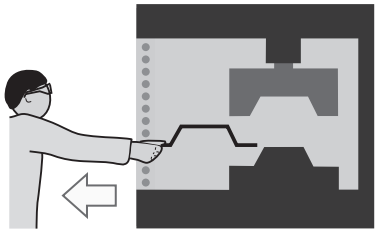
In-line muting requires the material to break the beams in a sequence, as shown. Only if all four MS beams are broken in turn and then clear in turn will the light curtain allow material through without initiating machine stop.



Cross-beam muting requires the material to break the beams in a sequence. MS1 first and then MS2. Only if the beams are broken in turn and then clear in turn will the light curtain allow material through without initiating machine stop.

Auto Initiation Sequence (Stepping)—Double Break Shown

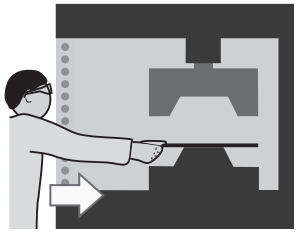
Auto initiation allows the machine to start and stop according to the number of times the light curtain beams are broken and cleared. Illustrated below is the MSR22LM set to auto initiation double break mode (after initial start-up sequence). Single- or three-break modes can also be selected.



First break—processed material removed

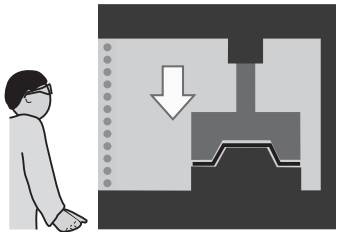
First clear—light curtain clear

Machine remains in stop mode



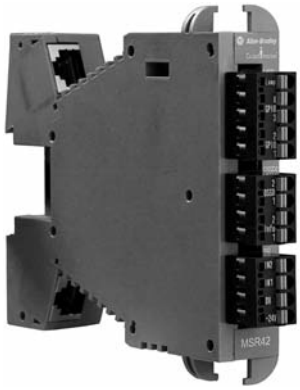
Second break—new material inserted

Machine remains in stop mode



Second clear—light curtain clear

Machine starts. Upon completion of cycle first break will start sequence again.



Description

The MSR42 multi-function safety relay is the control module for the GuardShield Micro 400 safety light curtain, but can also be used with any light curtain. This versatile Category 4 safety device has a pair of PNP solid state, 400 mA OSSDs for direct connection to the final switching device. When safety relay outputs are required, the MSR42 easily accommodates the interconnection of up to three MSR45E safety relay expansion modules, each providing a pair of safety relay outputs. Simply connect ribbon cable connectors from the back of the MSR42 to each of the MSR45E modules for a series of interconnections for two PNP OSSDs, and six N.O. relay outputs.

The MSR42 has four software configurable inputs. These configurable safety inputs allow the connection of a multitude of safety devices such as safety light curtains, safety laser scanners, e-stops, safety switches, etc.

This 22.5 mm DIN mount multi-function safety module has both hard wired and software configurable operating modes. The removable spring terminal connectors on the MSR42 allow for ease of wiring of the device as well as hard-wired operating mode configuration.

Manual/automatic reset and start/restart can be configured by simply changing the wiring (see basic configuration examples).

Features such as two or four sensor muting, connecting up to two additional safety light curtains or other safety devices and configuring one or two auxiliary outputs are easily configured using the optical interface with the supplied software.

The MSR42 and Micro 400 light curtains support fixed blanking which is only available in the basic configuration mode and configured through a "teach-in" selector switch via the GPIO pins.

Features

- Category 4 per EN 954-1
- SIL CL3 IEC 61508, IEC 62061
- 22.5 mm housing
- Stop category 0, 1
- 24V DC supply voltage
- Manual, monitored or automatic reset
- Thirteen diagnostic LEDs
- Unique design allows for easy addition of relay expansion modules
- Removable terminal blocks
- One or two configurable auxiliary, standard outputs
- Connection of one or two additional safety devices
- RJ45 connections for Micro 400 safety light curtain
- Two or four sensor muting (Micro 400 only)
- Fixed blanking (Micro 400 only)
- Two sensor muting all GuardShield light curtains
- Supports up to three MSR45E expander units
- Free configuration software can be downloaded at www.ab.com/safety

Specifications

Safety Ratings	
Standards	EN 954-1, IEC/EN 60204-1, IEC 61496-1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 61508, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 9.00E-10 MTTFd: > 331 years For use in SIL3 systems (according to IEC 61508) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	24V DC
Power Consumption	2.4 W (semi-conductor outputs unloaded)
Inputs	
Safety Inputs	2 N.C. or 2 OSSD, Micro 400 software selectable
Input Resistance, Max.	—
Reset	Auto./manual or manual monitored
Power On Delay Time	Determined by configuration
Response Time	Determined by configuration
Outputs	
Safety Contacts	2 PNP, 400 mA each
Auxiliary Contacts	2 PNP, configurable
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP20/ IP20
Operating Temperature [C (F)]	0…55 ° (32…131 °)
Vibration	0.35 mm 10…55 Hz
Mounting	35 mm DIN Rail
Weight [g (lbs)]	130 (0.287)
Conductor Size, Max.	1 x 2.5 mm^2 (14 AWG) stranded

✶ Usable for IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years

LED Indicators (Basic Configuration) ✶❄

LED	Green	Red
Lamp	—	—
GPI04	Automatic start	Manual start (off)
GPI03	Manual or automatic start	Manual start (off)
GPI02	Configurable	Configurable
GPI01	Configurable	Configurable
OSSD2	Output active	Output inactive
OSSD1	Output active	Output inactive
Info2 (LED)	Configurable	Configurable
Info1 (LED)	Configurable	Configurable
IN2	Start release	No start release signal
IN1	No test input	Test input
0V	—	—
+24V	Power connected	No power connected

✶ All I/O is configurable except OSSD1 and OSSD2.
❄ LED behavior depends on configuration (see instruction sheet for details).

Product Selection

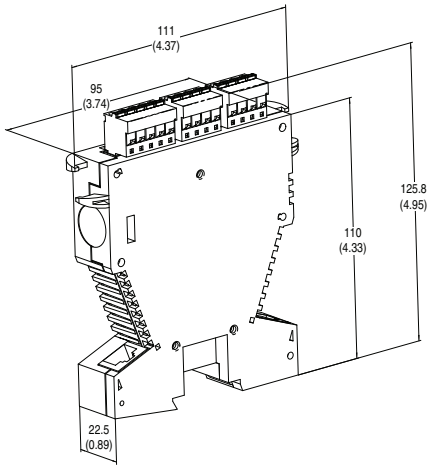
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
GuardShield Micro 400 and 4 x GPI0	2 PNP	2 PNP, configurable	Removable	Auto./manual or manual monitored	24V DC	**440R-P226AGS-NNR**

Accessories

Description	Cat. No.
MSR45E—Safety Relay for MSR41 or MSR42 (requires ribbon cable connection)	440R-P4NANS
Ribbon cable—for one MSR45E	**440R-ACABL1**
Ribbon cable—for two MSR45Es	440R-ACABL2
Ribbon cable—for three MSR45Es	440R-ACABL3
Replacement terminal block kit—MSR42	440R-ATERM2P
Replacement terminal block kit—MSR45E	440R-ATERM2C
USB optical interface software configuration tool used to configure the MSR42	445L-AF6150
Replacement suction cup	445L-AF6151
Optical interface fastener	445L-AF6152

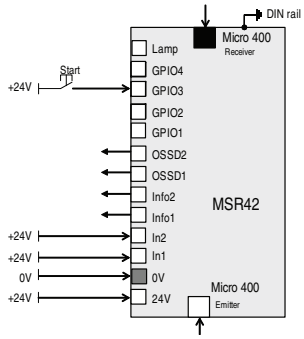
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

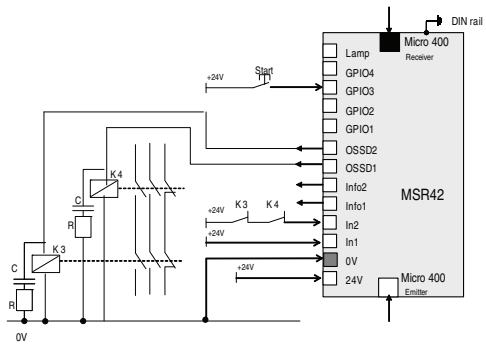


Typical Wiring Diagrams

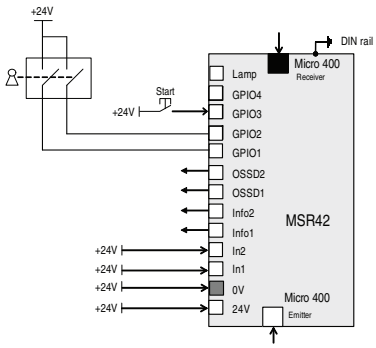
Basic Configurations (No Software)



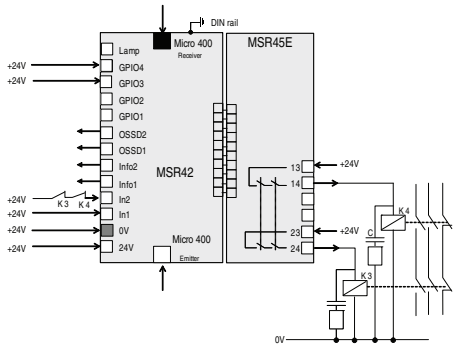
Micro 400 Light Curtain, Manual Reset, No Output Monitoring



Micro 400 Light Curtain, Manual Reset, Start/Restart Monitored Output

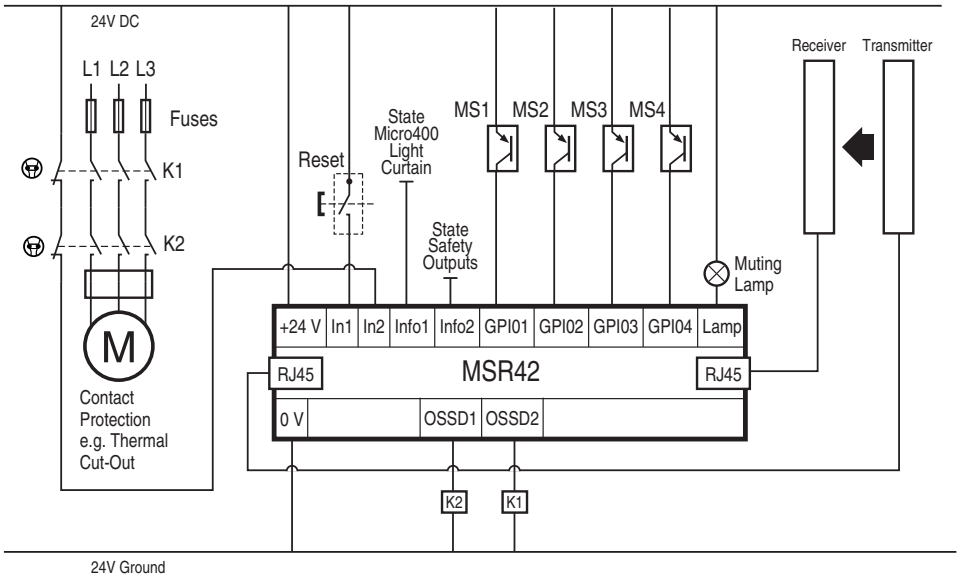


Fixed Blanking, Micro 400 Light Curtain, Manual Reset, No Output Monitoring

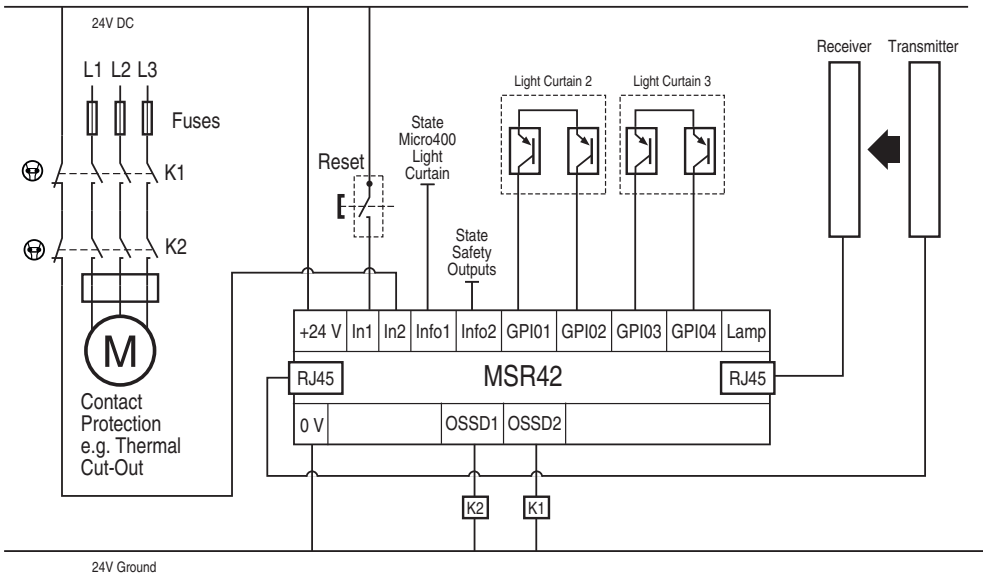


Micro 400 Light Curtain, Automatic Reset, Start/Restart Monitored Output and MSR45E Expansion Module

Software Configurations



Note: Four Sensor T-type muting: GuardShield Micro 400, four muting PNP sensors, manual reset, output monitoring



Note: Three-light curtain application: GuardShield Micro 400 light curtain, two GuardShield light curtains, manual reset, output monitoring

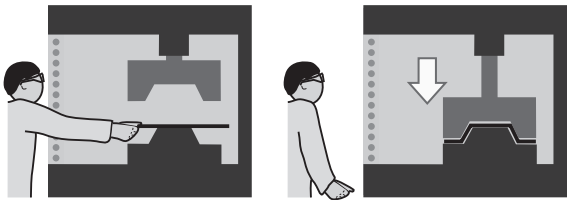
Application Details

MSR42—Shown connected to safety light curtains.

Multiple settings are available offering a variety of advantages.

Protective Mode

Example shows a press protected by a safety light curtain connected to the MSR42.

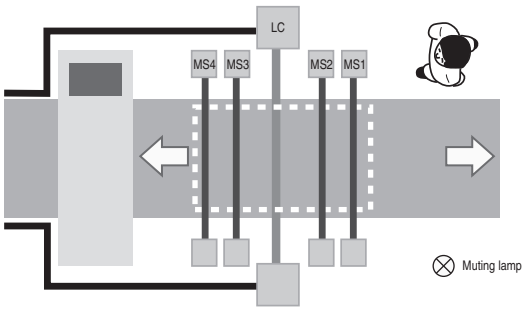


In machine operation, whenever the light curtain beams are broken the press immediately stops to help avoid danger to the operator. Once the beams are cleared the machine can then be started.

Muting Modes

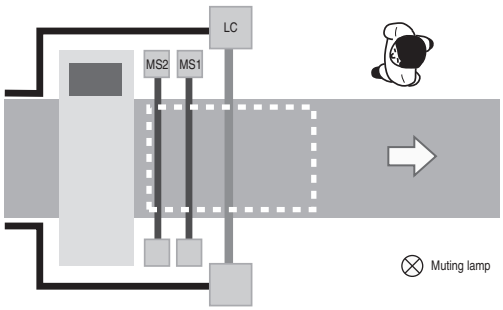
Four conveyor examples: All conveyor applications shown with a safety light curtain helping protect the dangerous area. In-line and cross beam muting is used to allow the material to pass through the light curtain without stopping the machine. Any other object or person will be detected by the light curtain which will initiate machine stop.

Four Sensor T-type



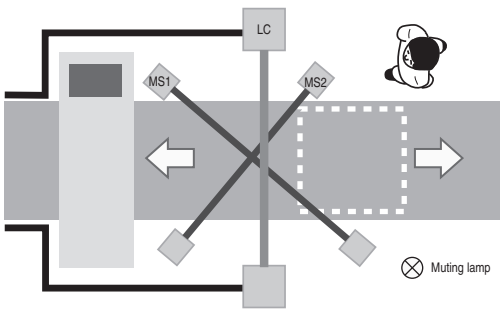
Bi-directional muting: In-line muting requires the material to break the beams in a sequence, as shown. Only if all four muting sensor (MS) beams are broken in turn and then clear in turn will the light curtain allow material through without initiating machine stop.

Two Sensor L-type



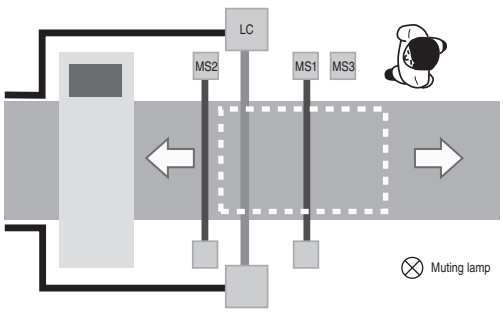
Uni-directional muting: This will allow material to exit the machine but not allow material or personnel to enter the machine without a fault condition. Only if both MS beams are broken in-turn and then cleared in-turn, will the light curtain allow material through without initiating a machine stop.

Two Sensor T-type



Bi-directional muting: Cross-beam muting requires the material to break the beams in a sequence. MS1 first and then MS2. Only if the beams are broken in turn and then clear in turn will the light curtain allow material through without initiating machine stop.

Two Sensor T-type with Enable



Bi-directional muting: The MS3 is an input to the MSR42 from a PLC output card. The MS3 enables the muting function to be performed. If a high signal is not detected on MS3, the muting function will not operate even if the MS1 and MS2 beams are broken. Only if MS3 is high and both MS beams are broken in-turn and then cleared in-turn, will the light curtain allow material through without initiating a machine stop.



Description

The CU2 control unit is a compact timing and stop motion detector interface module. By utilizing two independent inductive proximity inputs, which monitor the movement of two metal parts of the machine (e.g., sprockets, cams or linkages). The control unit detects when hazardous motion has ceased. When the hazardous motion has stopped the unit will send a signal to unlock guard locking devices. It has been developed to integrate guard locking interlock switches on machines which have variable or unpredictable run down cycles.

A removable cover allows access to the DIP switches and potentiometer which control the timing. The on-delay may be adjusted between 0.1 seconds to 40 minutes, through a series of 4 broad time ranges. The final adjustment is made by a potentiometer.

The Y1/Y2 terminals provide a check of contactors at machine power up. This is only relevant to certain special applications. For normal use these terminals should be linked. After all motion has ceased, the normally open safety on contacts close, which may be used to energize electrically operated solenoid locking guard switches. In addition the normally closed contacts open to indicate the unit's status.

LED indication in the unit displays power, timer on, and outputs.

Features

- Category 1 per EN 954-1
- Stop category 1
- NPN and PNP inputs
- Timed off-delay 0.1 s…40 min
- Two N.O. safety outputs
- One N.C. auxiliary output

LED Indicators

Red	Power on
Red/Green	Timing/Output On

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 1 per EN 954-1 (ISO 13849-1), SIL CL1 per EN IEC 62061, PL c per ISO 13849-1	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV	
Power Supply		
Input Power Entry	24V AC/DC or 110/230V AC	
Power Consumption	<4 VA	
Inputs		
Safety Inputs	1 NPN and 1 PNP, Normally Open	
Input Resistance, Max.	500 Ω	
Reset	Automatic/Manual	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C.	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V	
Fuses, Output	5 A quick acting (external)	
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category		
Inductive: B300: AC-15	5 A @ 250V AC	5 A @ 120V AC
Inductive: DC-13	3 A/24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]	-10…+55 ° (14…131 °)	
Vibration	0.75 mm (0.30 in) peak, 10…55 Hz	
Shock	30 g, 11 ms half-sine	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	360 (0.79)	
Conductor Size, Max.	1 x 2.5 mm^2 (14 AWG) stranded, 1 x 4 mm^2 (12 AWG) solid	

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

Description	Sensor Voltage	Sensor Size (mm)	Sensing Distance (mm)	Terminals	Reset Type	Control Unit Voltage	Cat. No.
Controller and Sensors	24V DC supplied by Control Unit	12	3	Fixed	Automatic/Manual	24V AC/DC	440R-S07279
						110/230V AC	440R-S07280
		18	5			24V AC/DC	440R-S07281
						110/230V AC	440R-S07282
		30	10			24V AC/DC	440R-S07283
						110/230V AC	440R-S07284

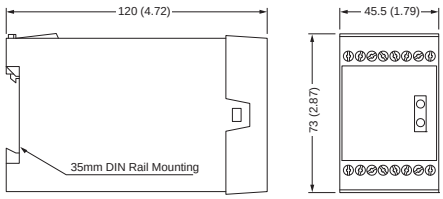
When you order a combination Cat. No.	You will receive a control unit, an NPN sensor and a PNP sensor.
440R-S07279	440R-S07139, 872C-D3NN12-E2, and 872C-D3NP12-E2
440R-S07280	440R-S07140, 872C-D3NN12-E2, and 872C-D3NP12-E2
440R-S07281	440R-S07139, 872C-D5NN18-E2, and 872C-D5NP18-E2
440R-S07282	440R-S07140, 872C-D5NN18-E2, and 872C-D5NP18-E2
440R-S07283	440R-S07139, 872C-D10NN30-E2, and 872C-D10NP30-E2
440R-S07284	440R-S07140, 872C-D10NN30-E2, and 872C-D10NP30-E2

Accessories

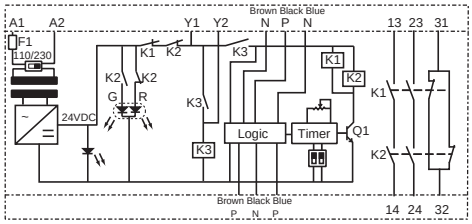
Description	Power Supply	Size (mm)	Output Type	Cat. No.
Control Unit Only	24V AC/DC	45	2 N.O. & 1 N.C.	440R-S07139
	110/230V AC		2 N.O. & 1 N.C.	440R-S07140
Sensor Only	24V DC supplied by Control Unit	12	NPN	872C-D3NN12-E2
			PNP	872C-D3NP12-E2
		18	NPN	872C-D5NN18-E2
			PNP	872C-D5NP18-E2
		30	NPN	872C-D10NN30-E2
			PNP	872C-D10NP30-E2
500 mA fuse—Bussmann Cat. No. ETF-500 mA				440R-A31562

Approximate Dimensions

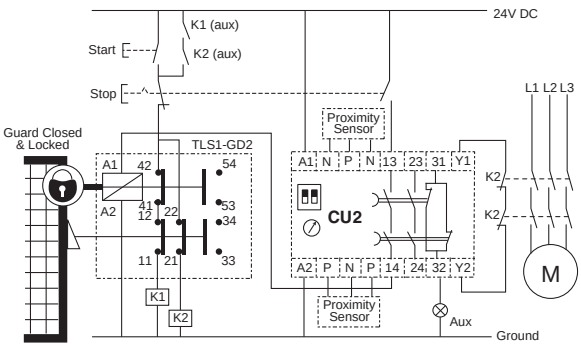
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Guard Locking Safety Gates, Motion Sensors, Delayed Gate Release, Automatic Reset, Monitored Output



Description

Bulletin 872C WorldProx inductive proximity sensors are self-contained, general purpose, solid-state devices designed to sense the presence of ferrous and nonferrous metal objects without touching them.

The switch body consists of a plastic face and a nickel-plated brass barrel. It meets NEMA 1, 2, 3, 4, 6P, 12, 13 and IP67 (IEC 529) enclosure standards. The electronic circuitry is fully potted for protection against shock, vibration, and contamination.

The CU2 is designed to operate with one normally-open NPN and one normally-open PNP inductive proximity sensor.

The sensors translucent end caps glow when the LED indicator is on, and are visible from almost every angle.

The sensors contained in this section are some of the more popular size inductive proximity sensors. See the Rockwell Automation/ Allen-Bradley Sensors catalog for an extensive range of proximity sensors.

LED Indicators

Amber	Output energized, 360° visibility

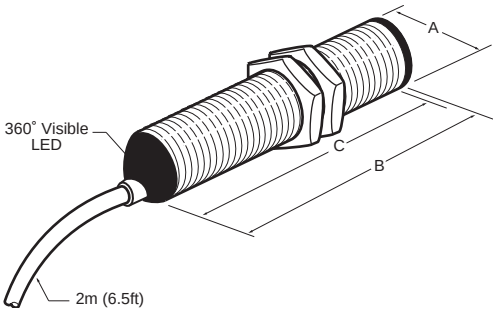
Specifications

Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS4024.1
Safety Classification	Cat. 1 per EN 954-1 (ISO 13849-1)
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Operating Voltage	10…30V DC
Sensing Distance	2, 5 or 10 mm
Correction Factors	Mild Steel = 1.0 Stainless Steel = 0.7…0.8 Brass = 0.4…0.5 Aluminum = 0.3…0.4 Copper = 0…0.3
Load Current, Max.	200 mA
Outputs	NPN or PNP normally open
Leakage Current	≤10 mA
Sensor Voltage Drop	≤1.64V
Repeatability	≤2%
Hysteresis	≤10% typical
Status Indicators	Red = Output energized
Operating Temperature [C (F)]	-25…+70 ° (-13…+158 °)
Relative Humidity	95%
Enclosure Type Rating	NEMA 1, 2, 3, 4, 6P, 12, 13, IP67
Protection	False pulse on power, transient noise, reverse polarity, short circuit, overload
Cable Size	3 x 1 mm² (26 AWG) stranded
Cable Length	2 m (6.5 ft)
Material	Plastic-faced, nickel-plated brass barrel
Mounting	M12, M18 or M30 Flush Fitting (Shielded Sensing)/IP20, DIN 0470
Shock	30 g, 11 ms half-sine
Vibration	1 mm peak, 10…55 Hz

Note: See Output Ratings on page 1-39 for details. Consult factory for ratings not shown.

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



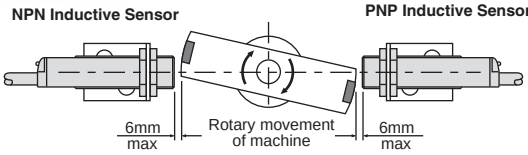
Thread Size	Shielded	mm (inches)		
		A	B (max)	C (min)
M12 x 1	Yes	12 (0.47)	50.8 (2.00)	46.7 (1.84)
M18 x 1		18 (0.71)		
M30 x 1		30 (1.18)		

Application Details

Application Accessories



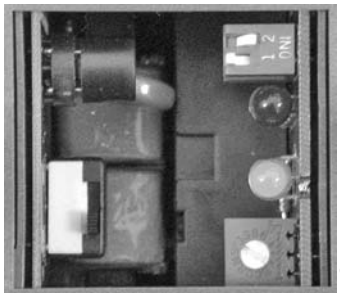
PNP and NPN Inductive Sensors for use with CU2
Sensors detect when motion has ceased by monitoring two targets on moving metal parts. When motion has ceased the CU2 begins timing down. Once preset time limit has been passed the CU2 sends a single allowing locked guard to be opened.



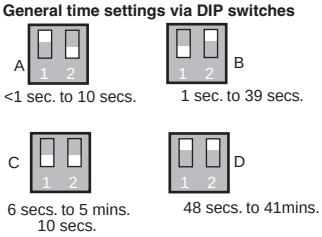


CU1 remote indication unit:
A remote indication unit to indicate the status of the circuit can be connected to the CU 1s, R1, R2 and R3 connections.

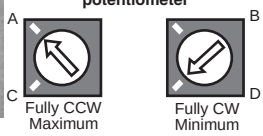
Adjustable Time Delay
DIP switches general time setting and the potentiometer fine tunes the time settings. Easy access 500 mAT replaceable fuse.



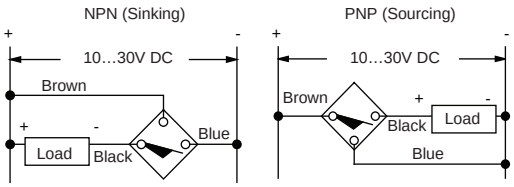
General time settings via DIP switches



Fine adjustment time setting via potentiometer



Typical Wiring Diagrams



Specialty Safety Relays

MSR57P Safe Speed and Standstill Monitor



Description

The MSR57P speed monitoring safety relay is designed to solve motion applications which require interaction by personnel during operation. It connects to any drive and monitors the speed using currently installed encoders. The MSR57P can be configured to unlock the access door only when the machine is either stopped or at a safe speed defined by the user. If required, the speed monitoring relay can monitor an enabling switch to constantly monitor personnel while in the hazardous area. Other supported functions are safe maximum speed and zero speed detection.

The MSR57P can be configured and monitored via two methods: drive explorer using a PC and the standard HIM device. During configuration, the user can set a variety of parameters to the specific requirements of their application including type of input devices, quantity, door locking and monitoring, enabling switches and a maintenance (safe speed) mode.

The MSR57P can easily be adapted to current installations with standard drives or drives with the safe-off feature. The safety relay uses standard outputs to control the drives speed but uses safety outputs to control the outputs of the drive. The speed is determined by using an encoder(s). This device can monitor the encoder data which is already transmitting to the drive, assuming an encoder is already installed, or a new encoder can be installed and only connected to the MSR57P. Two encoders are needed for Category 4, SIL 3 applications which cannot exclude shaft slippage and breakage.

This device also supports multiple axis applications. During configuration, it can be setup to be the first, middle or last axis in the chain. This is important since the input devices will all be installed on the first unit only while the output devices are connected to the last MSR57P in the chain.

Features

- SIL 3 IEC 61508
- Category 4 per EN 954-1
- Stop category 0, 1, 2
- Six N.O. solid-state safety outputs
- Four solid-state auxiliary outputs
- One or two encoders (sin/cos and TTL)
- Eight diagnostic LEDs
- DPI configuration port
- 67.5 mm DIN Rail housing
- Removable terminals

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, ISOTR 12100, IEC/EN 60204-1, ANSI B11.19, AS4024.1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: See website MTTFd: See website Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC, 0.8…1.1 x rated voltage PELV/SELV
Power Consumption	5 W
Inputs	
Safety Inputs	1 N.C. & 1 N.O., 2 N.C., 1 N.C., 2 OSSD
Input Simultaneity	Infinite or 3 sec (configurable)
Input Resistance, Max.	4 K Ω
Reset	Auto./Manual or Manual Monitored
Response Time	Configurable
Outputs	
Safety Contacts	6 N.O. Solid State
Auxiliary Contacts	4 N.O. Solid State
Current, Max	Outputs 14, 24, 68, 78 24V DC, 2 A, short-circuit protected Outputs 34, 44 24V DC, 100 mA, short-circuit protected Outputs Y35, Y37 24V DC, 50 mA, short-circuit protected Door switches 51, 52 24V DC, 750 mA, short-circuit protected Outputs Y1, Y32, Y33 24V DC, 100 mA, short-circuit protected Pulse Outputs S11, S21 24V DC, 100 mA, short-circuit protected Pulse Inputs S12, S22, S32, S42, S52, S62, S72, S82, X32, X42, S34, Y2 8.5 mA per input
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	335 (0.74)
Conductor Size, Max.	0.2…2.5 mm^2 (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

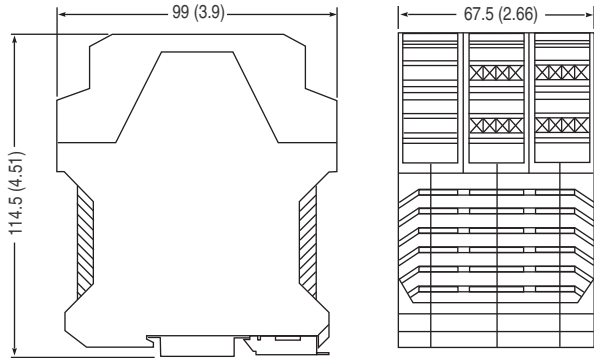
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
5 x 1 N.C., 2 N.C., LC, 1 N.O. + 1 N.C.	6 N.O. Solid State	4 N.O. Solid State	Removable	Auto./Manual or Manual Monitored	24V DC	440R-S845AER-NNL

Accessories

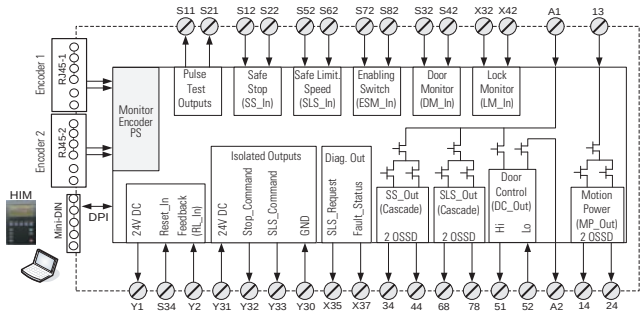
Description	Cat. No.
MSR57 Encoder cable with flying leads (2.5 meters)	1585J-M8RB-2M5
3 meter cable HIM	1202-C30
1 meter cable HIM	1202-C10
AnaCANda serial converter (RS232)	1203-SSS
AnaCANda USB converter	1203-USB
HIM full numeric LCD IP20 (NEMA 1)	20-HIM-A3
Kinetix 6000/7000 low profile connector kit	2090-K6CK-Dxxx
Kinetix 2000 low profile connector kit	2090-K2CK-D15M
HIM to MSR 57 cable (1 meter)	20-HIM-H10
Sin/Cos encoder (1024 PPR)	842HR-xJxxx15FWY2
TTL encoder (size 20)	845T-xxxxxxx
TTL encoder (size 25)	845H-SJxxx4xxYxx

Approximate Dimensions

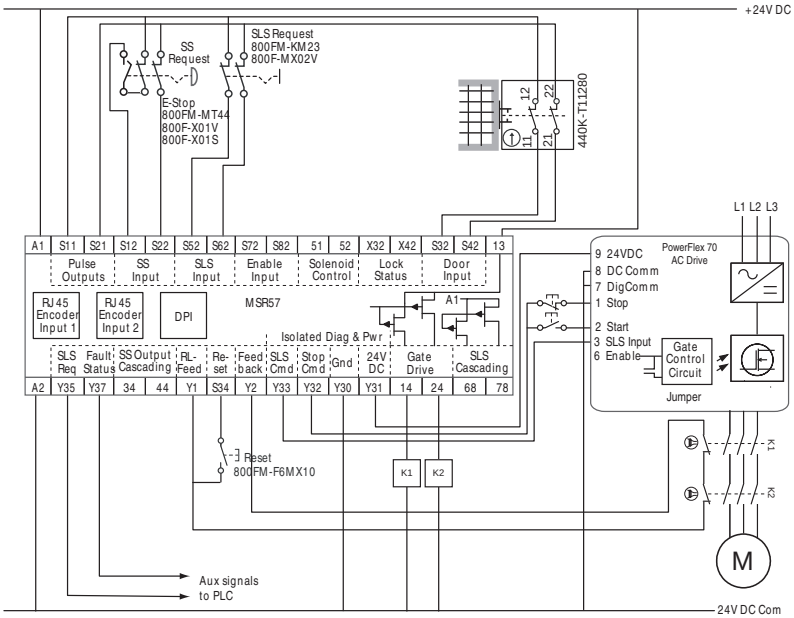
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



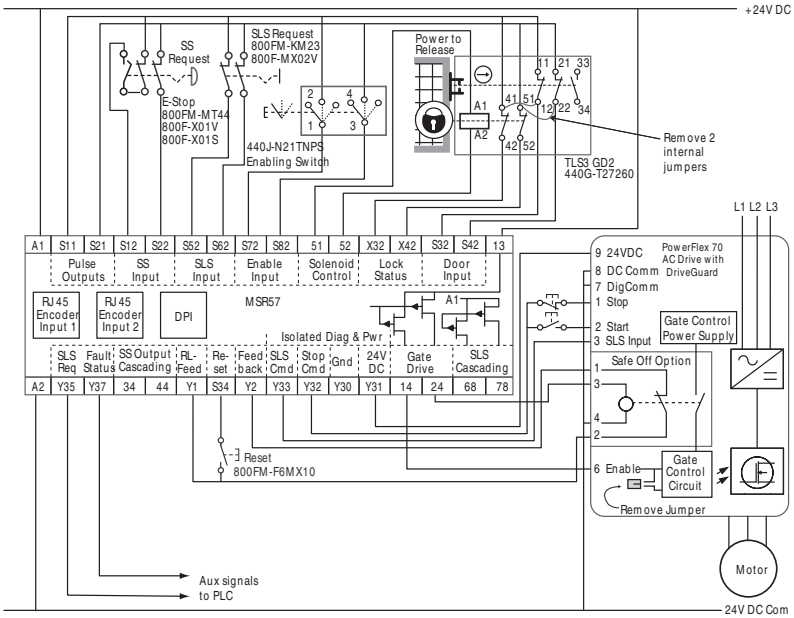
Block Diagram



Typical Wiring Diagrams

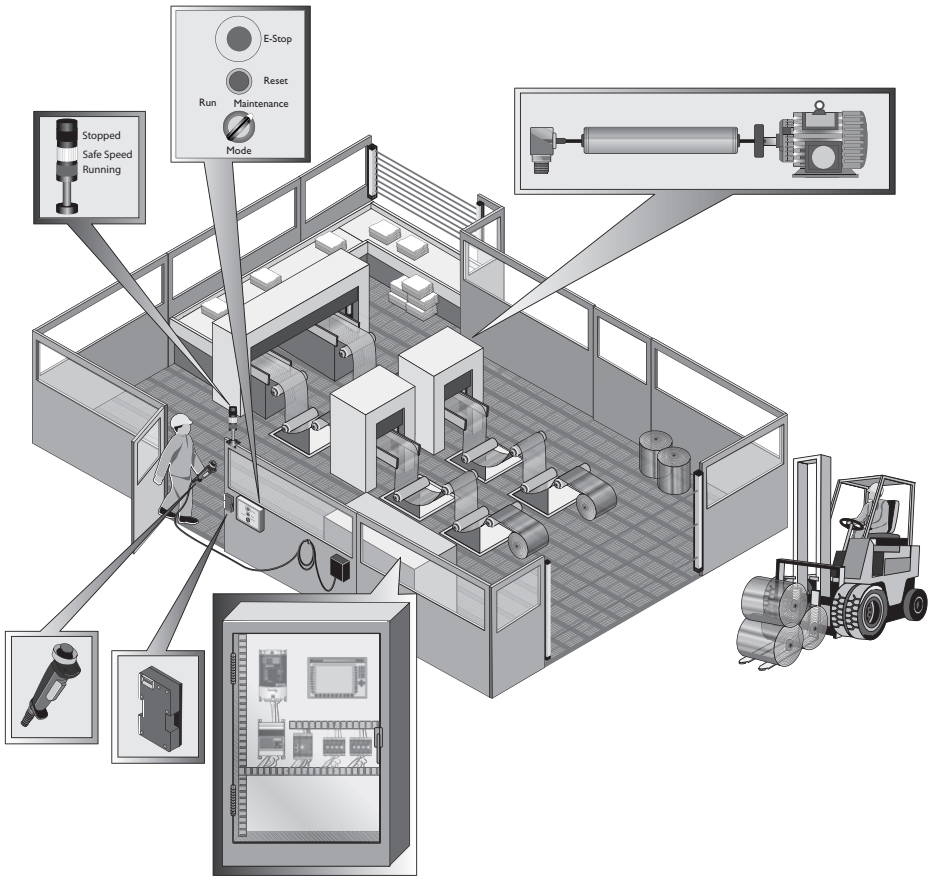


Note: Cat. 1 stop, 1 encoder, door monitoring, safe limited speed, PowerFlex 70 without safe off.



Note: Cat. 1 stop, 1 encoder, door monitoring, enabling switch, safe limited speed, PowerFlex 70 with safe off.

Application Details



Operating Conditions

- The door is closed and locked with a TLS3 safety switch
- The machine is running at normal speed

Maintenance Conditions

- In order to remove a jam condition or during start-up personnel must enter the hazardous area.
- The operator moves Limited Speed Selector switch to “enable.”
- The MSR57 monitors speed profile and verifies drive is reducing speed per the preconfigured profile.
- Once the speed is equal to or below limited speed value, the door is unlocked.
- If configured, user must hold enabling switch in the middle position before opening door. Otherwise the machine will shutdown.
- The operator performs maintenance on the machine.
- Once maintenance is complete, the operator exits machine, closes door and moves the safe limited speed switch to "maintenance" mode BEFORE releasing the enabling switch.
- The machine will resume normal speed according to the drive profile.

Remarks

- The MSR57 can also monitor if the speed has exceeded a preconfigured value and shutdown the process.
- The MSR57 is compatible with all drives and uses standard inputs on the drive to perform controlled start and stop sequences.
- Pressing the E-stop at any time, will cause the machine to stop according to the preconfigured stop mode.
- The MSR57 can also be used in cascading applications with multiple MSR57s and drives.



Description

The CU3 is a control unit which detects stopped motion and is ideal for use with guard locking interlock switches. It is designed to interface with single or three-phase induction motors by measuring the drive voltage and the back electro-magnetic field (emf) of the motor.

The front window of the CU3 can be popped off to reveal a replaceable fuse and a potentiometer. The potentiometer sets the threshold voltage measured at terminals Z1/Z2. The maximum threshold voltage is approximately 2.5V peak (potentiometer turned fully CCW). When the voltage at Z1/Z2 exceeds the threshold voltage, the safety outputs de-energize, and the safety contacts at terminals 13/14 and 23/24 open.

When the supply to a motor is disconnected, motor speed will reduce to zero. During the run down period the back emf generated by the motor is monitored by the CU3. When the level of the back emf dips below the threshold voltage, the safety outputs close. This enables the output device (e.g., solenoid locking or unlocking switch) to be activated.

If the Z1/Z2 circuit opens, the CU3 goes into a fault state, indicated by the fault led. The fault must be corrected and the power to the CU3 cycled to clear the fault state.

The 24V DC version must be operated with an isolated supply. The CU3 is not intended for use with variable frequency drives.

Features

- Category 1 per EN 954-1
- Stop category 1
- Two N.O. safety outputs
- One N.C. auxiliary output
- Automatic/manual, monitored reset supported
- Motor voltage up to 500V max.

LED Indicators

Red	Power on
Red/Green	Timing/Output On
Yellow	Fault
Red	Motor Running

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS4024.1	
Safety Classification	Cat. 1 per EN 954-1 (ISO 13849-1), SIL CL1 per EN IEC 62061, PL c per ISO 13849-1	
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: See website MTTFd: See website Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE marked for all applicable directives, cULus, c-Tick, and TÜV	
Power Supply		
Input Power Entry	24V AC/DC, 115/230V AC	
Power Consumption	<4 VA	
Motor Voltage	500V max.	
Inputs		
Safety Inputs	Z1/Z2 Motor Voltage	
Reset	Automatic/Manual	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C.	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA/10V	
Fuses, Output	5 A quick acting (external)	
Electrical Life (Operations)	220V AC/4 A/880VA $\cos\phi$ = 0.35…0.1 M 220V AC/1.7 A375VA $\cos\phi$ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category		
Inductive: B300: AC-15	5 A @ 250V AC	5 A @ 120V AC
Inductive: DC-13	3 A/24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40, DIN 0470/ IP20 DIN 0470	
Operating Temperature [C (F)]	-10…+55 ° (14…131 °)	
Vibration	0.75 mm (0.30 in) peak, 10…55 Hz	
Shock	30 g, 11 ms half-sine	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	510 (1.12)	
Conductor Size, Max.	1 x 2.5 mm^2 (14 AWG) stranded, 1 x 4 mm^2 (12 AWG) solid	

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

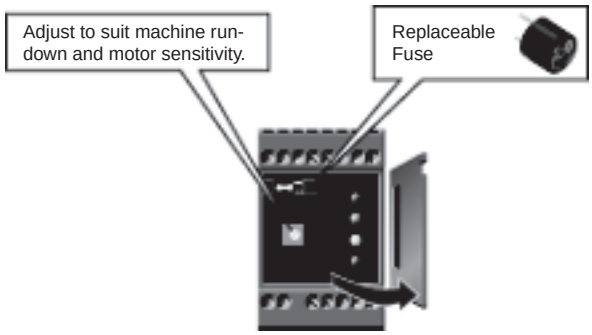
Safety Outputs	Auxiliary Outputs	Power Supply	Terminals	Reset Type	Cat. No.
2 N.O.	1 N.C.	24V AC/DC∗	Fixed	Monitored Manual, Automatic/Manual	440R-S35001
2 N.O.	1 N.C.	110V AC			440R-S35002
2 N.O.	1 N.C.	230V AC			440R-S35003

∗ The 440R-S35001 requires an isolated supply when operating on 24V DC.

Accessories

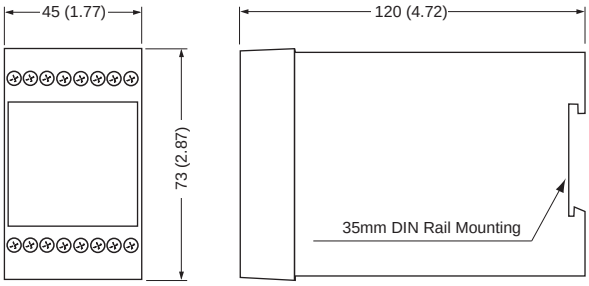
Description	Cat. No.
500 mA Fuse—Bussmann Cat. No. ETF-500 mA	440R-A31562

Application Details

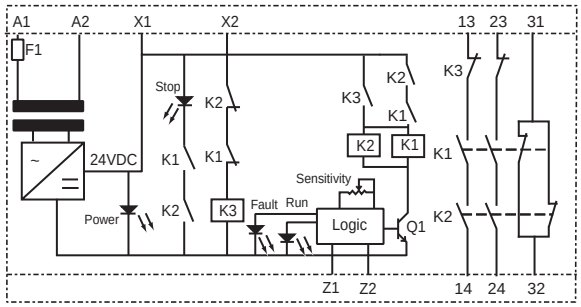


Approximate Dimensions

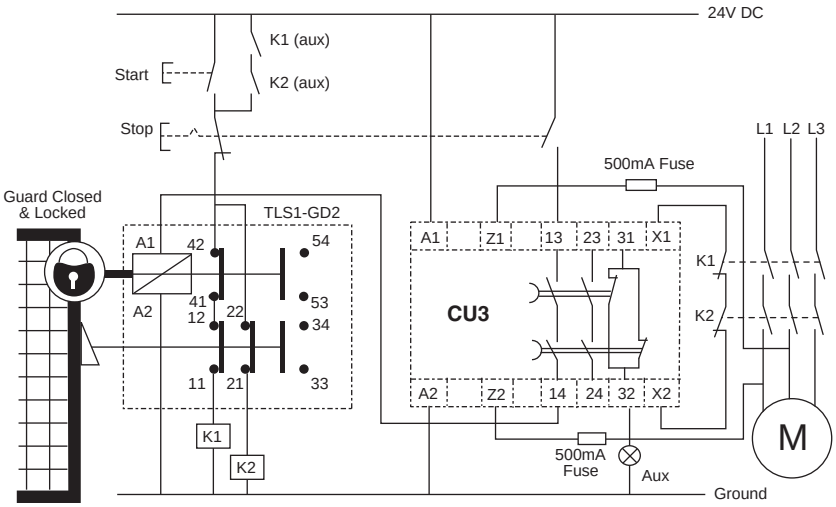
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Guard Locking Safety Gate, Back EMF Detection, Automatic Reset, Monitored Output

5-Safety Relays

Specialty Safety Relays

MSR23M Mat Controllers



Description

The MSR23M control unit is designed to monitor four-wire safety mats that are connected together to form a safeguarded zone. The size of the safeguarded zone is limited by the total input impedance (100 ohms maximum) created by the wiring and connections. The controller is designed to interface with the control circuit of the machine and includes two safety relays to help provide control redundancy.

The controller detects a presence on the mat, a short circuit, or an open circuit. Under each of these conditions, the safety output relays turn off. When interfaced properly, the machine or hazardous motion receives a stop signal, and an auxiliary output turns ON.

Features

- Category 4
- Stop category 0
- Removable terminals
- Monitored or automatic/manual reset
- Four-wire safety mats sensing

LED Indicators

Power: Green	Ready, Red = Mat Activated
K1: Green	K1 Closed. If K1 alone is lit, check for short across reset button.
K2: Green	K2 Closed

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS 4024.5	
Safety Classification	Cat. 3 per EN 954-1 (ISO 13849-1), SIL CL2 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: See website MTTFd: See website Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, BG, and CSA (24V only)	
Power Supply		
Input Power Entry	24V AC/DC or 115V AC	
Power Consumption	2 W	
Inputs		
Safety Inputs	2 N.C., 4-Wire SM	
Input Resistance, Max.	100 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay Time	40 ms (Manual Reset); 200 ms (Auto Reset)	
Response Time	15 ms	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C.	
Thermal Current I_{th}	1 x 8 A or 2 x 7 A nonswitching	
Switching Current @ Voltage, Min.	1 mA/10V	
Fuses, Output	6 A fast acting (external)	
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	10,000,000 operations	
Utilization Category (Inductive)		
N.O.—B300 AC-15	3 A @ 250V AC	3 A @ 120V AC
P300 DC-13	3 A @ 24V DC	
N.C.—B300 AC-15	2 A @ 250V AC	2 A @ 120V AC
DC-13	2 A @ 24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1) DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]	-15…+55 ° (5…131 °)	
Vibration	10 g 10…55 Hz	
Shock	30 g, 11 ms half-sine	
Mounting	22.5 mm housing, 35 mm DIN Rail	
Weight [g (lbs)]	220 (0.485)	
Conductor Size, Max.	1 x 2.5 mm^2 (14 AWG) stranded, 1 x 4 mm^2 (12 AWG) solid	

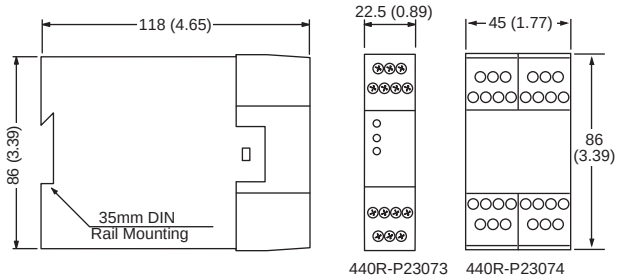
✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

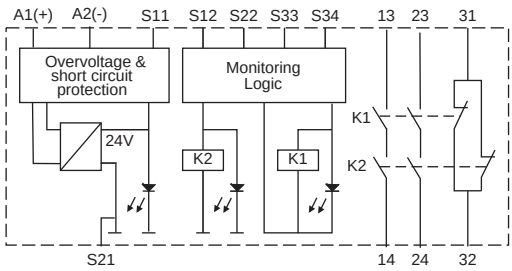
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
4-Wire Safety Mat	2 N.O.	1 N.C.	Fixed	Automatic/Manual Monitored Manual	24V AC/DC	440R-P23073
					115V AC	440R-P23074

Approximate Dimensions

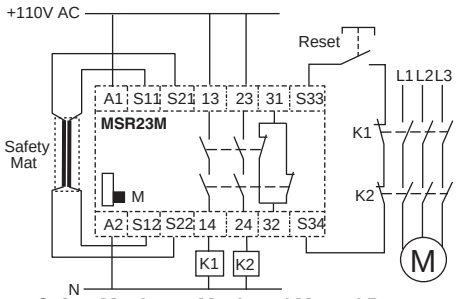
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



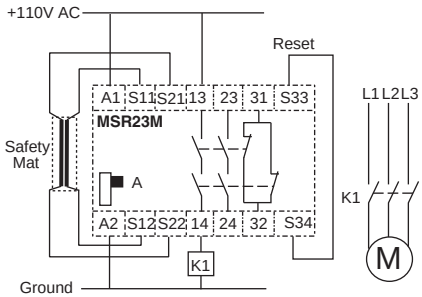
Block Diagram



Typical Wiring Diagrams

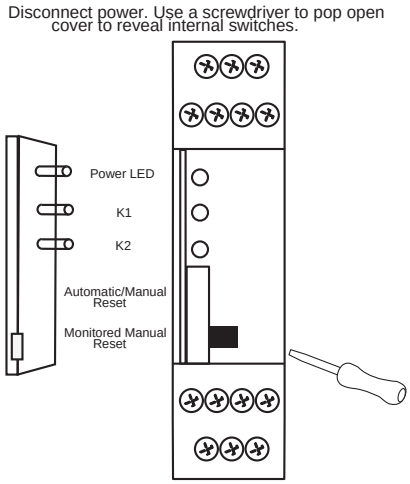


Safety Mat Input, Monitored Manual Reset, Dual Channel Output, Monitored Output



Safety Mat Input, Automatic Reset, Single Channel Output, No Monitored Output

Application Details



MatGuard™ Controllers Safety Relays



Description

The MatGuard Control Unit monitors all of the mats which are connected together to form a safeguarded zone. The safeguarded zone can be up to a total of 100 m^2 and made from any number of mats. The controller is designed to interface with the control circuit of the machine and includes two safety relays to help provide control redundancy.

The controller detects a presence on the mat, a short circuit, or an open circuit. Under each of these conditions, the safety output relays turn off. When interfaced properly, the machine or hazardous motion will receive a stop signal, and an auxiliary output relay turns ON.

The controller comes in two different package styles, a plastic case for surface or wall mounting, and a steel case for surface or wall mounting. Each style offers many of the same basic features. Each controller accepts power supplies of 24V AC/DC, and 110/230V AC. The plastic and steel-cased styles include reset buttons. The steel-cased controller offers extra protection against inadvertent impacts.

Alternatively, see the Product Selection table for safety relays that can also control and monitor safety mats.

Features

- Selectable voltage supply
- Auto/manual reset
- Four-wire system to detect opens and shorts
- Third party approval—AMTRI, TÜV

LED Indicators

Green	Power
Green	Auto Reset Mode
Green	Manual Reset Mode
Green	Machine Enabled

Specifications

Safety Ratings	
Standards	EN1760-1, EN 954-1, ISO13849-1, IEC/EN 60204-1, ANSI RIA R15.06, ANSI B11.19, AS 4024.5
Safety Classification	Cat. 3 per EN 954-1 (ISO 13849-1), SIL CL2 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: See website MTTFd: See website Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	24V AC/DC or 115/230V AC
Power Consumption	6 W, 9V A
Inputs	
Safety Inputs	Safety Mats
Reset	Monitored Manual or Automatic/Manual
Response Time	35 ms, Mat pressed to output open
Outputs	
Safety Contacts	2 N.O.
Auxiliary Contacts	1 N.C.
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	5 A fast acting (external)
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	10,000,000 operations
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	4000P: IP65 (NEMA 13); 4000S: IP62 (NEMA 12)/ IP20, DIN 0470
Operating Temperature [C (F)]	-10…+45 ° (14…113 °)
Vibration	0.15 mm, 10…55 Hz
Mounting	Surface (Wall) Mount
Weight [g (lbs)]	4000P: 880 (1.94); 4000S: 3200 (7.05)
Conductor Size, Max.	4000P, 4000S: 1 x 1.5 mm^2 (16 AWG), max.

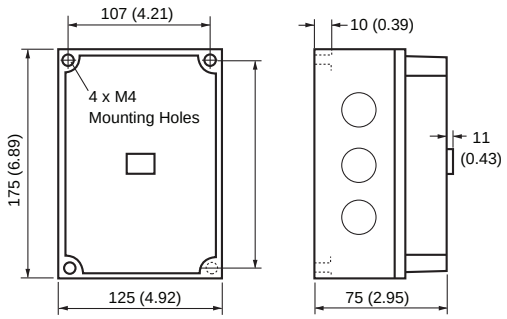
✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

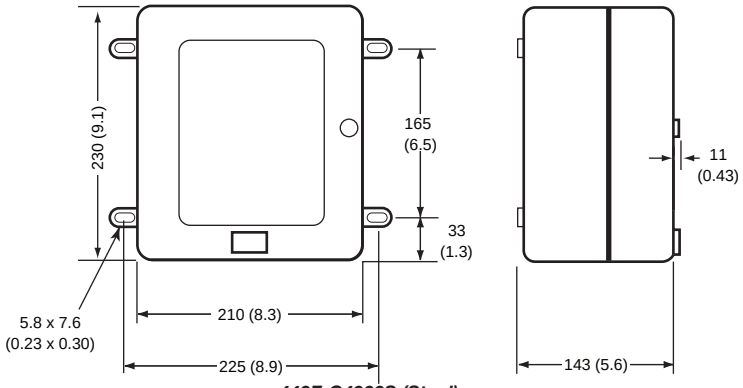
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
SM	2 N.O.	1 N.C.	NA	Monitored Manual or Automatic/Manual	24V AC/DC or 115/230V AC	440F-C4000P
						440F-C4000S

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

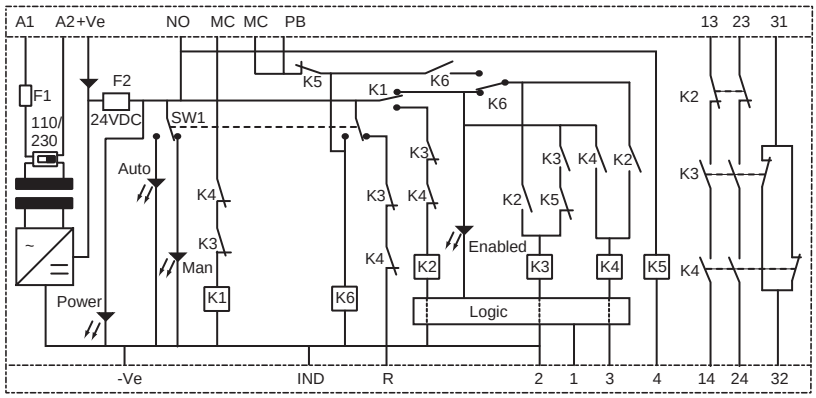


440F-C4000P (Polycarbonate)

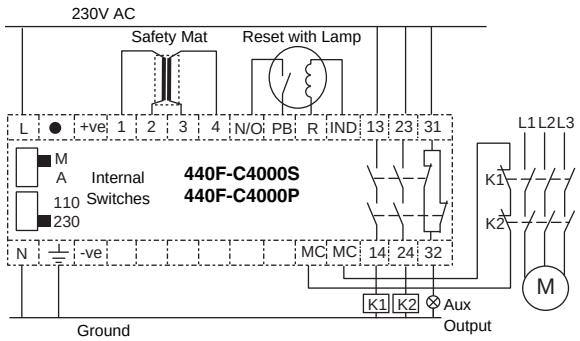


440F-C4000S (Steel)

Block Diagram



Typical Wiring Diagrams



MatGuard™ Mat Manager



Description

The Safety Mat Manager is designed to monitor multiple safety mats, each with its own connection. The Safety Mat Manager accepts up to eight individual mats with four-pin micro quick disconnect connectors.

The Safety Mat Manager provides an LED status indication for each of the mat connections. Since the LEDs indicate whether the mat is shorted or open, troubleshooting and replacement of a damaged mat within a mat system, is much quicker when compared to a traditional mat system where multiple mats are wired in series.

An internal switch allows for the setting of the reset to automatic/manual or monitored manual. When set to automatic/manual, the reset circuit can be jumpered, connected auxiliary contacts, or connected to an unmonitored manual reset by adding a momentary normally open switch in the monitoring loop. When set to monitored manual, the monitoring circuit must be closed and then opened to activate the outputs.

Stepping on any one of the mats deactivates the safety outputs. The outputs include two or six normally open safety rated outputs used to shut down the machine and one normally closed or normally open auxiliary output to indicate the status of the Mat Manager. The safety outputs have independent and redundant internal contacts to support the safety function.

Features

- Accepts up to eight individual mats
- Two or six safety output contacts
- One auxiliary output contact
- Automatic/manual or monitored manual reset

LED Indicators

Green	Power
Green	Machine Enabled
Green	Auto Reset Mode
Green	Manual Reset Mode
Mat Status:	
Green	Run Condition
Red	Stop Condition, Mat Pressed
Off	Not Used/Mat Disabled

Specifications

Safety Ratings	
Standards	EN 1760-1, EN 954-1, ISO 13849-1, IEC/EN 60204-1, ANSI RIA R15.06, ANSI B11.19, AS 4024.5, E 1760-1
Safety Classification	Cat. 3 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.59 x 10^{-9} MTTFd: > 290 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V AC/DC, 115/230V AC 50/60 Hz
Power Consumption	12 W or 9 VA
Inputs	
Safety Inputs	8, 4-Pin Micro-QD M12 Inputs (4 wire mats)
Input Resistance, Max.	500 Ω
Mat Size [mm (in.)]	100 m^2 (1076 ft^2) max.
Reset	Auto./Manual Monitored Manual
Power On Delay/ Recovery Time	3 s/48 ms
Response Time	35 ms
Outputs	
Safety Contacts	2 N.O. or 6 N.O.
Auxiliary Contacts	1 N.C. or 1 N.O.
Output Rating❄	B300, AC15, 4 A/250V AC; R300, DC13, 2 A/30V DC
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	External 6 A slow blow or 10 A fast acting
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	10,000,000 operations
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP65 (NEMA 13) steel with polycarbonate face plate/ —
Operating Temperature [C (F)]	-25…45° (-13…113°)
Vibration	0.15 mm, 10…55 Hz
Shock	10 g, 11 ms, half-sine
Mounting	Surface (Wall) Mount
Weight [g (lbs)]	3200 (7)
Conductor Size, Max.	0.2…2.5 mm^2 (24…14 AWG), max.

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

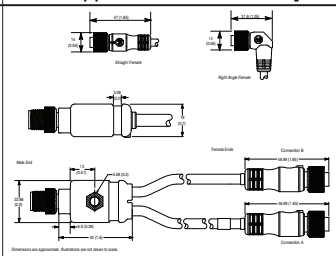
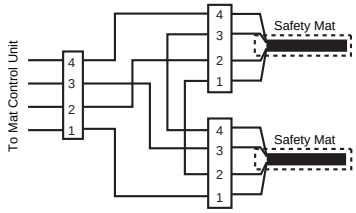
❄ Ratings vary due to output connectors. See installation instructions for details.

Product Selection

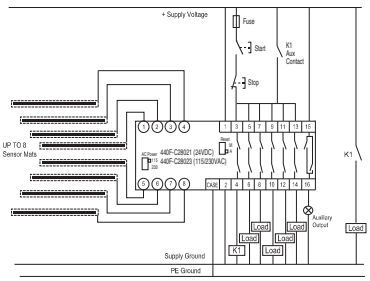
Safety Inputs	Safety Outputs	Aux. Outputs	Reset	Output Current	Connection Type	Power Supply	Cat. No.
8, 4-pin micro-QD M12 Inputs (4-wire mats)	2 N.O.	1 N.C.	Auto./Manual Monitored Manual	4 A	12-pin Brad Harrison	24V DC	440F-C28011
						115V or 230V AC	440F-C28012
					Terminal Strip	24V DC, 115V AC, or 230V AC	✶ 440F-C28013
	6 N.O.	1 N.O.		4 A	24-pin Harting	24V DC	440F-C28021
						115V or 230V AC	440F-C28023
8 Cable Grips	2 N.O.	1 N.C.		2 A	8-pin Lumberg M12 Micro	24V DC	✶ 440F-C28024
							440F-C28025
8, 4-pin micro-QD M12 Inputs (4-wire mats)	2 N.O.	1 N.C.		4 A	12-pin M23	24V DC	440F-C28026

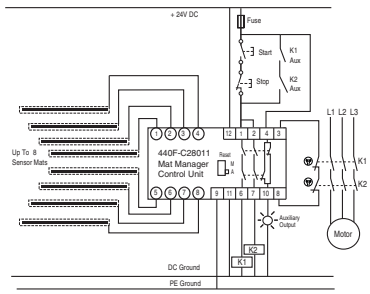
✶ Manual reset button located on front of unit.

Accessories

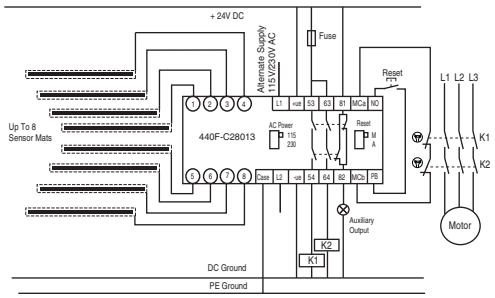
Description	Approximate Dimensions [mm (in.)]	Wiring	Cat. No.
Y-Cable			879D-F4ACDM-B0M3
Shorting Plug			440F-A28639
500 mA Fuse			440R-A31562
Fuse, 1 A—Bussman Cat. No. ETF-1			440R-A70972

Typical Wiring Diagram





Safety Mat System, Automatic Reset, Dual Channel Output, Output Monitoring



Safety Mat System, Monitored Manual Reset, Dual Channel Output, Output Monitoring

Safedge™ Controllers



Description

The Safedge controllers are designed to operate with the Safedge profiles. The controller continuously monitors the profile for actuation and generates an output signal when the profile is depressed.

The Safedge controller provides a low voltage to the profile. When the profile is pressed, the controller detects a change in resistance and turns off its output relays. When pressure is released from the profile, the output relays of the controller return to an on state. The controller has redundant voltage free positively-guided output relays, which can be used to interface with a machine control system.

The 251 controller comes capable of operating at 24V AC/DC, or 120/230V AC from separate terminals. An internal switch changes the operating voltage from 120V AC to 230V AC. The 252 controller operates at 24V AC/DC.

An auxiliary output relay is available to provide a signal about the controller's status. Three LEDs indicate whether the controller is in RUN, STOP or OPEN condition. The controller operates in manual or automatic reset mode.

Features

- One N.O. or two N.O. safety outputs
- One N.C. auxiliary output
- 24V AC/DC or 120/240V AC
- Output monitoring
- LED indicators for RUN, STOP, and OPEN
- Automatic/manual reset

LED Indicators

Green	Run
Yellow	Open Circuit
Red	Stop

Specifications

Safety Ratings	
Standards	EN1760-2, EN954-1, ISO 13849-1, AS 4024.5, EN 954-1, ANSI B11.19
Safety Classification	Cat. 3 per EN 954-1
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	251: 24V AC/DC or 115/230V AC 50/60 Hz; 252: 24V AC/DC 50/60 Hz
Power Consumption	251: < 6 VA 252: < 4 VA
Inputs	
Safety Inputs	Profile: 6 kΩ, 12V DC open circuit, 4V DC run condition Monitoring: 1 N.O.
Response Time	13 ms, max.
Outputs	
Safety Contacts	251: 2 N.O.; 252: 1 N.O.
Auxiliary Contacts	1 N.C.
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	4 A on AC, 2 A on DC (external)
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.3… 0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	251D, 252D: IP40 (NEMA 1); 251P: IP65 (NEMA 13)/ IP20 DIN 0470
Operating Temperature [C (F)]	-10…55° (-14…131°)
Vibration	0.15 mm, 10…55 Hz
Shock	10 g, 11 ms, half-sine
Mounting	Surface mount 35 mm or DIN Rail
Weight [g (lbs)]	251D: 450 (1.0) 252D: 181 (0.4) 251P: 650 (1.4)
Conductor Size, Max.	251D, 252D: 1 x 4 mm^2 (10 AWG) stranded, 1 x 4 mm^2 (10 AWG) solid 251P: 1 x 1.1 mm^2 (18 AWG) stranded, 1 x 1.5 mm^2 (16 AWG) solid

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

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Publication S117-CA001A-EN-P

Allen-Bradley
Guardmaster®

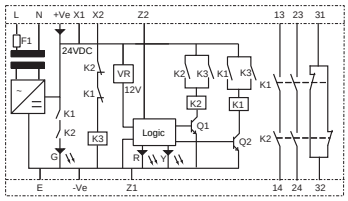
Product Selection

Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
Safedge	2 N.O.	1 N.C.	Fixed	Automatic/Manual	24V AC/DC or 115/230V AC	440F-C251D
	1 N.O.				24V AC/DC	440F-C252D
	2 N.O.				24V AC/DC or 115/230V AC	440F-C251P

Accessories

Description	Cat. No.
500 mA Fuse—Bussmann Cat. No. ETF-500 mA	440R-A31562
Fuse, 2 A—Bussmann Cat. No. ETF-2	440A-A09197

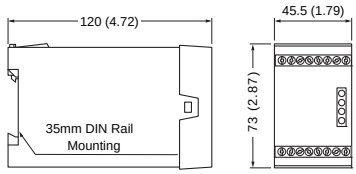
Block Diagram



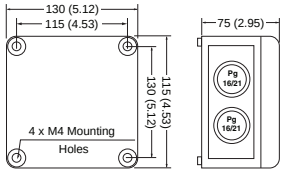
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

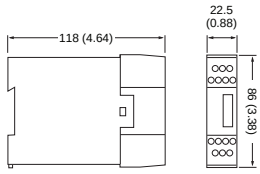
440F-C251D



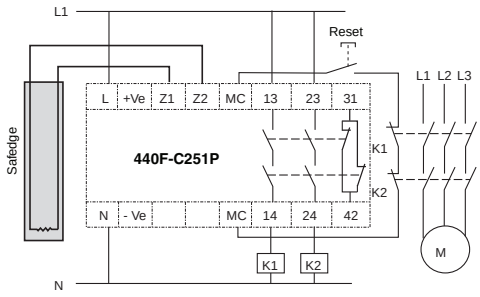
440F-C251P



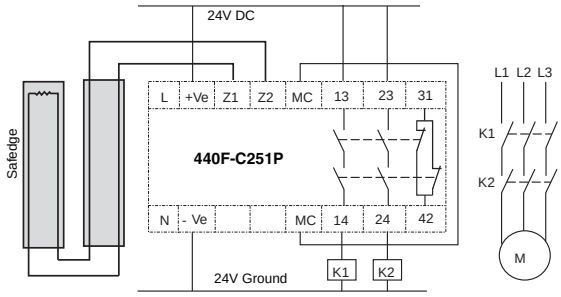
440F-C252D



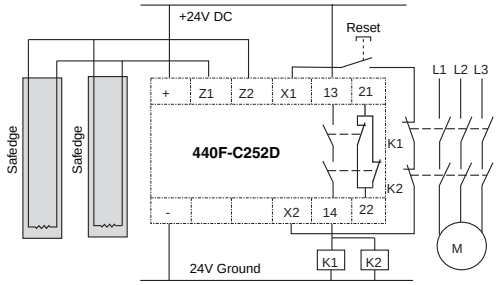
Typical Wiring Diagrams



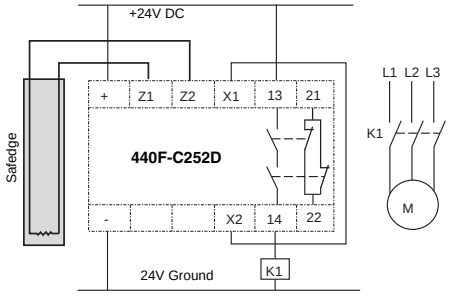
Series Terminated, Safedge Input, Manual Reset, Dual Channel Output, Monitored Output



Series Terminated, Cascaded, Safedge Input, Automatic Reset, Dual Channel Output, No Output Monitored



Parallel Terminated, Safedge Input, Manual Reset, Dual Channel Output, Monitored Output



Series Terminated, Safedge Input, Automatic Reset, Single Channel Output, No Output Monitored

Sipha Control Units



Description

With the increasing speed and complexity of applications a simple magnetic switch may be insufficient to meet the increased risks, therefore Sipha's design incorporates several magnetically sensitive elements which must be triggered in a particular sequence to operate correctly. The Sipha sensor, designed to operate with its own actuator, helps prevent defeatability by a simple magnet.

The control unit is available in three types. The Sipha 1 control unit operates on 24V AC/DC and offers one normally open safety output and one normally closed solid-state auxiliary output. The Sipha 2 control unit operates on either 24V AC/DC, 110V AC or 230V AC and offers two normally open safety outputs and one normally closed auxiliary output. The Sipha 6 has wiring terminals for up to six sensors, a delayed output for Category 1 stops and offers the same wide range of power supply capability as the Sipha 2 control unit. Between two and six Sipha sensors can be directly connected to the Sipha 6 control unit. An internal DIP switch mutes the unused connections to sensors 1, 2, 3 and 4. This allows for individual monitoring to each interlock and provides enhanced safety integrity when compared to six interlocks running off a single Sipha 2 control unit.

The Sipha control units are designed to operate with the Sipha sensors and actuators. The controllers have automatic reset.

Features

- Noncontact actuation
- Magnetic coded sensing
- Control unit acts as safety relay
- Four types of switches

LED Indicators

Green LED	Power on
Green LED	Output Closed

Application Details

See Sipha Sensors for details.

Specifications

Safety Ratings	
Standards	EN954-1, ISO13849-1, IEC/EN60204-1, NFPA79, EN1088, ISO14119, IEC/EN60947-5-1, ANSI B11.19, AS4024.1
Safety Classification	Sipha 1 & 2: Cat. 3 per EN954-1 Sipha 6: Cat. 4 per EN954-1
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	Sipha 1: 24V AC/DC; Sipha 2 & 6: 24V AC/DC and 115/230V AC
Power Consumption	Sipha 1: <2VA Sipha 2 & 6: <4VA
Inputs	
Safety Inputs	Sipha 1: 1 N.C. & 1 N.O. Sipha 2 & 6: 6 x (1 N.C. & 1 N.O.)
Input Resistance, Max.	Terminals 1…4: 200 Ω Terminals 2…3: 150 Ω
Outputs	
Safety Contacts	Sipha 1: 1 N.O. Sipha 2: 2 N.O. Sipha 6: 2 N.O. + 1 N.O. Delayed (0.6…30 sec.)
Auxiliary Contacts	1 N.C.
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	External 5 A quick blow AC, 3 A quick blow DC
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	2,000,000 operations
Environmental and Physical Characteristics	
Operating Temperature [C (F)]	-10…+55° (+14…+131°)
Vibration	1 mm, 10…55 Hz
Shock	30 g, 11 ms half-sine
Mounting	35 mm DIN Rail
Weight [g (lbs)]	Sipha 1: 140 (0.31) Sipha 2: 410 (0.90) Sipha 6: 675 (1.49)
Conductor Size, Max.	0.2…2.5 mm² (24…14 AWG)

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

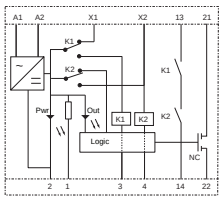
Housing	Supply Voltage	Safety Contacts	Auxiliary Contacts	Housing	Type	Cat. No.
	24V AC/DC	1 N.O.	1 N.C. Solid State	22.5 mm	Control Unit 1	440N-S32013
	24V AC/DC; 115/230V AC	2 N.O.	1 N.C.	45 mm	Control Unit 2	440N-S32021
	24V AC/DC; 115/230V AC	3 N.O. 1 N.O. Delayed	1 N.C.	90 mm	Sipha 6	440N-S32052

Accessories

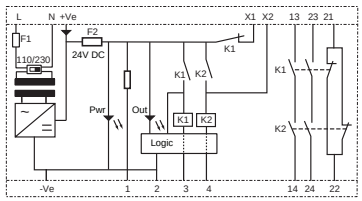
Description	Cat. No.
Replacement Fuse, 500 mA	440R-A31562

Block Diagrams

Sipha 1



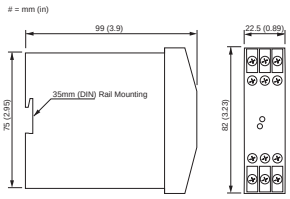
Sipha 2



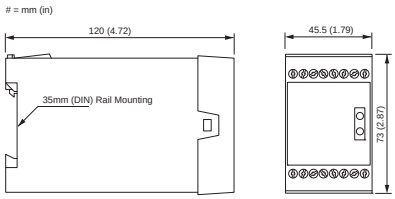
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

Sipha Control Unit Type 1



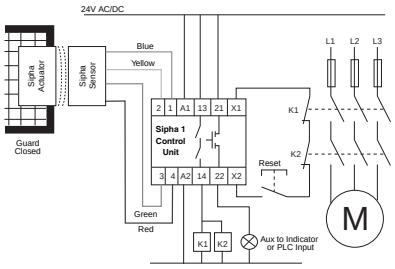
Sipha Control Unit Type 2



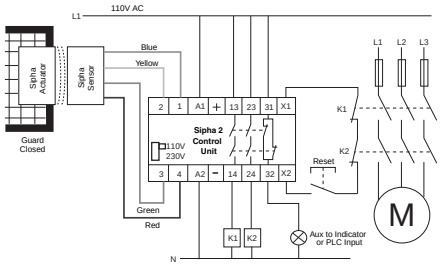
Sipha 6 Control Unit



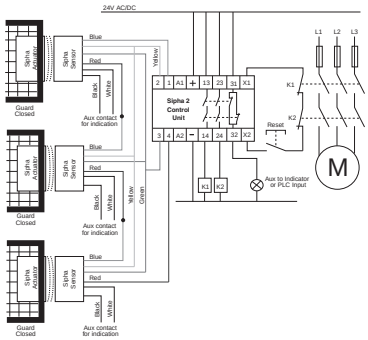
Typical Wiring Diagrams



Single Sipha Sensor, 24V Supply, Dual Channel Output, Manual Reset, Monitored Output



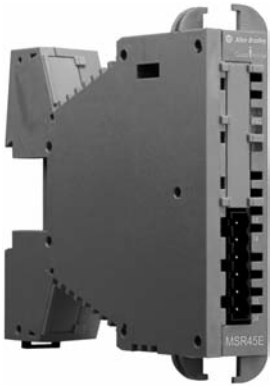
Single Sipha Sensor, 110V Supply, Dual Channel Output, Manual Reset, Monitored Output



Multiple Sipha Sensor, Manual Reset, Dual Channel Output, Monitored Output

Expansion Safety Relays

MSR45E



Description

The MSR45E is a safety relay expansion module for the MSR41/MSR42 (MSR4x) multi-function safety controller. The MSR45E comes in 22.5 mm DIN housing and is designed to easily connect to the MSR4x. The MSR45E safety relay expansion module is a Category 4 module with externally monitored contactors via the MSR4x. Interconnecting these devices is as simple as plugging ribbon-cable connectors to the back of each module. Up to three MSR45E safety relay expansion modules may be interconnected to an MSR4x. The ribbon-cable connectors must be ordered separately based on the number of MSR45E units that are attached to the MSR4x.

Features

- Category 4 per EN 954-1
- SIL CL3 per IEC 61508
- Stop category 0 or 1
- Two safety contacts N.O.

LED Indicators

Green	K1 Closed
Green	K2 Closed

Specifications

Safety Ratings	
Standards	EN 954-1, IEC/EN 60204-1, IEC 61496-1
Safety Classification	Cat. 4 per EN 954-1, SIL CL3 per EN IEC 61508
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.0E-10 MTTFd: > 206 years For use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, and TÜV
Power Supply	
Input Power Entry	24V DC from MSR41 or MSR42
Power Consumption	1.5 W
Inputs	
Reset	Determined by MSR41 or MSR42
Power On Delay/ Recovery Time	<35 ms/ Determined by configuration
Response Time	Determined by configuration
Outputs	
Safety Contacts	2 N.O.
Auxiliary Contacts	—
Thermal Current/I_{th}	1 x 8 A or 2 x 6 A nonswitching
Rated Impulse withstand Voltage/I_{th}	—
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	External 6 A slow blow or 10 A fast acting
Mechanical Life	10,000,000 operations
Utilization Category	
Inductive: AC-15	3 A @ 250V AC
Inductive: DC-13	6 A @ 24V DC
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP20/ IP20
Operating Temperature [C (F)]	0…55° (32…131°)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	150 (0.33)
Conductor Size, Max.	1 x 2.5 mm^2 (14 AWG) stranded

✶ Usable for IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

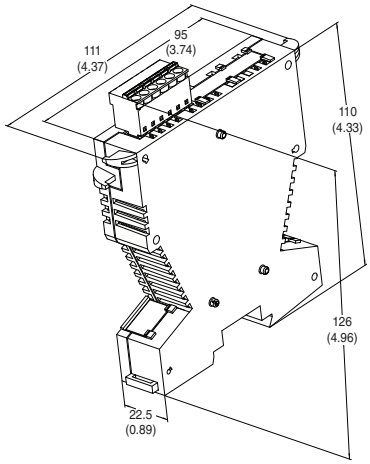
Inputs	Safety Outputs	Auxiliary Outputs	Time Delay	Terminals	Reset Type	Power Supply	Cat. No.
MSR4x base module	2	—	Software configurable thorugh MSR4x	Removable	MSR4x base module defines reset type	24V DC from the base unit	**440R-P4NANS**

Accessories

Description	Cat. No.
Ribbon cable—for one MSR45E	**440R-ACABL1**
Ribbon cable—for two MSR45Es	440R-ACABL2
Ribbon cable—for three MSR45Es	440R-ACABL3
Replacement terminal block kit—MSR45E	440R-ATERM2C

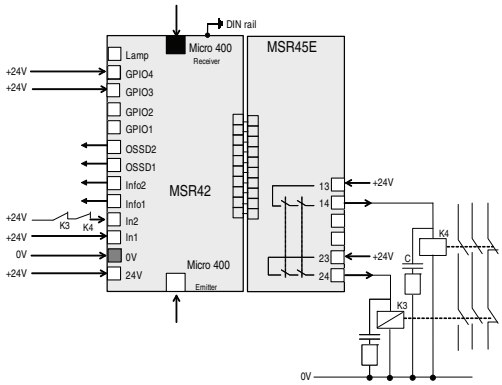
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



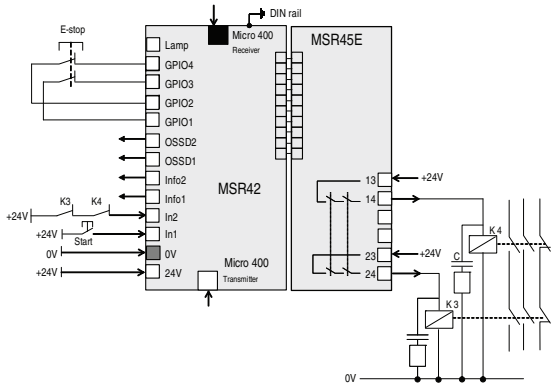
Typical Wiring Diagrams

Hardware Configuration



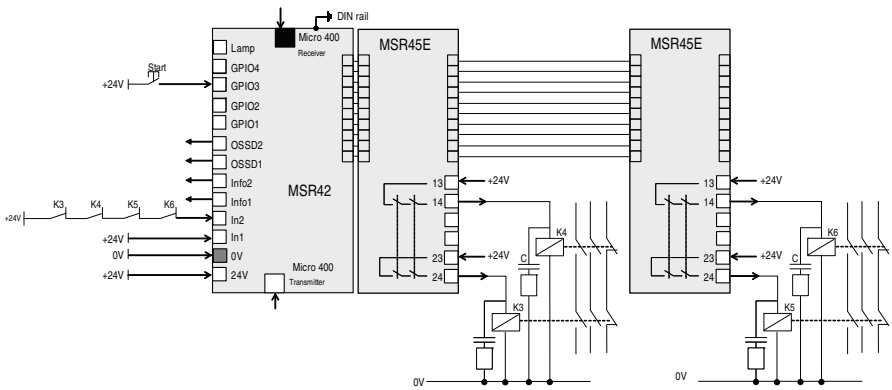
Micro 400, Automatic Reset, Start/Restart Monitored Output

Software Configuration



Micro 400 Light Curtain, E-Stop, Manual Reset, Start/Restart Monitored Output

Hardware Configuration



Micro 400 Light Curtain, Manual Reset, Start/Restart Monitored Output

Expansion Safety Relays with Delayed Outputs

MSR132E



Description

The Minotaur MSR132E is a monitoring safety expansion relay unit with single or dual channel input and either immediate or timed off-delay outputs. It is designed to be operated as an “extension” of a “master” safety relay. When wired properly, the outputs of the MSR132E will mimic the outputs of the master relay.

The outputs include four normally open safety rated outputs used to shut down the manufacturing system and two normally closed auxiliary outputs to indicate status of the MSR132E. One additional normally closed output is available to allow the host relay to monitor the status of the MSR132E. The safety, auxiliary and monitoring outputs have independent and redundant internal contacts to support the safety function.

A delayed output version is also available (MSR132ED) that have off-delayed outputs with a fixed time without the need for an auxiliary supply during the off-delay time.

Features

- Category 4/3 per EN 954-1
- Stop Category 0 or 1
- Four safety contacts N.O.
- Two auxiliary contacts N.C.
- One monitoring contact N.C.
- Single channel input

LED Indicators

Green	K1 Closed
Green	K2 Closed

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-5-1, ANSI B11.19, AS 4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 0.46 x 10^{-9} MTTFd: > 417 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and BG	
Power Supply		
Input Power Entry	24V AC/DC 50/60 Hz or 24V DC 0.8…1.1	
Power Consumption	1.5 W	
Inputs		
Safety Inputs	1 N.C. or 2 N.C.	
Reset	Automatic	
Power On Delay/ Recovery Time	100 ms/100 ms	
Response Time	50 ms	
Outputs		
Safety Contacts	4 N.O.	
Auxiliary Contacts	2 N.C.	
Thermal Current/I_{th}	2 x 6 A or 3 x 5 A or 4 x 4 A nonswitching	
Rated Impulse withstand Voltage/I_{th}	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 1…0.1 M 250V AC/2 A/500VA cosϕ = 1…0.5 M 250V AC/4 A/1000VA cosϕ = 0.35…0.3 M 250V AC/1.5 A/1000VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 operations	
Utilization Category		
Resistive: AC-1	6 A @ 250V AC	
Resistive: DC-1	3 A @ 24V DC	
Inductive: AC-15	6 A @ 250V AC	6 A @ 125V AC
Inductive: DC-13	3 A @ 24V DC	
UL:	B300, R300, 6 A/250V AC, 3 A/24V DC	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1), DIN 0470/ IP20, DIN 0470	
Operating Temperature [C (F)]	-5…55° (23…131°)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	215 (0.474)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Expansion Safety Relays with Delayed Outputs

MSR132E

Product Selection

Inputs	Safety Outputs	Auxiliary Outputs	Time Delay	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C. or 2 N.C.	4 N.O.	2 N.C.	0 s	Fixed	Automatic	24V AC/DC	440R-E23191✶
			0.5 s			24V DC	440R-E23192
			1 s				440R-E23193
			2 s				440R-E23194
			3 s				440R-E23195
			0 s	Removable		24V AC/DC	440R-E23097✶
			0.5 s			24V DC	440R-E23159
			1 s				440R-E23160
			2 s				440R-E23098
			3 s				440R-E23161
			4 s				440R-E23162❄

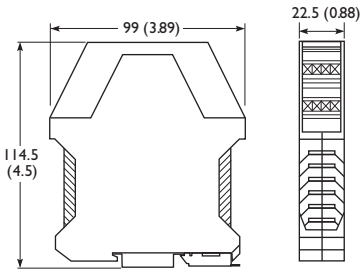
✶ Cat. 4 rated.
❄ 45 mm wide housing.

Accessories

Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

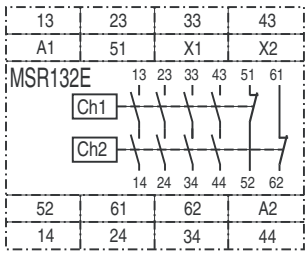
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

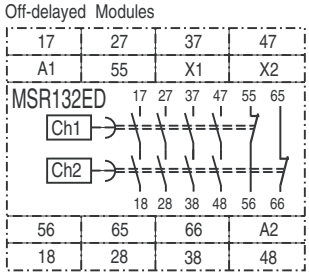


Block Diagram

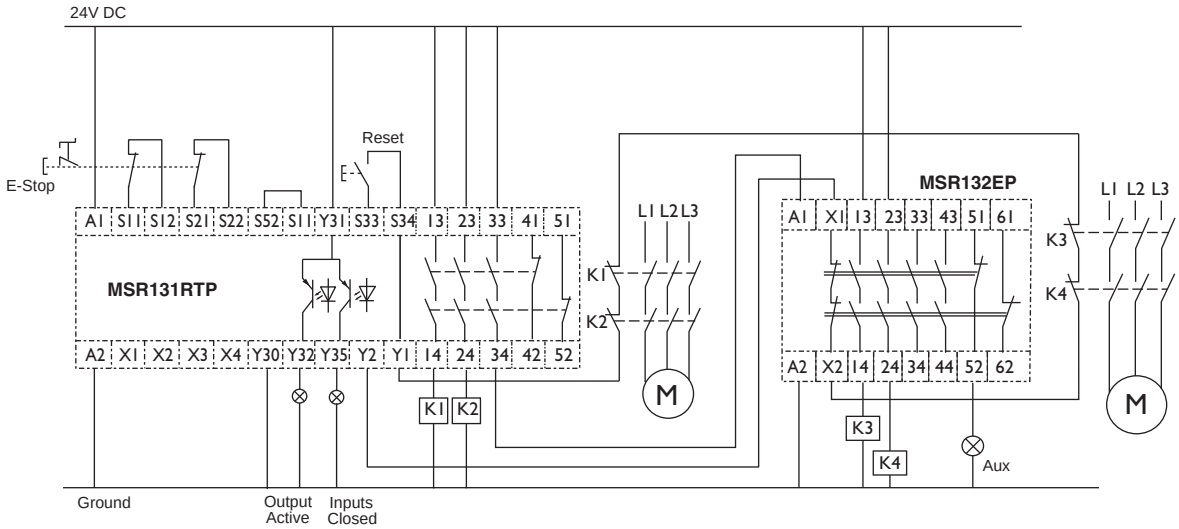
Standard Module



Off-delayed Modules



Typical Wiring Diagrams



Dual Channel E-Stop, Monitored Manual Reset, Dual Channel Output, Single Channel Delayed Expansion, Monitored Output

Modular Safety Relays

Module Selection

Input Module Selection

To determine the base module and input modules needed, start on the left side and count down the number of OSSD input devices you have to connect to the system. Then move to the right according to the number of non-OSSD input devices you need, such as 1 N.C. or 2 N.C. input devices. Count the modules and this will be your total required for the system.

# of OSSD Inputs \ # of non-OSSD Devices	0	1 2	3 4	5 6	7 8	9 10	11 12	13 14	15 16	17 18	19 20	21 22
0		**MSR210**	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220
1 2	**MSR211**	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	
3 4	MSR221	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220		
5 6	MSR221	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220			
7 8	MSR221	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220				
9 10	MSR221	MSR220	MSR220	MSR220	MSR220	MSR220	MSR220					
11 12	MSR221	MSR220	MSR220	MSR220	MSR220	MSR220						
13 14	MSR221	MSR220	MSR220	MSR220	MSR220							
15 16	MSR221	MSR220	MSR220	MSR220								
17 18	MSR221	MSR220	MSR220									
19 20	MSR221	MSR220										
21 22	MSR221											

Example 1: 7 OSSD inputs and 5 non-OSSD inputs required.
Solution: MSR211, 3 MSR221, and 3 MSR220.

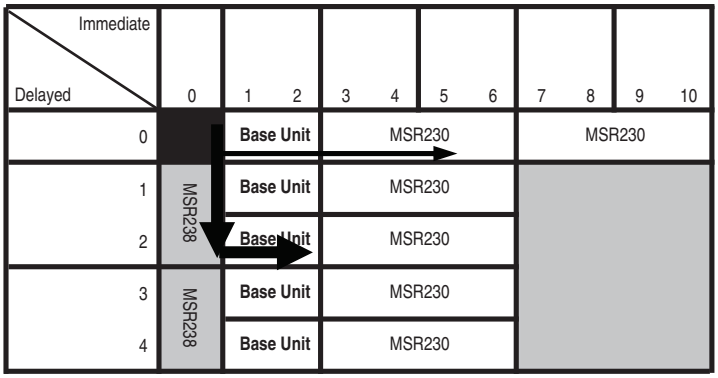
Example 2: 9 non-OSSD inputs required.
Solution: 1 MSR210 Base, 4 MSR220.

Note: This selection chart assumes that **if** you have OSSD input devices, they will be connected to the base module. If you do **not** want this, then change the MSR211 to the MSR210 and change one MSR220 to an MSR221. This will provide you the same system, but now the OSSD input device will not be on the base module.

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Publication S117-CA001A-EN-P

Output Module Selection

Start at the top left and count the number of delayed outputs required. Then count across the number of immediate outputs required. Ensure you only have a total of two output modules total.



Example 1: 2 Delayed outputs and 2 Immediate outputs

Solution: (black lines) One MSR238, 2 Immediate outputs built in the base module

Example 2: 5 Immediate outputs required

Solution: (red line) 1 MSR230 Output module and 2 immediate outputs built into base module

Note: The base module has two N.O. safety outputs built in.

Modular Safety Relays

MSR210P



Description

The MSR210P forms one of the base units for the modular Minotaur MSR200 family of monitoring safety relays. It can be combined with other modules of the MSR200 Series to configure a safety control system with numbers of inputs and outputs matching users' specific application requirements, as well as diagnostic and networking capabilities. Up to ten input modules and two output modules can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The terminators must be inserted into the final input and output modules.

The MSR210P has two inputs. Each input can be wired in one of four ways: one normally closed, two normally closed, three normally closed, safety mat connections. The MSR210P uses pulsed input monitoring to check for faults to power, ground or between inputs before a demand is placed on the safety system. Connecting a single device (must be at least dual channel) to each input meets the requirements of Category 4 per EN 954-1.

The MSR210P has the capability to perform external device monitoring (EDM). The EDM capability works in conjunction with the reset option. The user selects EDM and the reset function by jumpers across terminals Y40, Y41 and Y42.

The MSR210P has two semiconductor outputs designed to send status information to a PLC. Terminal Y33 indicates the inputs are closed (the ready LED is on). Terminal Y32 indicates the outputs are active.

The outputs include two normally open safety rated outputs and one normally closed auxiliary output.

Features

- Category 4 per EN 954-1
- Stop category 0
- Pulsed input monitoring
- Two input circuits: safety gate, E-stop or safety mat
- Up to 22 diverse input devices
- Two safety outputs, three auxiliary outputs
- Ten diagnostic LEDs
- Removable terminals

LED Indicators

Green	Input 1 Closed
Red	Input 1 Open
Green	Input 2 Closed
Red	Input 2 Open
Green	CH1 Output Active
Green	CH2 Output Active
Green	Power
Green	Run (Outputs Active)
Red	Stop (Outputs Off) + Diagnostics
Amber	Ready (Inputs Closed)

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI 11.19, AS 4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.44 x 10^{-9} MTTFd: > 203 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV	
Power Supply		
Input Power Entry	24V DC 0.8…1.1 x rated voltage	
Power Consumption	8 W	
Inputs		
Safety Inputs	1 N.C., 2 N.C., 3 N.C., or SM	
Input Simultaneity	Infinite	
Input Resistance, Max.	Inputs: 900 Ω Reset: 3200 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay/ Recovery Time	3 seconds/ 40…145 ms, depending on expansion modules used	
Response Time	MSR210: 29 ms MSR210 + Input Exp. Mod.: 34 ms + 6 ms/module	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C., 2 PNP	
Thermal Current I_{th}	1 x 6 A or 2 x 4 A (nonswitching)	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V DC	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Solid State Output Rating	20 mA @ 30V DC short-circuit protection	
Electrical Life (Operations)	(With surge suppression) 250V AC/6 A/1500VA cosϕ = 1…0.1 M 250V AC/2 A/500VA cosϕ = 1…0.5 M 250V AC/4 A/1000VA cosϕ = 0.35…0.3 M 250V AC/1.5 A/1000VA cosϕ = 0.6…0.1 M 24V DC/2 A/48 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 cycles	
Utilization Category		
Inductive: AC-15	3 A @ 250V AC	3 A @ 125V AC
Inductive: DC-13	2.5 A @ 24V DC	
UL	1 x B300, R300, or 2 x C300 1 x 6 A or 2 x 4 A Resistive	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	45 mm housing, 35 mm DIN Rail	
Weight [g (lb)]	280 (0.62)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

Inputs	Safety Outputs	Auxiliary Outputs	Solid State Outputs	Terminals	Reset Type	Power Supply	Cat. No.
Two independent inputs; 2 x 1 N.C., 2 N.C., 3 N.C., or Safety Mat	2 N.O.	1 N.C. and 2 PNP Solid State	2 PNP	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	440R-H23176

Accessories

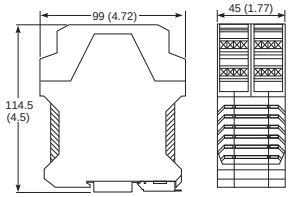
Description	Cat. No.
MSR200, Two Terminators	440R-A17138
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Diagnostics—Red Stop LED Blinks

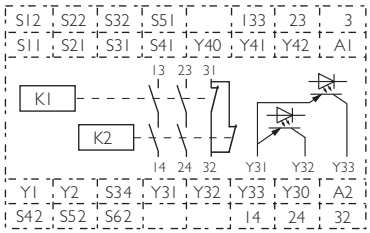
Blink Rate	Description
2	Change in Y40/Y41/Y42 circuit during operation.
3	Fault in external feedback circuit Y1-Y2. Clear fault and cycle power to reset the module.
Continuous	Internal fault in base or expansion module.

Approximate Dimensions

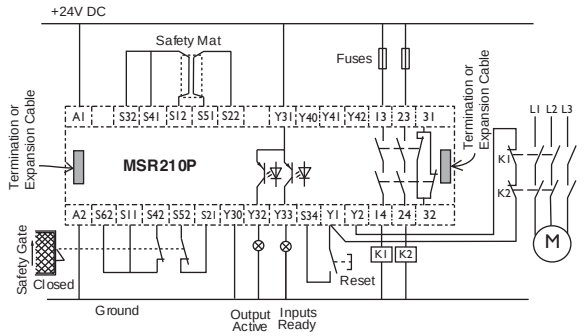
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



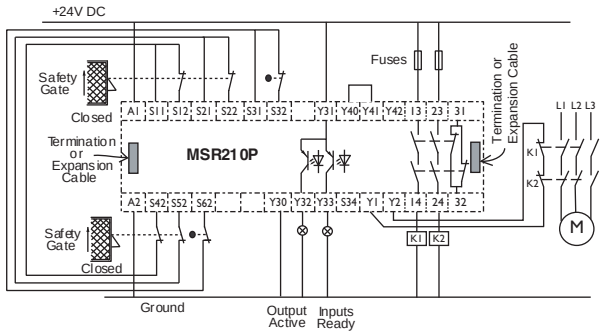
Block Diagram



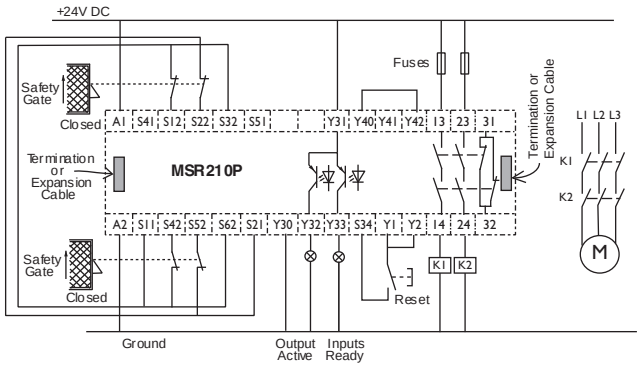
Typical Wiring Diagrams



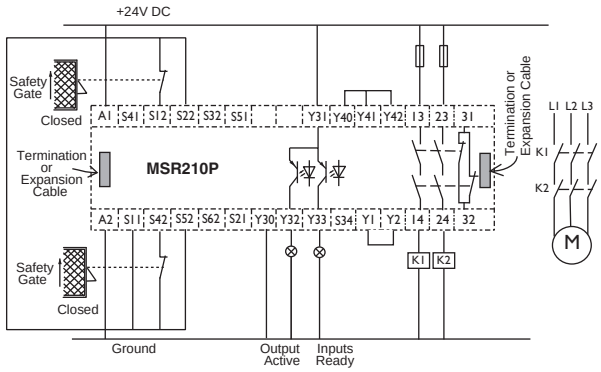
Safety Mat and Dual Channel Safety Gate, Monitored Manual Reset, Monitored Output



Two Triple Channel Inputs, Automatic Reset, Monitored Output



Two Dual Channel Safety Gates, Monitored Manual Reset, No Monitored Output



Two Single Channel Safety Gates, Automatic Reset, No Monitored Output

Modular Safety Relays

MSR211P



Description

The MSR211P forms one of the base units for the modular Minotaur MSR200 family of monitoring safety relays. It can be combined with other modules of the MSR200 Series to configure a safety control system with numbers of inputs and outputs matching users' specific application requirements, as well as diagnostic and networking capabilities. Up to ten input modules and two output modules can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The terminators must be inserted into the final input and output modules.

The MSR211P has two inputs. Each input can be wired in one of three ways: one normally closed, two normally closed, or two OSSD connections from a light curtain. The MSR211P does not perform cross fault monitoring, and would not detect a short across the inputs of a two normally closed input. When connected to light curtains, the light curtain must perform the cross fault detection.

The MSR211P has the capability to perform external device monitoring (EDM). The EDM capability works in conjunction with the reset option. The user selects EDM and the reset function by jumpers across terminals Y40, Y41 and Y42.

The MSR211P has two semiconductor outputs designed to send status information to a PLC. Terminal Y33 indicates the inputs are closed (the ready LED is on). Terminal Y32 indicates the outputs are active.

The outputs include two normally open safety rated outputs and one normally closed auxiliary output.

Features

- Category 4 per EN 954-1
- Stop category 0
- Two input circuits: light curtain, safety gate, or E-stop inputs
- Two safety outputs, three auxiliary outputs
- Ten diagnostic LEDs
- Monitored or automatic reset
- Removable terminals

LED Indicators

Green	Input 1 Closed
Red	Input 1 Open
Green	Input 2 Closed
Red	Input 2 Open
Green	CH1 Output Active
Green	CH2 Output Active
Green	Power
Green	Run (Outputs Active)
Red	Stop (Outputs Off) + Diagnostics
Amber	Ready (Inputs Closed)

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI 11.19, AS 4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.49 x 10^{-9} MTTFd: > 188 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV	
Power Supply		
Input Power Entry	24V DC 0.8…1.1 x rated voltage	
Power Consumption	8 W	
Inputs		
Safety Inputs	Two Inputs 1 N.C. or 2 N.C. or LC	
Input Simultaneity	Infinite	
Input Resistance, Max.	Inputs: 900 Ω Reset: 3200 Ω	
Reset	Auto./Manual or Monitored Manual	
Power On Delay/ Recovery Time	3 seconds/40…145 ms, depending on expansion modules used	
Response Time	MSR211: 25 ms MSR211+ MSR221.: 30 ms+2.4 ms per MSR221	
Outputs		
Safety Contacts	2 N.O.	
Auxiliary Contacts	1 N.C., 2 PNP	
Thermal Current/$_{Ith}$	1 x 6 A or 2 x 4 A (nonswitching)	
Rated Impulse withstand Voltage/$_{Ith}$	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V DC	
Fuses, Output	External 6 A slow blow or 10 A quick blow	
Solid State Output Rating	20 mA @ 30V DC short-circuit protection	
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 cycles	
Utilization Category		
Resistive: AC-1	6 A @ 250V AC	
Resistive: DC-1	6 A @ 24V DC	
Inductive: AC-15	3 A @ 250V AC B300	3 A @ 125V AC
Inductive: DC-13	2.5 A @ 24V DC	
UL	1 x B300, R300 or 2 x C300 1 x 6 A or 2 x 4 A Resistive	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	280 (0.62)	
Conductor Size, Max.	0.2…4 mm² (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

Inputs	Safety Outputs	Auxiliary Outputs	Solid State Outputs	Terminals	Reset Type	Power Supply	Cat. No.
Two independent inputs; 2 x 1 N.C., 2 N.C., or Light Curtain	2 N.O.	1 N.C.	2 PNP	Removable	Auto./Manual or Monitored Manual	24V DC from the base unit	440R-H23177

Accessories

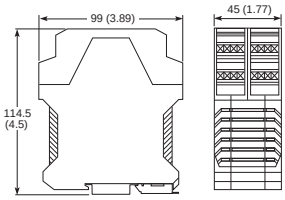
Description	Cat. No.
MSR200, Two Terminators	440R-A17138
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Diagnostics—Red Stop LED Blinks

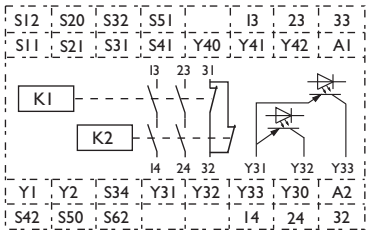
Blink Rate	Description
2	Change in Y40/Y41/Y42 circuit during operation.
3	Fault in external feedback circuit Y1-Y2. Clear fault and cycle power to reset the module.
Continuous	Internal fault in base or expansion module.

Approximate Dimensions

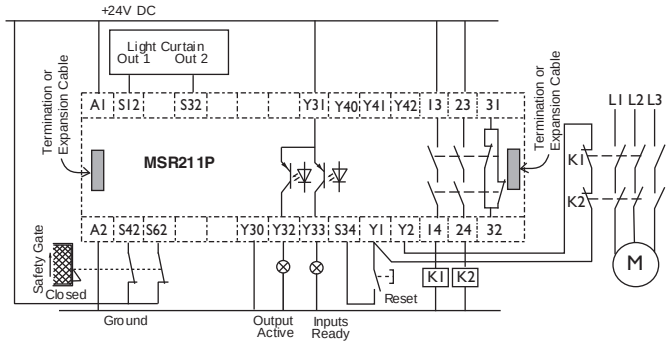
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



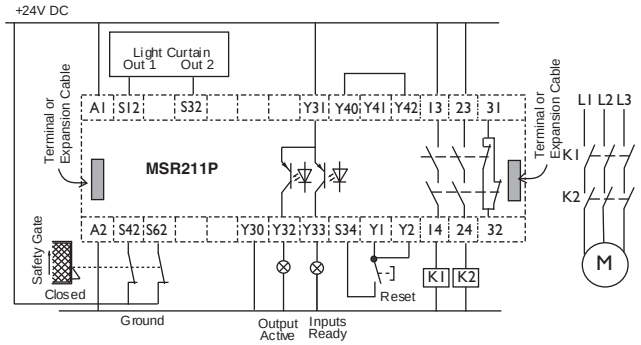
Block Diagram



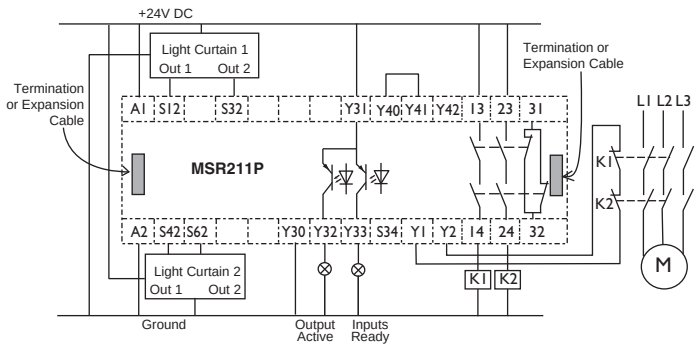
Typical Wiring Diagrams



Light Curtain and Dual Channel Safety Gate, Monitored Manual Reset, Monitored Output



Light Curtain and Dual Channel Safety Gate, Monitored Manual Reset, No Monitored Output



Two Light Curtains, Automatic Reset, Monitored Output

Modular Safety Relays

MSR220P



Description

The MSR220P is an input expansion module for the modular Minotaur MSR200 family of monitoring safety relays. It can be connected to either the MSR210P or MSR211P to provide additional inputs.

Up to ten input modules can be connected to a base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The connecting ribbon cable provides power to the MSR220P as well as a check on its status. The terminators must be inserted into the final output module. The input modules to a base unit can be either MSR220P or MSR221P in any combination or order.

The MSR220P has two independent inputs, which can be wired in one of five ways: one normally closed, two normally closed, three normally closed, one normally closed and one normally open or a safety mat. When used with the MSR210 base unit, the inputs to the MSR220 are continuously pulse-checked for shorts to power, ground and across inputs. Connecting a single device (must be at least dual channel) to each input meets the requirements of Category 4 per EN 594-1.

Four LEDs provide status information on the inputs. Green indicates the input is closed and red indicates the input is open.

Features

- Category 4 per EN 954-1
- Stop category 0
- 17.5 mm DIN Rail housing
- Two input circuits: safety gate, E-stop or safety mat
- Four diagnostic LEDs
- Removable terminals

LED Indicators

Green	Input 1 Closed
Red	Input 1 Open
Green	Input 2 Closed
Red	Input 2 Open

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI 11.19, AS4024.1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.7 x 10^{-10} MTTFd: > 825 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and BG
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	2 W
Inputs	
Safety Inputs	1 N.C. or 2 N.C. or 3 N.C. or 1 N.C. + 1 N.O. or SM
Input Simultaneity	Infinite
Input Resistance, Max.	900 Ω
Reset	See base unit
Power On Delay/ Recovery Time	See base unit
Response Time	See base unit
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	17.5 mm housing, 35 mm DIN Rail
Weight [g (lbs)]	90 (0.20)
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

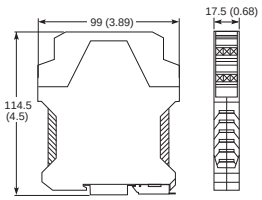
Inputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
Two Independent Inputs: 1 N.C., 2 N.C., 3 N.C., 1 N.C. + 1 N.O., or SM	—	Removable	—	24V DC	440R-H23178

Accessories

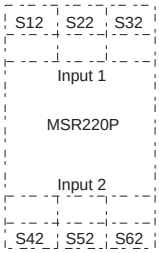
Description	Cat. No.
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

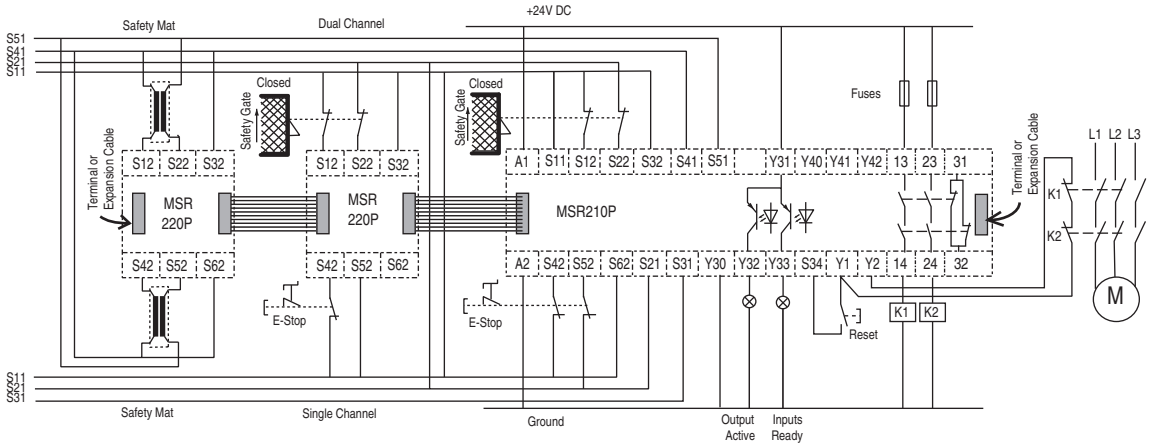
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



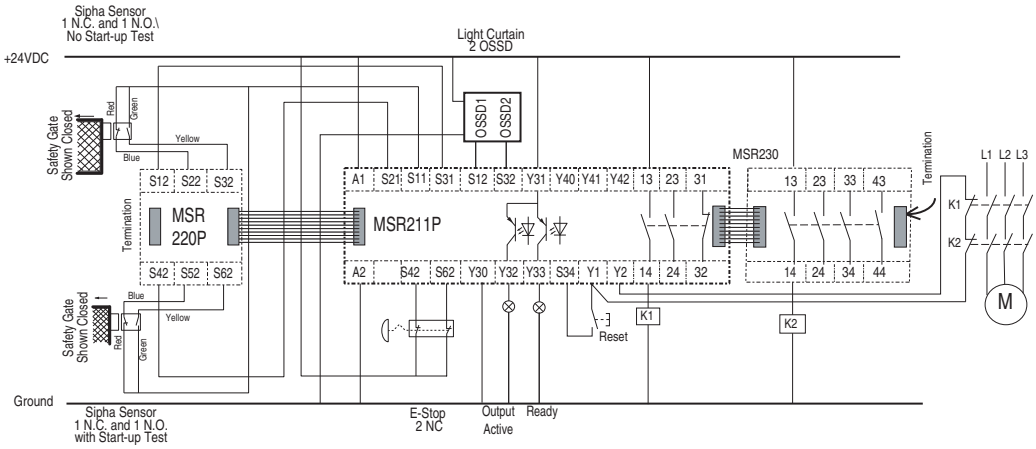
Block Diagram



Typical Wiring Diagrams



MSR220P Expanding an MSR210P



MSR220P Expanding an MSR211P

Modular Safety Relays

MSR221P



Description

The MSR221P is an input expansion module for the modular Minotaur MSR200 family of monitoring safety relays. It can be connected to either the MSR210P or MSR211P to provide additional inputs.

Up to ten input modules can be connected to a base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The connecting ribbon cable provides power to the MSR220P as well as a check on its status. The terminators must be inserted into the final output module. The input modules to a base unit can be either MSR220P or MSR221P in any combination or order.

The MSR221P has two independent inputs, which can be wired in one of three ways: one normally closed, two normally closed, or a light curtain. When connected in the two normally closed configuration, the MSR221P does not perform cross fault monitoring (i.e., checks for shorts between the two inputs).

Four LEDs provide status information on the inputs. Green indicates the input is closed and red indicates the input is open.

Features

- 17.5 mm DIN Rail housing
- Two input circuits: gate, E-stop or light curtains
- Four diagnostic LEDs
- Removable terminals

LED Indicators

Green	Input 1 Closed
Red	Input 1 Open
Green	Input 2 Closed
Red	Input 2 Open

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISOTR 121100, ISO 13849-1 (EN 954-1), B11.19, AS 4024.1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.7 x 10^{-10} MTTFd: > 825 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	2 W
Inputs	
Safety Inputs	1 N.C. or 2 N.C. or LC
Input Simultaneity	Infinite
Input Resistance, Max.	1300 Ω
Reset	See base unit
Power On Delay/ Recovery Time	See base unit
Response Time	See base unit
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	90 (0.20)
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

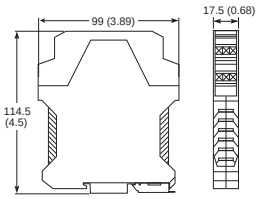
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
Two Independent Inputs: 1 N.C., 2 N.C., or LC	—	—	Removable	—	24V DC from the base unit	440R-H23179

Accessories

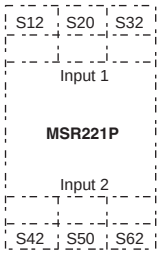
Description	Cat. No.
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

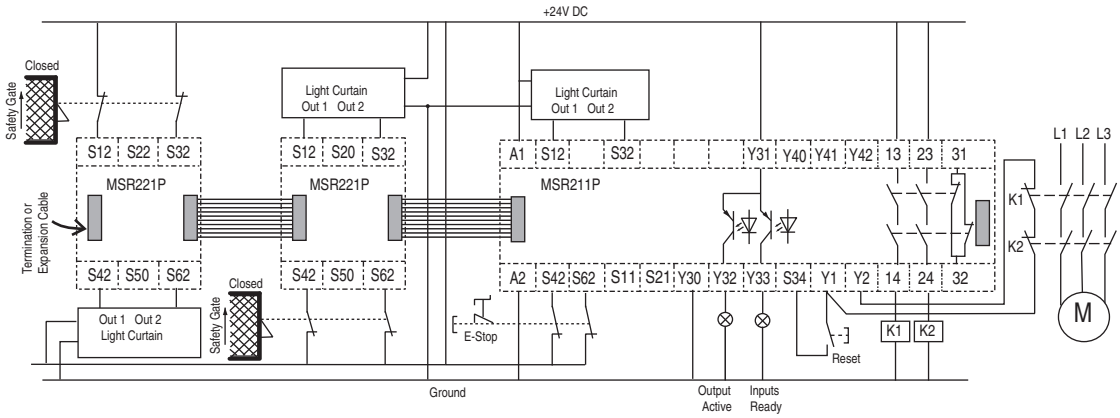
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



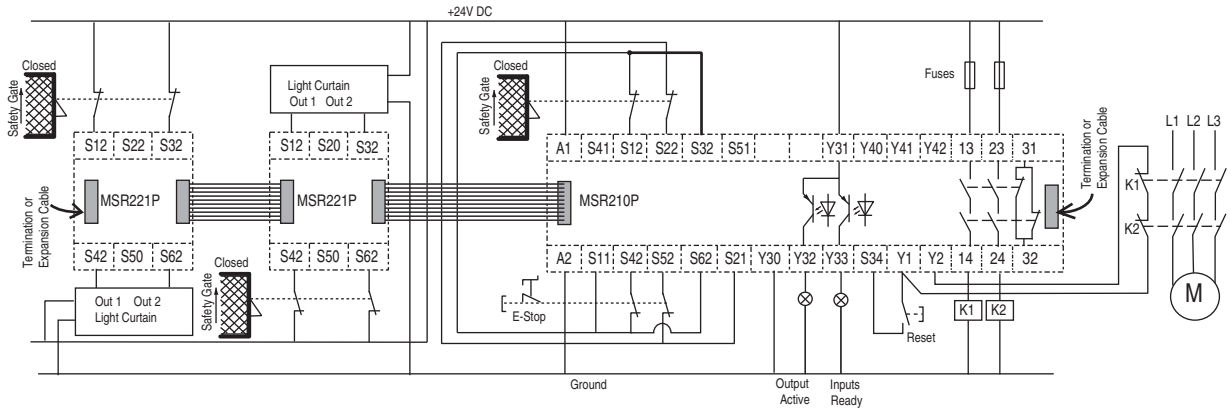
Block Diagram



Typical Wiring Diagrams



Light Curtain, Safety Gate, E-Stop, Monitored Manual Reset, Monitored Output



Light Curtain, Dual Channel Safety Gates and E-Stop, Monitored Manual Reset, Monitored Output

Modular Safety Relays

MSR230P



Description

The MSR230P is an output expansion module for the modular Minotaur MSR200 family of monitoring safety relays. It can be connected to either the MSR210P or MSR211P base unit to provide additional outputs.

Up to two MSR230P output modules can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The connecting ribbon cable provides power to the MSR230P as well as a check on its status. The terminators must be inserted into the final output module.

The MSR230P has four safety rated outputs that work in parallel with the safety outputs of the base unit. When the output of the base unit is activated, the outputs of the MSR230P are also activated.

The outputs are four normally open safety rated outputs. The safety outputs have independent and redundant internal contacts to help support the safety function.

Features

- Four N.O. safety outputs
- Two diagnostic LEDs
- Removable terminals

LED Indicators

Green	Channel 1 Output ON
Red	Channel 1 Output OFF
Green	Channel 2 Output ON
Red	Channel 2 Output OFF

Specifications

Safety Ratings		
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI 11.19, AS 4024.1	
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1	
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.3 x 10^{-10} MTTFd: > 454 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics	
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV	
Power Supply		
Input Power Entry	24V DC from the base unit	
Power Consumption	1.5 W	
Inputs		
Response Time	Does not add additional response time to base module	
Outputs		
Safety Contacts	4 N.O.	
Thermal Current I_{th}	2 x 6 A or 3 x 5 A or 4 x 4 A (nonswitching)	
Rated Impulse withstand Voltage	2500V	
Switching Current @ Voltage, Min.	10 mA @ 10V DC	
Fuses, Output	External 6 A slow blow or 10 A fast acting	
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M	
Mechanical Life	2,000,000 cycles	
Utilization Category		
Resistive: AC-1	6 A @ 250V AC	
Resistive: DC-1	6 A @ 24V DC	
Inductive: AC-15	3 A @ 250V AC	3 A @ 125V AC
Inductive: DC-13	2.5 A @ 24V DC	
UL	3 x B300, P300 or 4 x C300 2 x 6 A or 3 x 5 A or 4 x 4 A Resistive	
Environmental and Physical Characteristics		
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20	
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)	
Vibration	10…55 Hz, 0.35 mm	
Shock	10 g, 16 ms, 100 shocks	
Mounting	35 mm DIN Rail	
Weight [g (lbs)]	215 (0.47)	
Conductor Size, Max.	0.2…4 mm^2 (24…12 AWG)	

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

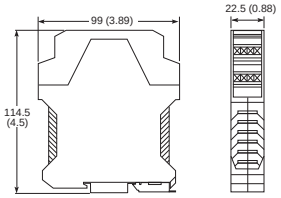
Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
NA	4 N.O.	—	Removable	—	24V DC from the base unit (terminals only)	440R-H23180

Accessories

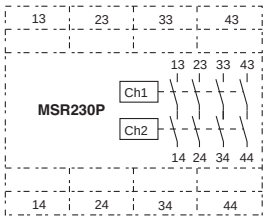
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

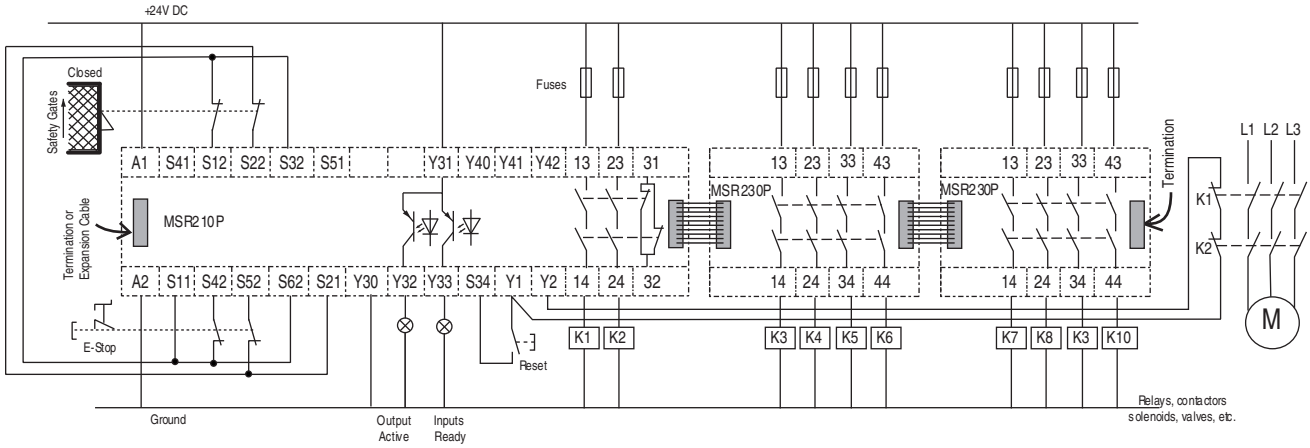
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



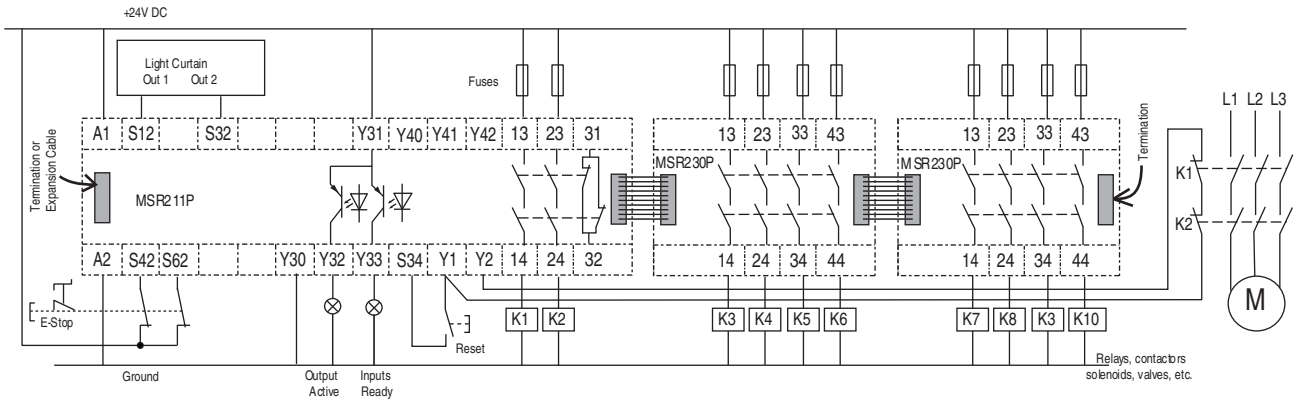
Block Diagram



Typical Wiring Diagrams



Dual Channel Safety Gate and E-Stop, Monitored Manual Reset, Monitored Output



Light Curtain and Dual Channel E-Stop, Monitored Manual Reset, Monitored Output

Modular Safety Relays

MSR238DP



Description

The MSR238 is an time-delayed output expansion module for the modular Minotaur MSR200 family of monitoring safety relays. It can be connected to either the MSR210 or MSR211 base unit or to the MSR230 output module to provide time-delayed outputs.

Up to two output modules can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The connecting ribbon cable provides power to the MSR238 as well as a check on its status. The terminators must be inserted into the final output module.

The MSR238 has two safety rated outputs that work in parallel with the safety outputs of the base unit. When the output of the base unit is de-activated, the outputs of the MSR238 are de-activated after the time delay expires. The time delay is set by connecting jumpers to the wiring terminals.

The outputs are two normally open safety rated outputs. The safety outputs have independent and redundant internal contacts to help support the safety function. The delayed normally closed output is an auxiliary signal that must only be used to indicate the status of the MSR238.

Features

- Category 3 per EN 954-1
- Stop category 1
- Two diagnostic LEDs
- Removable terminals
- Two N.O. delayed safety outputs
- One N.C. delayed auxiliary output

LED Indicators

Green	CH1 Output Active
Green	CH2 Output Active

Specifications

Safety Ratings	
Standards	EN 954-1, ISO 13849-1, IEC/EN 60204-1, IEC 60947-4-1, IEC 60947-5-1, ANSI 11.19, AS4024.1
Safety Classification	Cat. 3 per EN 954-1 (ISO 13849-1), SIL CL2 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 7.7 x 10^{-9} MTTFd: > 373 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	2.5 W
Outputs	
Safety Contacts	2 N.O.
Auxiliary Contacts	1 N.C.
Thermal Current I_{th}	1 x 6 A or 2 x 4 A (nonswitching)
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V DC
Fuses, Output	Recommended External 6 A slow blow or 10 A fast acting
Electrical Life (Operations)	220V AC/4 A/880VA cosϕ = 0.35…0.1 M 220V AC/1.7 A375VA cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	10,000,000 cycles
Utilization Category	
Resistive: AC-1	6 A @ 250V AC
Resistive: DC-1	6 A @ 24V DC
Inductive: AC-15	5 A @ 250V AC
Inductive: DC-13	3 A @ 24V DC
UL:	1 x B300, P300 or 2 x C300, 1 x 6 A or 2 x 4 A Resistive
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	215 (0.47)
Conductor Size, Max.	0.2…2.5 mm^2 (24…14 AWG)

✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

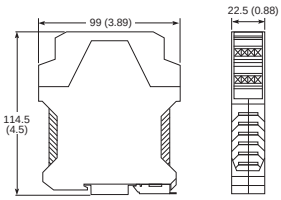
Delayed Safety Outputs	Delayed Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
2 N.O.	1 N.C.	Removable	—	24V DC from the base unit	440R-H23196

Accessories

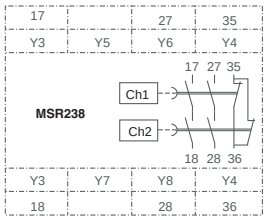
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

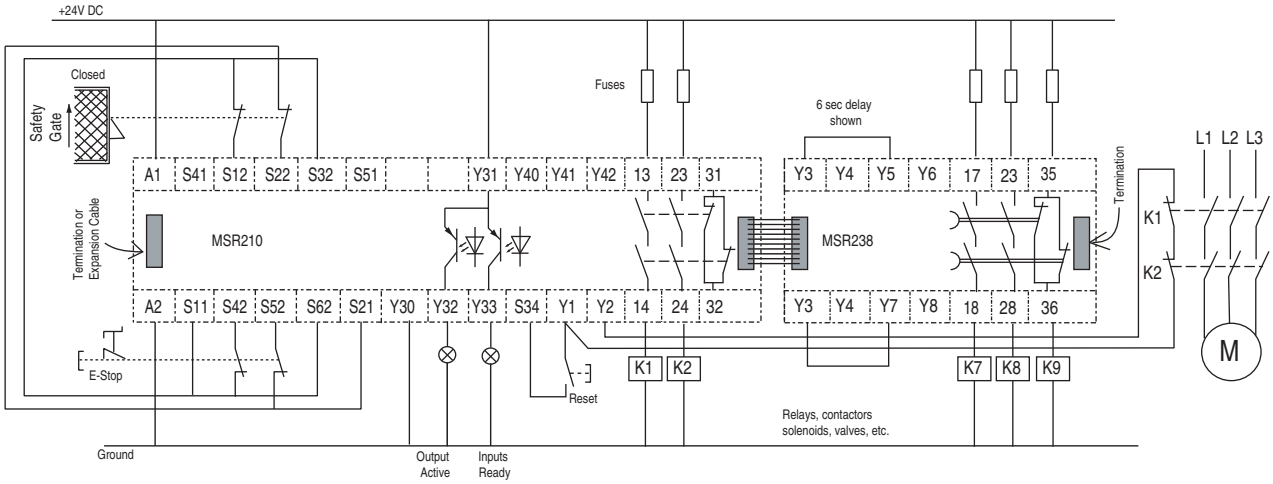
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Application Details (Typical)

Apply jumpers (links) on the terminals identified to achieve the desired off delay.

Delay (s)	Jumper	Jumper	Delay (s)	Jumper	Jumper	Delay (s)	Jumper	Jumper
0	None	None	8	Y3-Y6	Y3-Y7	50	Y3-Y6	Y3-Y8
0.5	Y3-Y5	None	9	Y4-Y5	Y3-Y7	60	Y4-Y5	Y3-Y8
1	Y4-Y6	None	10	None	Y4-Y8	80	None	Y4-Y7
1.5	Y3-Y6	None	12	Y3-Y5	Y4-Y8	100	Y3-Y5	Y4-Y7
2	Y4-Y5	None	15	Y4-Y6	Y4-Y8	120	Y4-Y6	Y4-Y7
3	Y3-Y5	Y4-Y6	18	Y3-Y6	Y4-Y8	160	Y3-Y6	Y4-Y7
4	Y3-Y6	Y4-Y5	21	Y4-Y5	Y4-Y8	200	Y4-Y5	Y4-Y7
5	None	Y3-Y7	26	None	Y3-Y8	250	Y3-Y5, Y4-Y6	Y3-Y7
6	Y3-Y5	Y3-Y7	30	Y3-Y5	Y3-Y8	300	Y3-Y5, Y4-Y5	Y3-Y7
7	Y4-Y6	Y3-Y7	40	Y4-Y6	Y3-Y8			

Modular Safety Relays

MSR240P



Description

The MSR240P is a communications module for the modular Minotaur MSR200 family of monitoring safety relays. It can be connected to either the MSR210P or MSR211P base unit to provide diagnostic and status information to remote devices like the MSR245P display.

The MSR240P is connected in place of the terminator plug to the free bus connector of the Basic Module or the last connected Expansion Module, depending on the system configuration. Data transfer and power supply are routed through the same bus cable and connectors.

A green LED in the front of the MSR240P indicates the presence of supply voltage. A blinking yellow LED signals data exchange activity through the RS232/RS485 interface.

The transmission rate for the RS485 can be set with the help of two DIP switch segments at 2400, 4800, 9600, or 19200 baud.

The station address can be set by five additional DIP switch segments. Up to 32 stations can be connected onto a single RS485 network.

The connected supervisory monitoring or data acquisition system can process and store the data, display it, and record the reason causing a shutdown, along with the time and date of each such occurrence. This makes fault diagnosis much easier.

Features

- Data transmission
- RS232 or RS485
- Supported baud rates: 2400, 4800, 9600, or 19200
- Galvanically isolated interfaces
- 17.5 mm DIN Rail housing
- Two diagnostic LEDs
- Removable terminals

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISOTR 12100
Certifications	CE Marked for all applicable directives
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	2 W
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	90 (0.20)
Conductor Size, Max.	0.2…4 mm² (24…12 AWG)

Product Selection

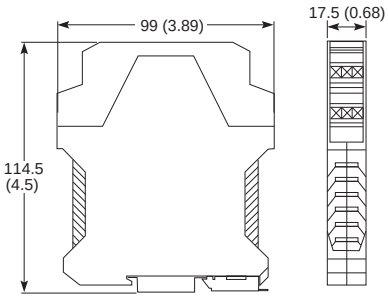
Communication Interface	Cat. No.
RS232	440R-H23181
RS232 + RS485	440R-H23183

Accessories

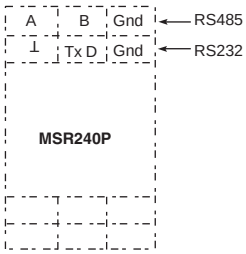
Description	Cat. No.
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

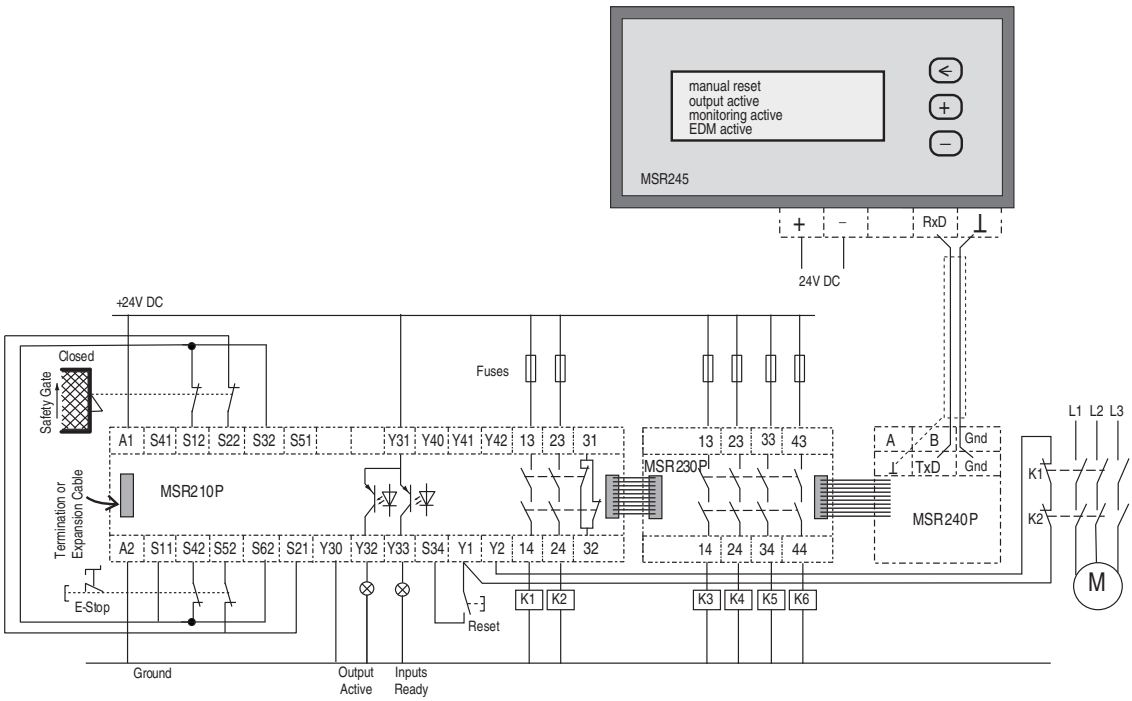
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Safety Gate, E-Stop, Manual Reset, Monitored Output

Modular Safety Relays

MSR241P



Description

The MSR241P is a DeviceNet™ communications module for the modular Minotaur MSR200 family of monitoring safety relays. It can be connected to either the MSR210P, MSR211P, or MSR230P modules to provide diagnostic and I/O status information to remote locations.

The MSR241P is connected via the flat ribbon cable to the base module or the last connected expansion module, depending on the system configuration. Data transfer and power supply are routed through the same bus cable and connectors.

The MSR241P has two nonsafety rated relay outputs that are activated with the last two bits of the one input byte.

The baud rate and address is set by means of the dipswitch on the front panel.

The connected supervisory monitoring or data acquisition system can process and store the data, display it, and record the reason causing a shutdown, along with the time and date of each such occurrence. This makes fault diagnosis much easier.

Features

- DeviceNet™ data transmission
- Switch selectable baud rates: 125 K, 250 K, 500 K
- Switch selectable address
- 45 mm DIN Rail housing
- Four diagnostic LEDs
- Removable terminals
- Group two only slave

LED Indicators

Green	K1 Active
Green	K2 Active
Green	Module Status Operative Network Status
Green	Online
Red	Critical Connection Error
Blinking Green	Connection Interrupted
Blinking Red	Connection Timed Out

Specifications

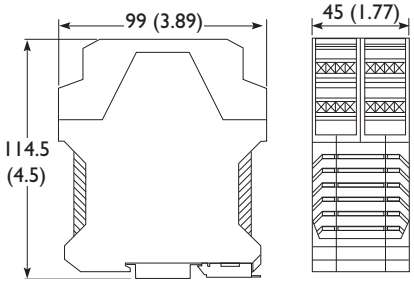
Safety Ratings	
Standards	IEC/EN 60204-1, ISOTR 12100, ISO 13849-0
Certifications	CE Marked for all applicable directives
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	2 W
Outputs	
Auxiliary Contacts	2 N.O.
Thermal Current/$_{Ith}$	2 A @ 30V DC, 300 mA @ 110V DC, 500 mA @ 125V DC
Rated Impulse withstand Voltage	60 W max. switching voltage
Switching Current @ Voltage, Min.	10 mA @ 10V DC
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+50 ° (23…122 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	180 (0.396)
Conductor Size, Max.	0.2…2.5 mm (24…12 AWG)

Product Selection

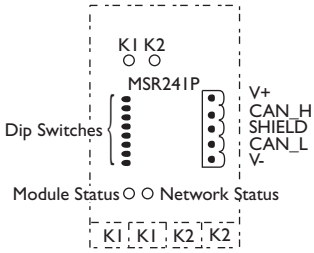
Interface Type	Cat. No.
DeviceNet™	440R-H23187

Approximate Dimensions

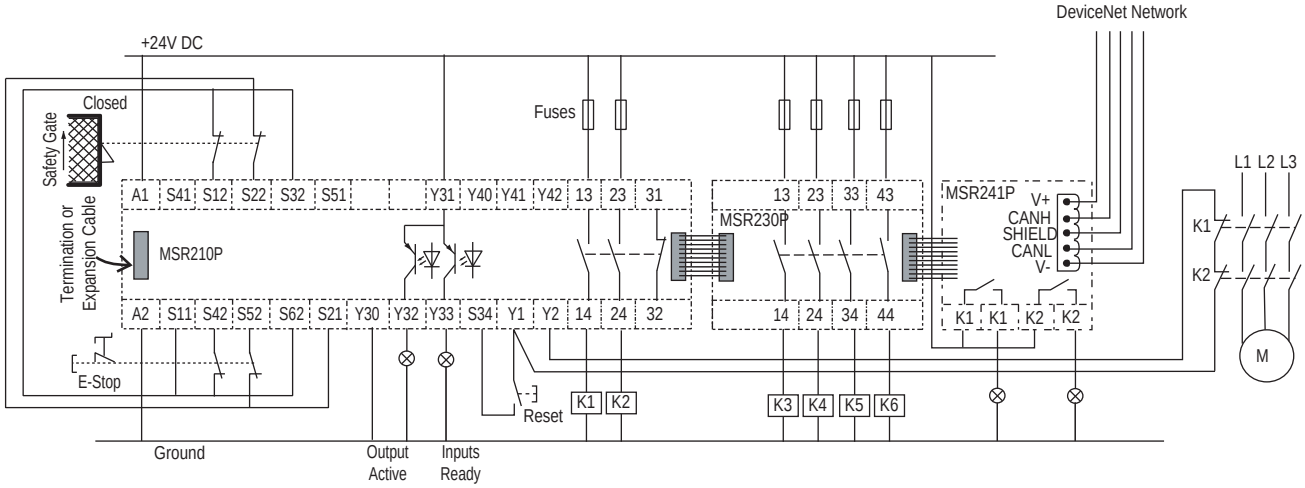
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Switch Settings

Switch	125K	250K	500K
1	0	0	1
2	0	1	0
3	Bit 5	Switches 3-8 set the node address	
4	Bit 4		
5	Bit 3		
6	Bit 2		
7	Bit 1		
8	Bit 0		

Modular Safety Relays

MSR245P



Description

The MSR245P is a display module for the modular Minotaur MSR200 family of monitoring safety relays. The MSR245P Display Module is interfaced to an MSR200 system through an MSR240P Communication Module, using the RS232 interface, with a two-core shielded cable. The display is refreshed approximately every six seconds.

Using the four-line LCD display and the three function key-switches, the configuration of external circuits, and the on-off status of all inputs of the system can be checked and interrogated.

The microprocessor, in the base module, scans all the inputs starting with the base module and working its way to the left. The first scanned input is “base module input 1.” The last scanned input would be input two of the module furthest from the base module.

The display shows the lowest scanned input that de-energized the safety outputs (safety outputs open). After the lowest scanned input is cleared, the display will refresh and show the next input which is open. In this way, each open input circuit can be troubleshot and closed. When all inputs are closed, the user can scroll through the display.

The MSR245P requires 24V DC supply voltage. The power supply input as well as the RS232 are galvanically isolated from the MSR200 system, but can be connected non-isolated if required.

The messages in the MSR245 are capable of being customized with application specific text. The first three lines of the display can be changed to describe each of the inputs (3 x 20 characters). The text language can be selected and written in either English or German.

For programming, a PC running under Windows™ must be connected to the nine-pole sub-miniature D connector on the back of the MSR245 using a standard serial data interface cable.

The program allows the user to generate and transfer the text blocks into the nonvolatile memory of the MSR245.

The software for text programming and the manual is available for download on the Rockwell Automation safety website at *www.ab.com/safety*.

Features

- Recalls and displays system information
- Simple menu selection
- Stores details of last registered stop occurrence
- Clearly readable backlit display
- Back-lit four-line alphanumeric display
- RS232 interface

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISOTR 12100
Certifications	CE Marked for all applicable directives
Power Supply	
Input Power Entry	24V DC
Power Consumption	0.5 W
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	Panel or 35 mm DIN Rail (option)
Weight [g (lbs)]	210 (0.46)
Conductor Size, Max.	0.2…2.5 mm² (24…14 AWG)

Example Messages

Bold = standard text

Not Bold = text depending on function

System menu:

Manual/auto **reset**

Output active/deactivated

Monitoring active/device ready

EDM active/deactivated (feedback circuit)

Input configuration:

Input Module 4

MSR220 emergency off

Input 1: 2-channel

Input 2: 1-channel

Functions/Interruption messages:

Input Module 4

Input 2 causes interrupt

safety mats or cross-fault causes interrupt

transmission fault

fault EDM loop

fault Y40 loop

malfunction

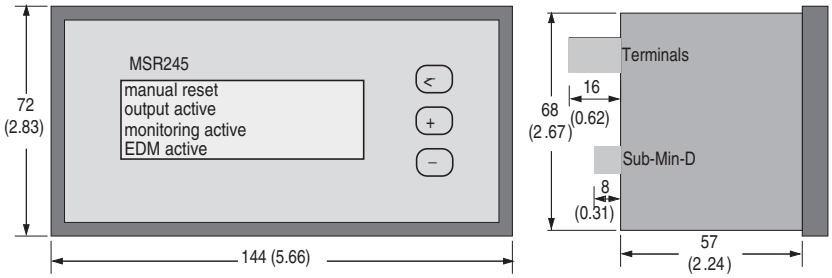
Output active/inactive

Product Selection

Description	Cat. No.
Display module	440R-H23184
DIN Rail Base Adapter Kit	440R-H23185

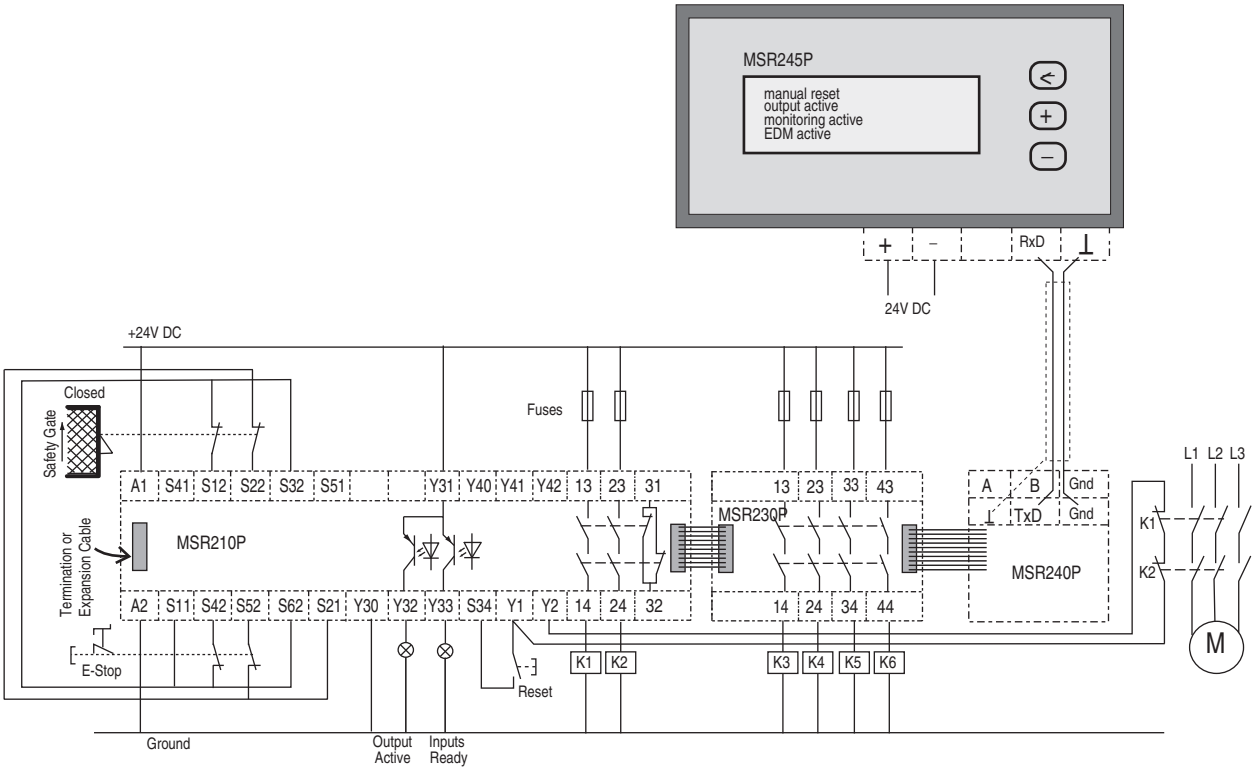
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Front cut out: 68 x 138
Optional DIN rail mounting base EN 50022-35 x 7.5

Typical Wiring Diagrams



Input Module Selection

Groups / # of inputs	Group 1	Group 2	Group 3
1 2	MSR320	MSR320	MSR320
3 4	MSR320	MSR320	MSR320
5 6	MSR320	MSR320	MSR320
7 8	MSR320	MSR320	MSR320
9 10	MSR320	MSR320	MSR320
11 12	MSR320	MSR320	MSR320
13 14	MSR320	MSR320	MSR320
15 16	MSR320	MSR320	MSR320
17 18	MSR320	MSR320	MSR320
19 20	MSR320	MSR320	MSR320

				<=10 modules
Example 1: Total System: MSR310/MSR312 +	1	2	3	<=10 modules
Example 2: Total System: MSR310/MSR312 +	2	1	4	<=10 modules

Note: If a muting module is required in the application, it counts as one of the ten input modules.

Output Module Selection

Groups / # of outputs	Immediate Group 1	Immediate Group 2	Immediate Group 3	Delayed Group 1	Delayed Group 2	Delayed Group 3
1 2 3	W23221	W23222	W23223	W23224	W23225	W23226
4 5 6	W23221	W23222	W23223	W23224	W23225	W23226
7 8 9	W23221	W23222	W23223	W23224	W23225	W23226
10 11 12	W23221	W23222	W23223	W23224	W23225	W23226
13 14 15	W23221	W23222	W23223	W23224	W23225	W23226
16 17 18	W23221	W23222	W23223	W23224	W23225	W23226

	+	+	+	+	+	<=6 modules

Example 1: 2 Group 1 Immediate Outputs, 1 Group 2 Immediate Outputs, 2 Group 3 Immediate Outputs:	2	1	2	0	0	0	5
Example 2: 1 Group 1 Immediate Outputs, 2 Group 3 Immediate Outputs, 1 Group 1 Delayed Outputs:	1	0	2	1	0	0	4
Example 3: 1 Group 2 Immediate Outputs, 2 Group 3 Immediate Outputs, 3 Group 3 Delayed Outputs:	0	1	2	0	0	3	6
							Total Modules

Configurable Safety Relays

MSR310P RS232



Description

The MSR310P is one of the base units available for the MSR300 system. It can be combined with other modules of the MSR300 Series to configure a safety control system with numbers of inputs and outputs matching users' specific application requirements, as well as diagnostic and networking capabilities. Up to ten input modules and six output modules can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The terminators must be inserted into the final input and output modules. A fully utilized system can support up to 20 inputs devices (e-stops/gates) and 18 normally open outputs.

The MSR300 System supports up to three group outputs. The input modules can be configured to control one or more of the output groups. This creates flexibility for the customer to solve applications requiring simple logic functions (simple AND and OR function). No software is needed for configuration, only rotary switches on the Input Modules are required. Please see the Input Modules for more information.

The base module supports multiple reset configurations for each group output. The user can select from the following choices: manual, manual monitored and automatic reset. The reset configuration is set up by jumpers on the base module terminals. If manual monitored and automatic reset is mixed, the preferred combination of Output Group Modules should be considered.

The MSR310P base module does not have any inputs or safety outputs within the device. A minimum of one input module and one output module are required to make a functional system. The base module does have three solid-state auxiliary outputs to signify the status of the output groups—one output for each Group (1, 2, or 3).

The MSR310P has the capability to monitor external devices individually for each group with a separate feedback loop control.

Features

- Category 4 per EN 954-1
- SIL3 per IEC 61508
- EN 574 Type IIIC
- Stop category 0
- Pulsed input monitoring
- Three auxiliary group outputs
- Six diagnostic LEDs
- Manual, monitored or automatic reset
- Zone control—up to three
- RS232 Diagnostic Comms
- Unidirectional RS232, 4800 baud
- Bidirectional RS232, 2400, 4800, 9600, 19200 baud
- Removable terminals

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISOTR 12100, EN 61508, ISO 13849-1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.15 x 10^{-9} MTTFd: > 396 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, C-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC 0.8…1.1 x rated voltage PELV/SELV
Power Consumption	5 W
Inputs	
Safety Inputs	MSR300 Series Input Modules
Input Simultaneity	Infinite or 3 seconds
Reset	Auto./Manual or Monitored Manual
Power On Delay/Recovery Time	3 seconds/26 ms + 6 ms per connected input
Response Time	26 ms + 6 ms per connected input
Outputs	
Auxiliary Contacts	3 PNP, 24V DC @ 50 mA
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	210 (0.46)
Conductor Size, Max.	0.2…2.5 mm^2 (#24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

System-Supported Inputs

- 1 N.C., 2 N.C., or 3 N.C. inputs—E-stops/Gates
- 1 N.C. and 1 N.O inputs—Gates
- Two-Hand Control
- Two OSSD—Light Curtains
- Safety Mats

Product Selection

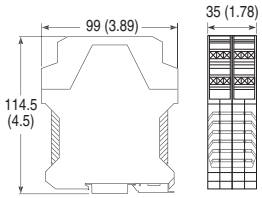
Safety Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
MSR300 Series Input Modules	MSR300 Series Output Modules	3 PNP Solid State	Removable	Auto./Manual Monitored Manual	24V DC	440R-W23219

Accessories

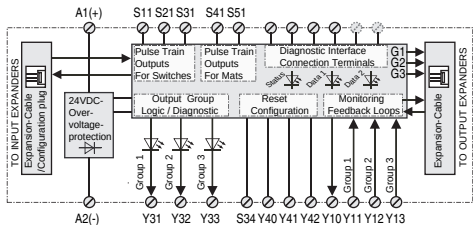
Description	Cat. No.
MSR300 Two Terminators	440R-A17234
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

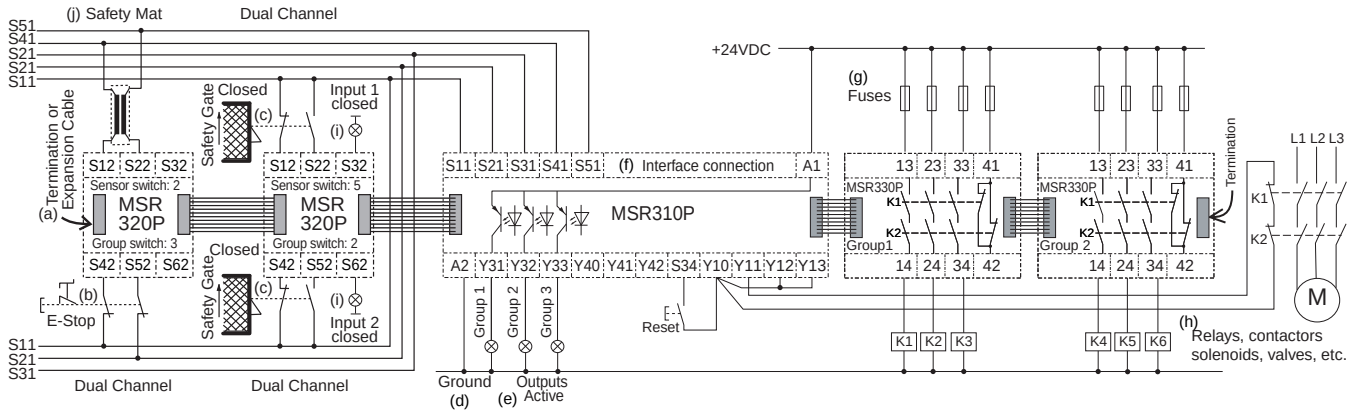
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram

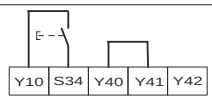
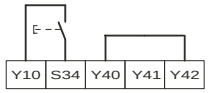
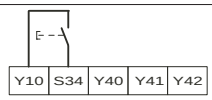
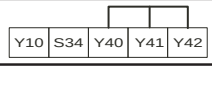


Typical Wiring Diagrams



(k) MSR 300 system with various Inputs, Two Output Groups with common monitored reset, Group 1 with monitored contactors Safety Mat or E-Stop shut down both Output modules, Safety Gates only shut down the Group 2 module

Reset Behavior

Reset Behavior	Circuit
Groups 1 and 2: manual, monitored reset Group3: automatic reset	
Groups 1 and 2: automatic reset Group3: manual, monitored reset	
Groups 1, 2, and 3: manual, monitored reset	
Groups 1, 2, and 3: automatic reset	

Configurable Safety Relays

MSR312P DeviceNet™



Description

The MSR312P is one of the base units available for the MSR300 system. It can be combined with other modules of the MSR300 Series to configure a safety control system with numbers of inputs and outputs matching users' specific application requirements, as well as diagnostic and networking capabilities. Up to ten input modules and six output modules can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The terminators must be inserted into the final input and output modules. A fully utilized system can support up to 20 inputs devices (e-stops/gates) and 18 normally open outputs.

The MSR300 System supports up to three group outputs. The input modules can be configured to control one or more of the output groups. This creates flexibility for the customer to solve applications requiring simple logic functions (simple AND and OR function). No software is needed for configuration, only rotary switches on the Input Modules are required. Please see the Input Modules for more information.

The base module supports multiple reset configurations for each group output. The user can select from the following choices: manual, manual monitored and automatic reset. The reset configuration is set up by jumpers on the base module terminals. If manual monitored and automatic reset is mixed, the preferred combination of Output Group Modules should be considered.

The MSR312P base module does not have any inputs or safety outputs within the device. A minimum of one input module and one output module are required to make a functional system. The base module does have three solid-state auxiliary outputs to signify the status of the output groups—one output for each group (1, 2, or 3).

The MSR312P has the capability to monitor external devices individually for each group with a separate feedback loop control.

Features

- Category 4 per EN 954-1
- SIL3 per IEC 61508
- EN 574 Type IIIC
- Stop category 0
- Pulsed input monitoring
- Three auxiliary group outputs
- One PNP solid state output controlled via DeviceNet™ connection
- Six diagnostic LEDs
- Manual, monitored or automatic reset
- Zone control—up to three
- DeviceNet™ Comms including UCMM
- Support baud rates: 125 k, 250 k, 500 k
- Removable terminals

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISOTR 12100, EN 61508, ISO 13849-1
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.15 x 10^{-9} MTTFd: > 396 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC 0.8…1.1 x rated voltage PELV/SELV
Power Consumption	3 W
Inputs	
Safety Inputs	MSR300 Series Input Modules
Input Simultaneity	Infinite or 3 seconds
Reset	Auto./Manual or Monitored Manual
Power On Delay/ Recovery Time	3 seconds/26 ms + 6 ms per connected input
Response Time	26 ms + 6 ms per connected input
Outputs	
Auxiliary Contacts	3 PNP, Diagnostic, 1 PNP Output, 24V DC @ 50 mA
Switching Current @ Voltage, Min.	24V DC @ 50 mA
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	210 (0.46)
Conductor Size, Max.	0.2…2.5 mm^2 (24… AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

System-Supported Inputs

- 1 N.C., 2 N.C., or 3 N.C. inputs—E-stops/Gates
- 1 N.C. and 1 N.O inputs—Gates
- Two-Hand Control
- Two OSSD—Light Curtains
- Safety Mats

Product Selection

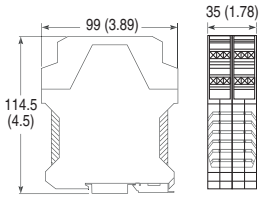
Safety Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
MSR300 Series Input Modules	MSR300 Series Output Modules	3 PNP, DeviceNet	Removable	Auto./Manual or Monitored Manual	24V DC	440R-W23220

Accessories

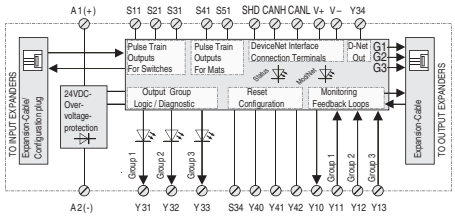
Description	Cat. No.
MSR300 Two Terminators	440R-A17234
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

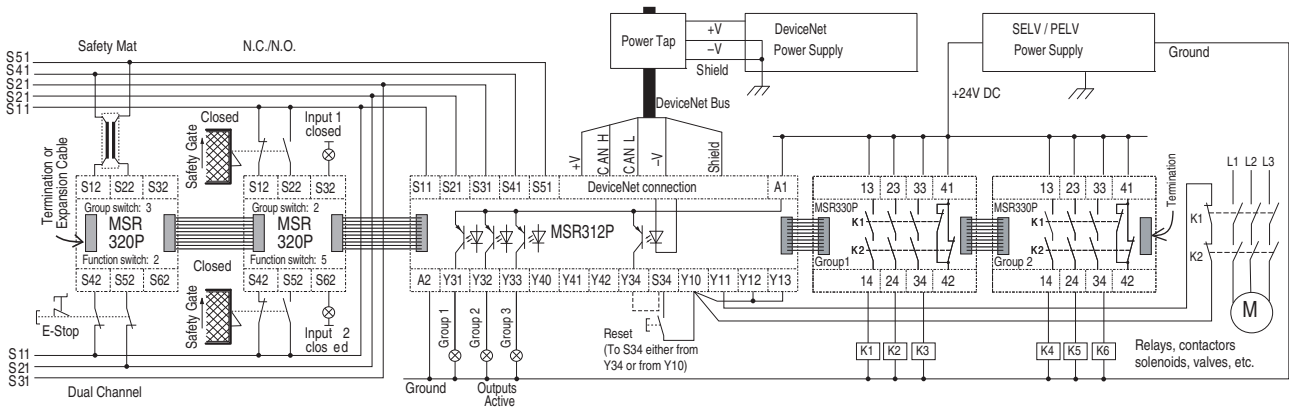
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram

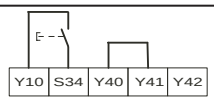
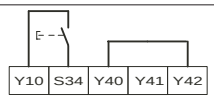
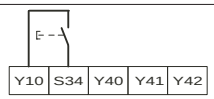
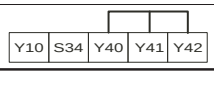


Typical Wiring Diagrams



MSR300 system with various Inputs, Two Output Groups with common monitored reset (reset alternative via DeviceNet with S34 linked to Y34), Group 1 with monitored contactors Safety Mat or E-Stop shut down both Output modules, Safety Gates only shut down the Group 2 module.

Reset Behavior

Reset Behavior	Circuit
Groups 1 and 2: manual, monitored reset Group3: automatic reset	
Groups 1 and 2: automatic reset Group3: manual, monitored reset	
Groups 1, 2, and 3: manual, monitored reset	
Groups 1, 2, and 3: automatic reset	

Configurable Safety Relays

MSR320P Input Module



Description

The MSR320P is an input expansion module for the modular MSR300 family of monitoring safety relays. Up to ten input modules can be connected to a base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The connecting ribbon cable provides power to the MSR320P as well as a check on its status. The terminator removed from the base module must be inserted into the input module furthest to the left.

Although the base module of the MSR300 system holds all of the configuration information, the input modules are the devices that actually configure the base module. The input modules select both the type of inputs connected and the outputs or groups those inputs will control.

The MSR320P has two independent inputs, which are configured by the rotary switches on the side of the module. There are two switches, for redundancy, so both must be set to the same value. An example of the switch settings is to the right. The selection of the switch setting signifies to the base module what inputs to expect and what to test for. Connecting a single device (must be at least dual channel) to each input meets the requirements of Category 4 per EN594-1. Below is a list of supported inputs.

The MSR320P Input module supports up to three group outputs. Two rotary switches, for redundancy, on the side of the module select the output group or groups the connected inputs will control. Below is an example of the possible group settings.

When three channel N.C. inputs are not chosen, functions switch setting three, one solid-state output is available for each input to provide annunciation for that input.

Two LEDs provide the status information on the inputs. Green indicates the input is closed and red indicates the input is open. Three LEDs provide information regarding which output groups are controlled by this input module.

Features

- Category 4 per EN 954-1
- SIL3 IEC 61508
- EN 574 Type IIIC
- Stop category 0
- 17.5 mm DIN Rail housing
- Five diagnostic LEDs
- Configurable inputs
- Output group configurable
- Removable terminals

LED Indicators

2x input status	Input Closed
Green	Input Open; 3x output switch group assignment

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISO TR 12100, EN 61508, ISO 13849-1, EN 574 Cat IIIC
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ✶ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.1 x 10^{-10} MTTFd: > 835 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	3 W
Inputs	
Safety Inputs	1 N.C., 2 N.C., or 3 N.C., 1 N.C and 1 N.O., LC, SM, or two-hand control
Input Simultaneity	3 seconds or infinite
Input Resistance, Max.	900 Ω
Reset	Selected on base module
Outputs	
Auxiliary Contacts	2 PNP, 24V DC @ 50 mA
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	17.5 mm housing, 35 mm DIN Rail
Weight [g (lbs)]	110 (0.24)
Conductor Size, Max.	0.2…2.5 mm^2 (24…12 AWG)

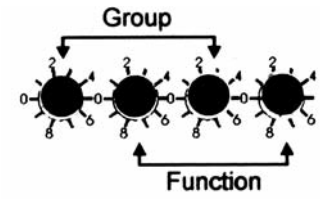
✶ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

System-Supported Inputs

- E-stops
- Safety Gates
- Safety Mats
- Light Curtains
- Two-Hand Control

Input Configurations

- 1 N.C., 2 N.C., 3 N.C.
- 1 N.C. and 1 N.O.
- 2 OSSD
- 3-second or infinite simultaniety



Group
0 Logic function
1 Group 1
2 Group 2
3 Group 1+2
4 Group 3
5 Group 1+3
6 Group 2+3
7 Group 1+2+3
8 Muting - Robotcell
9 Add Safe Area

Function
1 1-channel 1N/C
2 2-channel 2N/C, Safety Mat
3 3-channel 3N/C
4 Safety gate with startup-test 1N/C 1N/O
5 Safety gate 1N/C 1N/O
6 Light curtain 2OSSD
7 Two-hand control 2 sets of 1N/C+1N/O
8 Input1: 2-channel Input2: Light curtain
9 Input1: Safety gate Input2: Light curtain

Allen-Bradley
GuardMaster®

Product Selection

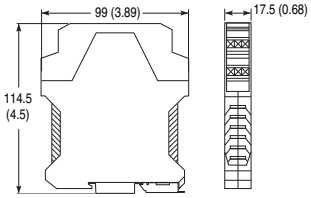
Safety Inputs	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1 N.C., 2 N.C., or 3 N.C., 1 N.C and 1 N.O., LC, SM, or two-hand control	—	2 PNP Solid State	Removable	—	24V DC from the base unit	440R-W23218

Accessories

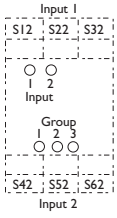
Description	Cat. No.
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



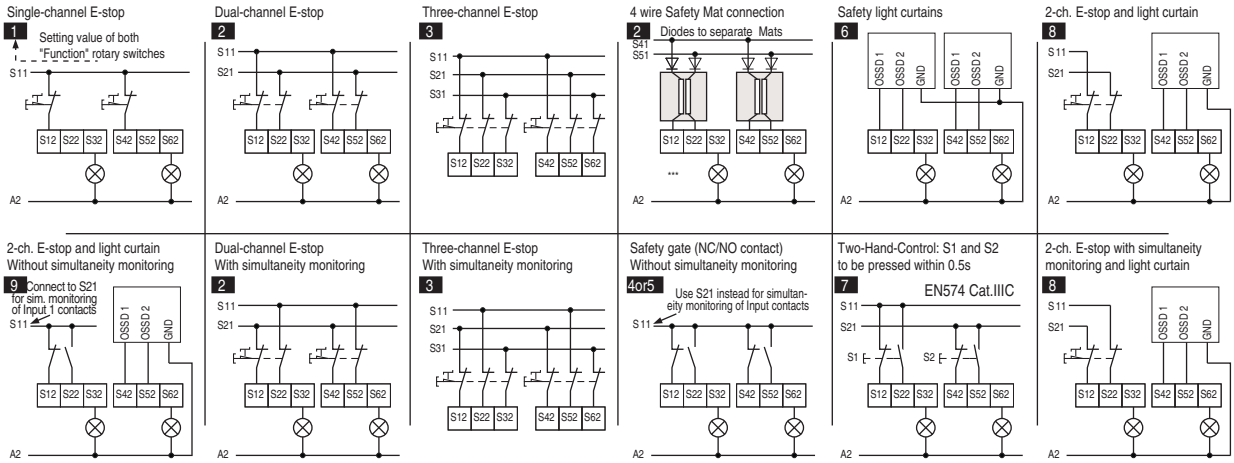
Block Diagram



Typical Wiring Diagrams

Wiring of input according to switch-selected function

Applications in the first row have infinite time to reset the contacts per input. Second row options require the connection per input to be simultaneous reset (within three second time frame). ✶



✶ "Infinite Reset" and "Simultaneous Reset" time refers to the amount of time the user has to close all the contacts of one input without causing a fault condition. Infinite configuration indicates to the base unit NOT to check when the contacts close. Simultaneous reset time requires that all the contacts on each input MUST reset within 3 seconds or a fault/lockout condition will occur.

❄ When applying safety mats to the MSR300, it is recommended to use diodes, as shown, to indicate which mat has been pressed. If only one safety mat is connected to the system, no diodes are needed.

MSR329 Muting Lamp Module



Description

The MSR329P is an input expansion module for the modular MSR300 family to monitor the function of connected muting lamps if the system is setup for a robot cell application. One muting lamp module can be used in each MSR300 system. To use the muting module there must be at least two MSR320P input modules. The muting lamp module can be connected anywhere in the string of input modules but the terminator must be located in the left most module. The connecting ribbon cable provides power to the MSR329P as well as a check on its status. The muting lamp module is used to drive and to monitor the muting lamps only. The MSR320 input module can operate a muted cell operation without the muting lamp module present.

The MSR329P can be used for robot cell applications when the application requires a portion(s) of the inputs devices to the cell to be temporarily disabled. If for example, parts needed to be added or removed from the machine. The light curtain may need to be muted during this time to prevent the machine from stopping during this condition. Interlock switches can be used to determine the position of the robot within the cell to initiate the muting function.

When using the muting module, group three MSR330P output modules are required for the robot control or power. Group outputs 1 and 2 will still change state normally when an input changes state such as a light curtain. Output groups 1 and 2 are not required for robot cell applications but can be used to remove hazardous local voltages such as an arc welder during a muting condition.

The muting module has two main lamp modules and two spare lamp modules. If the main lamp module fails, the spare lamp module will be used. The MSR329P muting module requires an incandescent bulb operating between 30…200 mA to accurately determine the bulb status. LEDs cannot be used. Two LEDs provide the status information on all four lamps. They indicate if the bulbs are okay or if any have failed.

Lamp Outputs

- Two Main Lamps
- Two Auxiliary Lamps

Features

- Category 4 per EN 954-1
- SIL3 IEC 61508
- 17.5 mm DIN Rail housing
- Two Diagnostic LEDs
- Removable terminals

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISO TR 12100, EN 61508, ISO 13849-1 (EN 954-1)
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 3.8 x 10^{-10} MTTFd: > 662 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	1 W
Inputs	
Safety Inputs	Monitoring of 2 muting lamps 24V DC current between 30.....200 mA
Reset	Selected on base module
Outputs	
Safety Contacts	2 x muting lamps, 2 x reserve lamps
Status Indicator	Status of lamps
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	110 (0.24)
Conductor Size, Max.	0.2…2.5 mm^2 (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

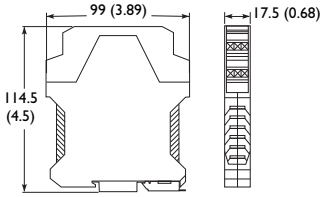
No. of Main Lamps	No. of Auxiliary Lamps	Current Range	Terminals	Reset Type	Power Supply	Cat. No.
2	2	30…200 mA	Removable	—	24V DC from the base unit	440R-W23217

Accessories

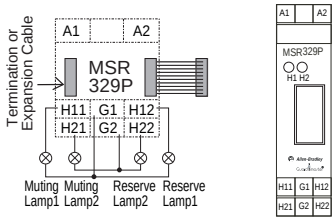
Description	Cat. No.
Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229

Approximate Dimensions

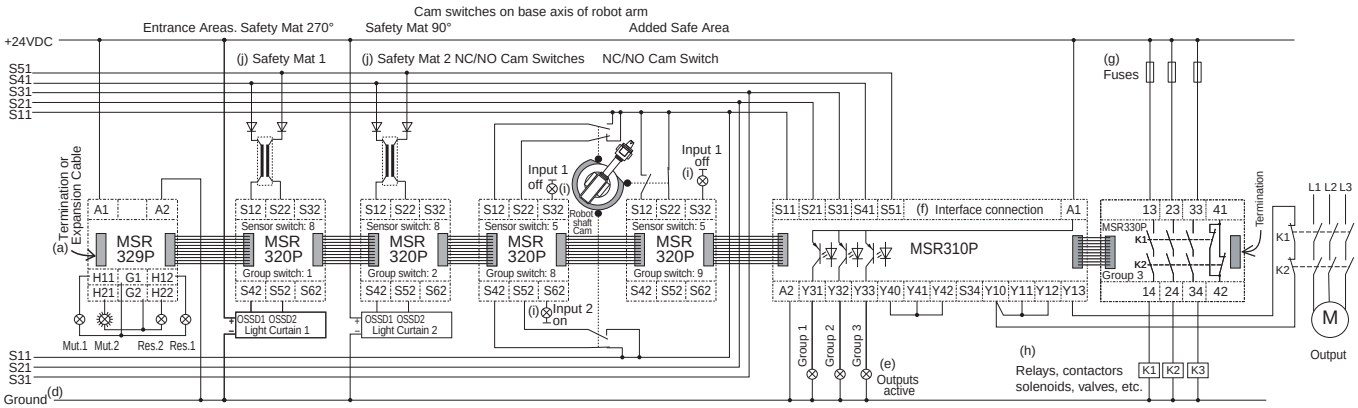
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



MSR300 three-zone Robot Cell application allowing safe material flow in and out of the cell without process interruption as long as the robot arm is working in monitored safe zones.

Configurable Safety Relays

MSR330P Output Module



Description

The MSR330P is an output expansion module for the modular Minotaur MSR300 family of monitoring safety relays. Up to six MSR330P output modules and 18 N.O. safety outputs, can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The six MSR330P output modules can be used in any combination and order when connected to the MSR300 system. The connecting ribbon cable provides power to the MSR330P as well as a check on its status. The terminator must be inserted into the final output module.

The MSR330P has three safety-rated outputs and one auxilary output controlled by the base unit. There are three different MSR330P modules, one for each group. In most instances, the output group module is not specific to each application. The exceptions are robot cell applications and logic or functions which correspond with group three outputs. The safety outputs have independent and redundant internal contacts to help support the safety function.

Features

- Category 4 per EN 954-1
- SIL3 IEC 61508
- Stop category 0
- Three N.O. safety outputs
- One N.C. auxiliary output
- Three group modules available
- Two Diagnostic LEDs
- 22.5 mm DIN Rail housing
- Removable terminals

Specifications

Safety Ratings	
Standards	IEC/EN 60204-1, ISO TR 12100, EN 61508, ISO 13849-1 (EN 954-1)
Safety Classification	Cat. 4 per EN 954-1 (ISO 13849-1), SIL CL3 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 2.3 x 10^{-10} MTTFd: > 454 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC from the base unit
Power Consumption	1.5 W
Inputs	
Reset	Selected on base module
Response Time	Does not add additional response time to base module
Outputs	
Safety Contacts	3 N.O.
Auxiliary Contacts	1 N.C.
Thermal Current I_{th}	2 x 6 A or 3 x 5 A
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V
Fuses, Output	External 6 A slow blow or 10 A quick blow
Mechanical Life	2,000,000 cycles
Utilization Category	
UL	B300, P300, 2 x 6 A or 3 x 5 A/250V AC, 24V DC
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20, DIN 0470
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	190 (0.42)
Conductor Size, Max.	0.2…2.5 mm^2 (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

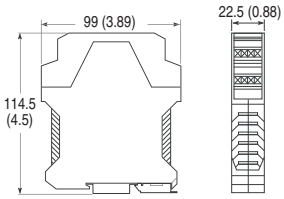
Group No.	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1	3 N.O.	1 N.C.	Removable	Selected on base module	24V DC	440R-W23221
2						440R-W23222
3						440R-W23223

Accessories

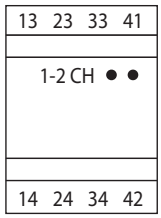
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

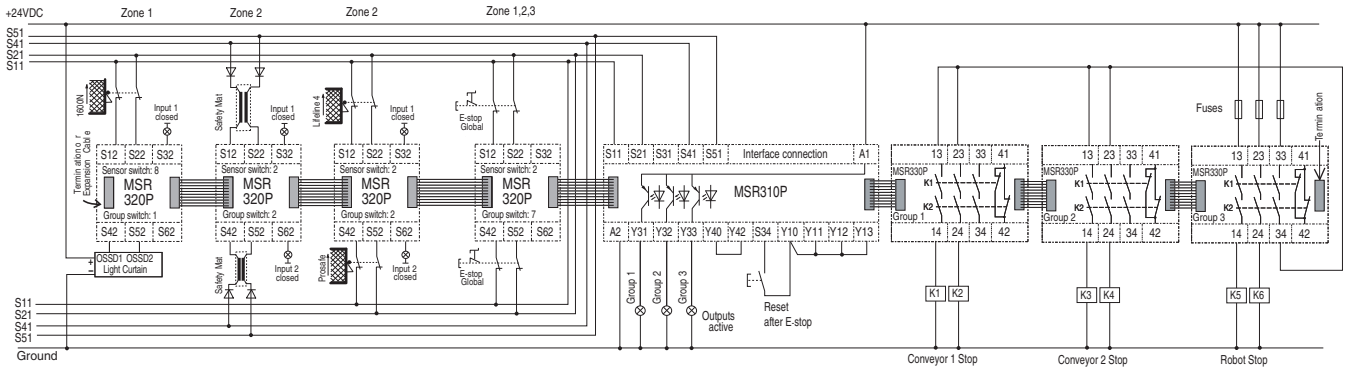
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



Zone 1 inputs shut down conveyor 1 and zone 2 inputs shut down conveyor 2, global e-stops shut down the complete line and require a reset.

Configurable Safety Relays

MSR338DP



Description

The MSR338 is an time-delayed output expansion module for the configurable Minotaur MSR300 family of monitoring safety relays. Up to six output modules, can be connected to one base unit by simply removing the terminator, included with each base unit, and connecting the ribbon cables of the neighboring module. The MSR338DP output modules can be used in any combination and order also together with the instant modules MSR330P when connected to the MSR300 system. The connecting ribbon cable provides power to the MSR338DP as well as a check on its status. The terminator must be inserted into the final output module.

There are three different MSR338P modules, one for each group. In most instances, the output group module is not specific to each application. The exceptions are robot cell applications and logic OR functions which correspond with group three outputs.

The MSR338 has three safety rated outputs that work in parallel with the immediate safety outputs of the MSR330P outputs modules. When the output signal from the base unit is de-activated, the outputs of the MSR338 are de-activated after the time delay expires. The time delay is set by connecting jumpers to the wiring terminals. The outputs are three normally open and one normally closed safety rated outputs. The safety outputs have independent and redundant internal contacts to help support the safety function.

Features

- Category 3 per EN 954-1 performance
- Level D per ISO 13849-1 Stop category 1
- Three N.O. safety outputs
- One N.C. safety output
- Three group modules available
- Diagnostic LED
- 22.5 mm DIN Rail housing
- Removable terminals

LED Indicators

Off	Output Inactive
Green	Output Active

Specifications

Safety Ratings	
Standards	EN 954-1, EN IEC 62061, ISO 13849-1, IEC/EN 60204-1, ISO 12100, IEC 60947-4-1, IEC 60947-5-1, ANSI B11.19, AS 4024.1
Safety Classification	Cat. 3 per EN 954-1 (ISO 13849-1), SIL CL2 per EN IEC 62061, PLe per ISO 13849-1
Functional Safety Data ∗ **Note**: For up-to-date information, visit *http://www.ab.com/Safety/*	PFH_D: < 7.7 x 10^{-10} MTTFd: > 373 years Suitable for performance levels Ple (according to ISO 13849-1:2006) and for use in SIL3 systems (according to IEC 62061) depending on the architecture and application characteristics
Certifications	CE Marked for all applicable directives, cULus, c-Tick, and TÜV
Power Supply	
Input Power Entry	24V DC from base unit
Power Consumption	2.5 W
Inputs	
Safety Inputs	Configured on base unit
Reset	Configured on base unit
Outputs	
Safety Contacts	3 N.O.
Auxiliary Contacts	1 N.C.
Thermal Current I_{th}	2 x 5 A, 3 x 4 A (nonswitching)
Rated Impulse withstand Voltage	2500V
Switching Current @ Voltage, Min.	10 mA @ 10V DC
Fuses, Output	6 A slow blow or 10 A quick blow (external recommended)
Electrical Life (Operations)	220V AC/4 A/880V A cosϕ = 0.35…0.1 M 220V AC/1.7 A/375V A cosϕ = 0.6…0.5 M 30V DC/2 A/60 W = 1 M 10V DC/0.01 A/0.1 W = 2 M
Mechanical Life	10,000,000 cycles
Status Indicators	Output: Green = Output active
Output Utilization	
Resistive:	AC-1: 6 A/250V AC; DC-1: 6 A/24V DC
Inductive:	AC-15: 5 A/250V AC; DC-13: 3 A/30V DC
UL	B300, P300, 2 x 5 A or 3 x 4 A res 250V
Environmental and Physical Characteristics	
Enclosure Type Rating/ Terminal Protection	IP40 (NEMA 1)/ IP20
Operating Temperature [C (F)]	-5…+55 ° (23…131 °)
Vibration	10…55 Hz, 0.35 mm
Shock	10 g, 16 ms, 100 shocks
Mounting	35 mm DIN Rail
Weight [g (lbs)]	205 (0.45)
Conductor Size, Max.	0.2…2.5 mm^2 (24…12 AWG)

∗ Usable for ISO 13849-1:2006 and IEC 62061. Data is based on the following assumptions:
- Mission time/Proof test interval of 20 years
- Functional test at least once within six-month period

Product Selection

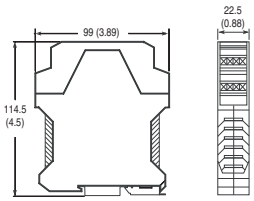
Group No.	Safety Outputs	Auxiliary Outputs	Terminals	Reset Type	Power Supply	Cat. No.
1	3 N.O.	1 N.C.	Removable	—	24V DC from the base unit	440R-W23224
2						440R-W23225
3						440R-W23226

Accessories

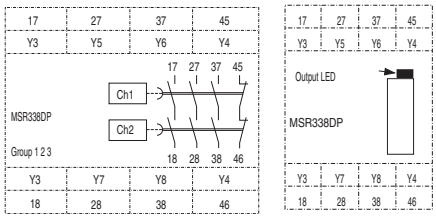
Description	Cat. No.
Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228

Approximate Dimensions

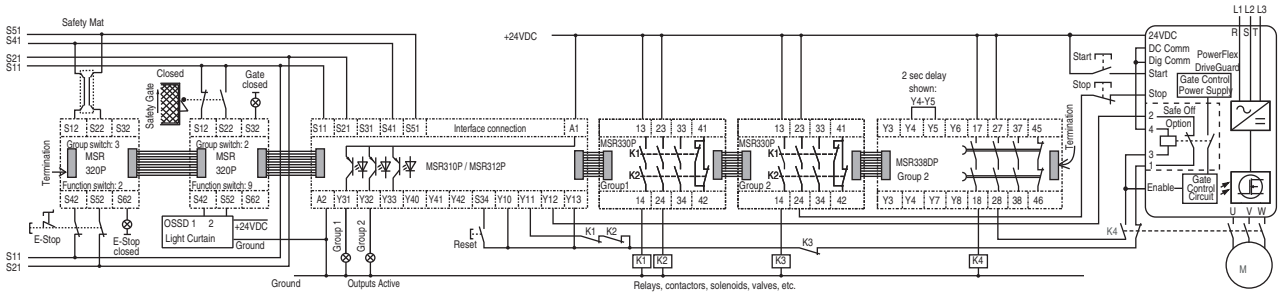
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Block Diagram



Typical Wiring Diagrams



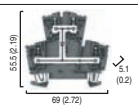
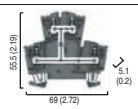
MSR 300 system with various Inputs. Two Output Groups with common monitored reset, each Group with monitored contactors Safety Mat or E-Stop shut down both Groups, Safety Gate and Light Curtain only shut down the Group 2 modules: Controlled Stop via instant contacts, delayed Safe Off and Power removal via MSR338DP

Off-Delay Time Table

			All jumpers (links) on the terminals identified to achieve the desired off delay.					
Delay(s)	Jumper	Jumper	Delay(s)	Jumper	Jumper	Delay(s)	Jumper	Jumper
0	None	None	8	Y3-Y6	Y3-Y7	50	Y3-Y6	Y3-Y8
0.5	Y3-Y5	None	9	Y4-Y5	Y3-Y7	60	Y4-Y5	Y3-Y8
1	Y4-Y6	None	10	None	Y4-Y8	80	None	Y4-Y7
1.5	Y3-Y6	None	12	Y3-Y5	Y4-Y8	100	Y3-Y5	Y4-Y7
2	Y4-Y5	None	15	Y4-Y6	Y4-Y8	120	Y4-Y6	Y4-Y7
3	Y3-Y5	Y4-Y6	18	Y3-Y6	Y4-Y8	160	Y3-Y6	Y4-Y7
4	Y3-Y6	Y4-Y5	21	Y4-Y5	Y4-Y8	200	Y4-Y5	Y4-Y7
5	None	Y3-Y7	26	None	Y3-Y8	250	Y3-Y5, Y4-Y6	Y4-Y7
6	Y3-Y5	Y3-Y7	30	Y3-Y5	Y3-Y8	300	Y3-Y6, Y4-Y5	Y4-Y7
7	Y4-Y6	Y3-Y7	40	Y4-Y6	Y3-Y8			

Accessories

Description		Cat. No.
	Fuse, 250 mA—Bussmann Cat. No. ETF-250mA	440A-A09196
	500 mA fuse—Bussmann Cat. No. ETF-500 mA	440R-A31562
	Fuse, 1 A—Bussman Cat. No. ETF-1	440R-A70972
	Fuse, 2 A—Bussmann Cat. No. ETF-2	440A-A09197
	MSR200, Two Terminators	440R-A17138
	MSR300 Two Terminators	440R-A17234
	Bag of 4, 4-Pin Screw Terminal Blocks	440R-A23209
	Bag of 4, 3-Pin Screw Terminal Blocks	440R-A23210
	Bag of 4, 4-Pin Spring Clamp Terminal Blocks	440R-A23228
	Bag of 4, 3-Pin Spring Clamp Terminal Blocks	440R-A23229
	Ribbon cable—for one MSR45E	**440R-ACABL1**
	Ribbon cable—for two MSR45Es	440R-ACABL2
	Ribbon cable—for three MSR45Es	440R-ACABL3
	Replacement terminal block kit—MSR41	440R-ATERM1P
	Replacement terminal block kit—MSR42	440R-ATERM2P
	Replacement terminal block kit—MSR45E	440R-ATERM2C
	USB optical interface software configuration tool used to configure the MSR42	445L-AF6150
	Replacement suction cup	445L-AF6151
	Optical interface fastener	445L-AF6152

Description		Cat. No.
	24V DC power supply 2.1 A	1606-XLP50E
	24V DC power supply 3.0 A	1606-XLP72E
	24V DC power supply 5 A	1606-XL120D
	Non-illuminated, 40 mm Twist-to-release maintained mushroom (plastic)	800FP-MT44
	Non-illuminated, 40 mm Twist-to-release maintained mushroom (metal)	800FM-MT44
	Terminal Block with Diode (Forward)	**1492-JD3DF**
	Terminal Block with Diode (Reverse)	**1492-JD3DR**
	70 mm Tower Light Clear Module—Black Base (no bulb)	855T-B00XN7
	70 mm Tower Light Clear Module—Grey Base (no bulb)	855T-G00XN7
	70 mm Tower Light Clear Module—Black Base (LED)	855T-B24YL7
	70 mm Tower Light Clear Module—Grey Base (LED)	855T-G24YL7

Programmable Safety Solutions Overview

Safety PLC systems bring the programmability and flexibility of traditional PLC systems to complex safety applications. Their programmable nature means that safety applications can now be solved in software rather than hard-wiring large, cascaded relay systems. This makes activities such as zone control and simplified machine access procedures much easier to achieve. Safety I/O modules are connected to Safety PLCs via safety certified networks, reducing wiring costs and allowing for advanced diagnostic information to be monitored by the safety PLC and shared with HMI systems. This results in reduced costs associated with wiring, troubleshooting and managing production equipment.

Benefits of safety PLCs include:

- **Flexibility.** Safety PLCs are programmable systems. This allows control engineers to easily design applications in which the behavior of the safety system can be flexible and based on the mode that the machine is currently operating in, the zone of the machine being accessed or the task that an operator or maintenance person is performing. This means that Safety PLCs can be used to help solve applications that are difficult if not impossible to solve with traditional safety relay systems.
- **Productivity.** The flexible programming of Safety PLCs permits control engineers to create maintenance modes of operation with "limited shutdown" capability, allowing for quicker access to production equipment and faster restart times, which help to reduce downtime. The extensive diagnostics also aid in the troubleshooting and repair of the system, improving MTTR (Mean Time to Repair) and further reducing downtime and improving productivity.
- **Wiring Simplification.** Safety input and output devices are wired directly to Safety I/O modules. These modules communicate to Safety PLCs via a single network cable. In applications that require logic or have safety devices distributed around equipment, Safety PLC systems can reduce the amount of wiring and commissioning effort required to install and start up production equipment.
- **Diagnostics.** Safety PLC systems perform internal and external diagnostics checks many times per second. Safety I/O modules also perform checks on their connected input and output devices. This information can be made easily available to operators and service personnel meaning that the exact source of a safety event can often be quickly identified and appropriate action taken, reducing MTTR, getting a machine back into production sooner.
- **Integration.** Safety PLCs enable machine makers to think of safety as part of the normal control of the machine, not just a piece that is added on at the end. Because safety PLCs communicate on standard automation networks, they allow for easy interlocking between the standard control system and the safety system. Some safety systems are so integrated, they can perform all of the standard machine control (sequential, motion, …) plus safety control, all from one unit.
- **Reliability.** Safety PLC systems are designed specifically for very high MTBF (Mean Time Between Failure) and very low PFD (Probability of Failure on Demand).
- **Expandability.** Safety PLC systems are easily expanded. Additional I/O modules can be added to the system and application code can be easily modified and expanded by control engineers.
- **Security.** All safety PLCs have a "Safety Signature" associated with them, a unique identifier that changes whenever any part of the safety configuration or program is changed. This allows for quick spot checks to determine that the safety system is still the way it was when commissioned. Also, some safety PLCs have multiple layers of password protection to allow only authorized personnel to make changes.
- Safety Certification. Safety PLCs are designed to meet stringent standards for programmable safety systems. To demonstrate their compliance, they are certified by professional testing agencies that they meet the appropriate standard. All Rockwell Automation safety systems are certified by the TÜV Rheinland Group for use in applications up to SIL 3 per IEC 61508, and PLe/Category 4 per ISO 13849-1.

Typical applications for safety PLCs include (i) perimeter access control of production cells, robotic systems and complex manufacturing processes and lines, (ii) point of operation control for press and manual loading applications, and (iii) maintenance simplification, alternative methods for lockout/tagout and other applications where users want to streamline the service procedures for production equipment. Safety PLC systems typically consist of (i) a safety PLC where the user-designed application code is executed, (ii) safety I/O which is where safety input and output devices are wired, and (iii) a safety network that allows the safety PLC to communicate with the safety I/O and with each other. The safety PLC system provides you with an environment to write and execute application code with a very high safety integrity. You generate the application code that is executed in the safety PLC system and then, as part of the commissioning process, validate (test) that the safety PLC system mitigates the safety hazards that it was designed to monitor and control.

Rockwell Automation Safety PLCs

Rockwell Automation manufactures three distinct families of safety PLCs and a variety of safety I/O modules.

SmartGuard™ 600 Controllers

The SmartGuard 600 controller is designed for applications that require some complex logic. It is a "packaged safety controller" that includes the CPU, 16 Safety Inputs and 8 Safety Outputs and an embedded DeviceNet communications port all in one unit. Using the DeviceNet communications port, the SmartGuard 600 controller can control additional safety I/O modules including the 1791DS CompactBlock Guard I/O and 1732DS ArmorBlock Guard I/O, as well as 1734 POINT Guard I/O modules via a 1734-PDN module. In addition, the SmartGuard controller can also communicate with standard PLCs and HMIs on DeviceNet or EtherNet/IP networks. SmartGuard 600 systems are programmed using RSNetWorx for DeviceNet software. For more information on SmartGuard 600 controllers, see page 5-119.

GuardPLC™ Controllers

GuardPLC refers to a family of safety controllers that are programmed with the RSLogix Guard PLUS software package. Like the SmartGuard 600, the GuardPLC 1600 and GuardPLC 1800 Safety PLCs are "packaged safety controllers" with a CPU, safety I/O and embedded communication networks. In the case of the GuardPLC 1600 and 1800 the embedded communication network is Ethernet for communication to GuardPLC Safety I/O modules as well as EtherNet/IP for communications to standard controllers and HMIs. The GuardPLC 1600 includes 20 safety inputs and 8 safety outputs. The GuardPLC 1800 includes 24 safety inputs, 8 safety outputs, 8 safety analog inputs and 2 safety rated high speed counters. For more information on GuardPLC controllers, see page 5-123.

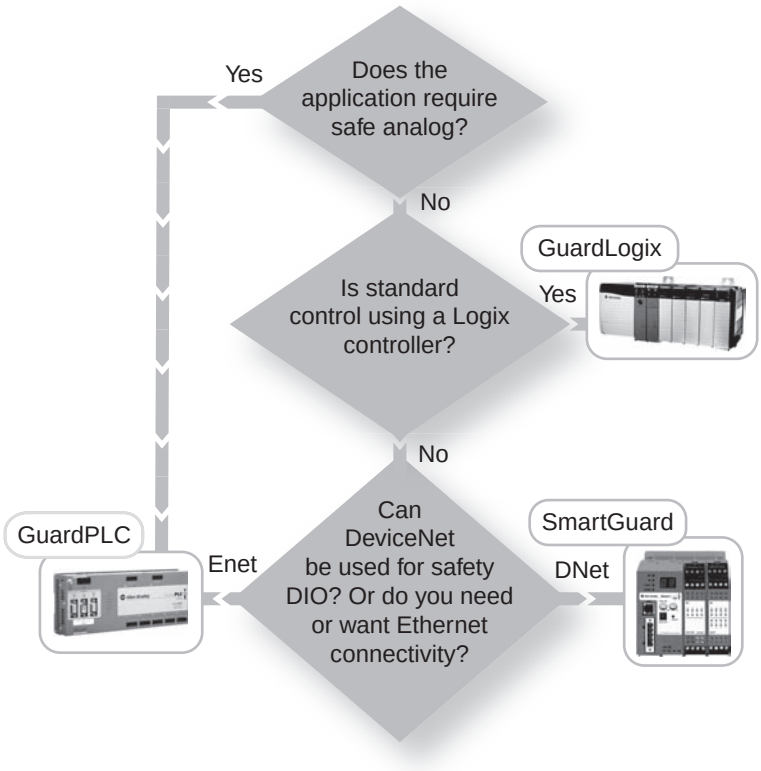
GuardLogix® Controllers

The GuardLogix system is a Logix5000™ controller that in addition to running all standard control functions like sequential, motion, etc., also has the ability to run a Safety Task and control safety I/O. This enables both safety and standard applications to run simultaneously in a single application project. This reduces integration, spare parts, training and improves the flow of data to HMI and information systems. A GuardLogix controller communicates to Guard I/O modules via standard control networks (EtherNet/IP or DeviceNet™) using the CIP Safety protocol. It is programmed with RSLogix™ 5000 software, just like a Logix5000™ processor. For more information on GuardLogix controllers, see page 5-133.

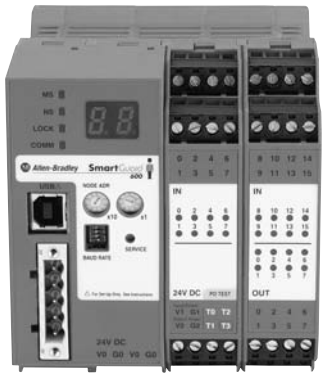
Guard I/O™ Modules

Guard I/O is the name for the Rockwell Automation family of Safety I/O modules that communicate via CIP Safety on EtherNet/IP and DeviceNet networks. CompactBlock Guard I/O modules on EtherNet/IP and DeviceNet networks are available in IP20 (in-cabinet) form-factor ArmorBlock Guard I/O modules on DeviceNet networks are available in IP67 (on-machine) form-factors. POINT Guard I/O modules provide EtherNet/IP connectivity in a maximum density in-cabinet I/O solution. For more information on Guard I/O modules, see page 5-137.

Safety Logic Selection Flowchart



Product	 SmartGuard™ 600 (Bulletin 1752) page 5-119	 GuardPLC™ Controllers (Bulletin 1753) page 5-123	 GuardLogix® Controllers (Bulletin 1756) page 5-133
Form Factor	• Standalone	• Standalone	• ControlLogix® Chassis (1756 GuardLogix controller) • 1768 CompactLogix (1768 Compact GuardLogix controller)
Safety Communication Network	• DeviceNet™ (on-board)	• GuardPLC Ethernet (on-board)	• DeviceNet and EtherNet/IP via 1756-based communication bridges
Standard Communication Network	• DeviceNet (on-board) • EtherNet/IP (on-board 1752-L24BBBE)	• EtherNet/IP (on-board) • Profibus or Modbus (on-board)	• Many via 1756-based or 1768-based communication bridges
Programming Network	• DeviceNet (on-board) • USB (on-board) • EtherNet/IP (on-board 1752-L24BBBE)	• GuardPLC Ethernet (on-board)	• EtherNet/IP, ControlNet, DeviceNet via 1756-based or 1768-based communication bridges
Programming Editor	• RSNetWorx™ for DeviceNet™ Software	• RSLogix Guard PLUS! Software	• RSLogix™ 5000 Software
Discrete Safety I/O	• 16 safety inputs/8 safety outputs (on-board) • Guard I/O (remote via DeviceNet network)	• 20 or 24 safety inputs/8 safety outputs • GuardPLC I/O (remote via GuardPLC Ethernet)	• Guard I/O™ (remote via DeviceNet or EtherNet/IP networks)
Safety Analog Input	N/A	• 8 safety analog inputs (on-board GuardPLC 1800) • 8 safety analog inputs (remote via GuardPLC I/O Module)	N/A
High Speed Counter	N/A	• 2 high speed counter inputs (on-board GuardPLC 1800)	N/A



Description

The SmartGuard 600 safety controller is a programmable safety controller designed for safety applications that require some complex logic allowing for more advanced safety functionality. It features 16 safety-rated inputs, 8 safety-rated outputs, 4 pulse test sources and an optional EtherNet/IP™ port. To support both standard CIP and CIP safety, a DeviceNet™ connection is also included. Configuration and programming is accomplished on EtherNet/IP, DeviceNet, or through the built-in USB port.

Since the SmartGuard 600 safety controller is a safety master on the DeviceNet network, you can use Rockwell Automation Guard I/O™ modules to expand the number of safety devices the SmartGuard 600 controller can control. It can also perform safety interlocking between a GuardLogix or other SmartGuard 600 controllers. With your choice of EtherNet/IP™ or DeviceNet™ communication, other devices such as standard PLCs and HMIs can read data out of the SmartGuard 600 controller for system-level diagnostics and troubleshooting.

Use RSNetWorx™ for DeviceNet™ software to configure the network and program the controller. From within RSNetWorx for DeviceNet software, you can launch an editor that lets you write function block programs for the SmartGuard 600 controller. No additional programming software is required. With ten safety application instructions, plus another dozen logic and timing instructions, you can write powerful, yet simple safety control programs.

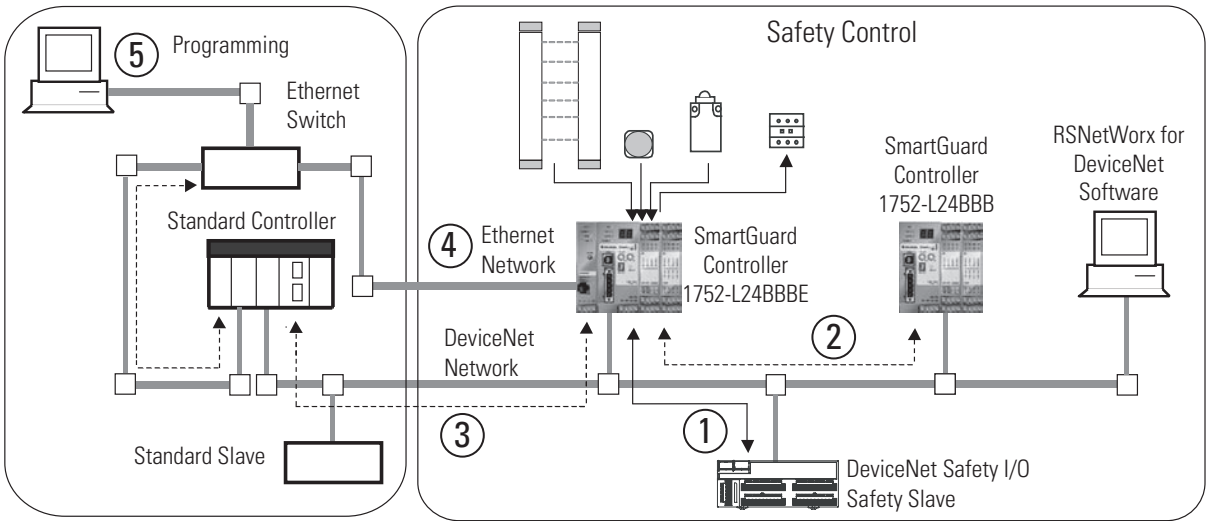
Benefits

- Small, cost-effective, intelligent safety controller
- Ideal mid-level safety controller when the application is too complex for a safety relay, yet too simple for a full-sized safety PLC
- Use the DeviceNet network to distribute safety I/O and integrate into a standard control system
- Use RSNetWorx for DeviceNet software for configuration and programming — no special programming software required

Networking with SmartGuard 600 Controllers

The SmartGuard 600 controller can function simultaneously as a DeviceNet safety master, DeviceNet safety slave, and DeviceNet standard slave as well as an EtherNet/IP target (see network illustration).

- As a DeviceNet safety master (1), the SmartGuard 600 controller can control up to 32 Guard I/O modules. These 1791DS and 1732DS modules are the same distributed safety I/O modules used with GuardLogix controllers.
- As a DeviceNet safety slave (2), the SmartGuard 600 controller looks like distributed safety I/O to a safety master. A GuardLogix or another SmartGuard safety master can read and write safety data to the SmartGuard slave controller. This lets you perform distributed safety control through the interlocking of multiple controllers via CIP Safety on DeviceNet networks.
- As a DeviceNet standard slave (3), the SmartGuard 600 controller can look like a standard distributed I/O module and respond to explicit messages so that standard DeviceNet masters like ControlLogix, SLC 500, or PLC-5 controllers or an HMI can read and write information to and from the SmartGuard 600 controller. This facilitates coordination with your standard PLC application, including displaying safety system information on an HMI.
- As an EtherNet/IP standard target (4), the SmartGuard 600 controller communicates with an Ethernet/IP standard originator, such as a CompactLogix or MicroLogix controller or an HMI device.
- As a limited EtherNet/IP bridge device (5), the SmartGuard 600 controller lets programming tools bridge to DeviceNet to view and program the SmartGuard 600 controller and configure other DeviceNet devices.



Configuration and Programming

You can program and configure the SmartGuard 600 controller through its USB port, through a DeviceNet connection or through an Ethernet connection. The SmartGuard's USB port has limited pass-through capabilities, letting you configure other devices on DeviceNet networks. You can use any type of A-to-B connection USB cable that supports USB 1.x or 2.0. Alternatively, you can connect to the SmartGuard controller through its DeviceNet port via a PCD card or a PC connected to an EtherNet/IP-to-DeviceNet linking device or gateway. You can also connect the 1752-L24BBBE SmartGuard controller to a PC's Ethernet port using a Category 5 Ethernet cable.

Safety System Management

Multiple system management tools are built into the SmartGuard 600 controller and RSNetWorx for DeviceNet software.

- You can password-protect the entire SmartGuard 600 controller so you cannot download any changes without the password. You can also password-protect the program with a separate password, to help prevent unauthorized edits to the program.
- Each safety device contains a configuration signature that changes any time the DeviceNet configuration or SmartGuard program changes, even if it is changed back to its original state. The configuration signature can be read by external devices, such as standard PLCs, HMI, or asset management software, to determine whether the configuration or program has been changed.
- Lastly, you can use the Safety Device Verification Wizard in RSNetWorx for DeviceNet software to safety-lock the SmartGuard 600 controller. Safety-locking via the Safety Device Verification Wizard verifies that the offline and online configuration and program are identical and provides documentation that you can keep in your files to show that the controller has not been tampered with.

Typical Applications

The SmartGuard 600 controller is positioned between a safety relay system and a safety PLC. It is ideally sized for applications that cannot be solved with safety relays, or are very cumbersome to solve with relays, but are not complex enough for a traditional safety PLC like a GuardLogix® or GuardPLC™ controller.

- Applications where a safety relay solution (or configurable safety relay solution) is just too complex
- Applications that require distributed safety I/O and/or network integration with a standard PLC
- Applications where GuardLogix or GuardPLC controllers seem too big (or are not cost-effective)
- Applications that require multi-zone control
- Complex light curtain applications; for example, implementing light curtain muting when a robot is not in the operator load zone and monitoring an enable pendant that lets the operator enter the zone with the robot present.

Catalog Numbers and Related Products

Cat. No.	Product Description
1752-L24BBB	SmartGuard 600 Safety Controller
1752-L24BBBE	SmartGuard 600 Controller with EtherNet/IP
9357-DNETL3	RSNetWorx for DeviceNet✶
9355-WAB100ENE	RSLinx Classic (Lite)❄

✶ 1752-L24BBB requires version 8 (minimum) or version 9.1 (recommended); 1752-L24BBBE requires version 9.1 or later
❄ 1752-L24BBB requires version 2.51 or later; 1752-L24BBBE requires version 2.55 or later

Specifications

Environmental Specifications and Certifications

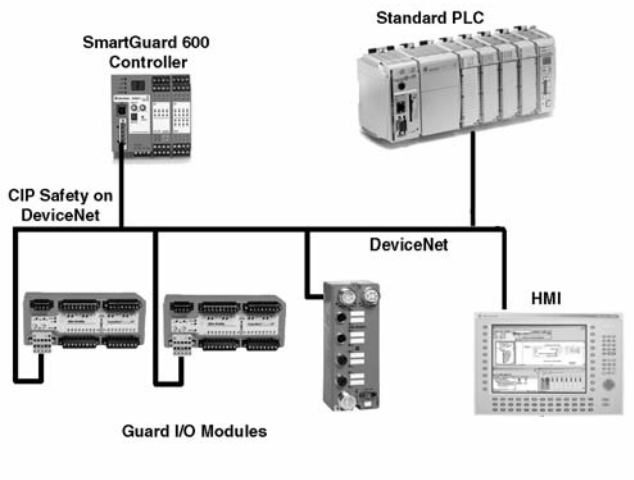
Cat. No.	1752-L24BBB	1752-L24BBBE
Operating Temperature	-10…55 °C (14…131 °F)	
Non-Operating Temperature	-40…70 °C (-40…158 °F)	
Relative Humidity	10…95% noncondensing	
Vibration	0.35 mm @ 10…57 Hz 5 g @ 57…500 Hz	5 g @ 10…500 Hz
Shock, Operating	15 g	
Certifications✶	UL, CE, C-Tick, cULus Class I Div 2 Hazardous, UL NRGF, NFPA 79, certified by TÜV for Functional Safety up to SIL 3, and PLe/Cat. 4	

✶ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.

Controller Specifications

Cat. No.	1752-L24BBB	1752-L24BBBE
Supply Voltage	20.4…26.4V DC (24V DC, -15…10%)	20.4…26.4V DC (24V DC, -15…10%)
Input Voltage Range	11…25V DC DeviceNet Specification	11…25V DC DeviceNet Specification
DeviceNet Current (mA)	15 mA	15 mA
Current Consumption	230 mA @ 24V DC	280 mA @ 24V DC
Digital Inputs		
Number of Digital Inputs	16	16
Voltage, On-State Input, Min.	11V DC	11V DC
Voltage, Off-State Input, Max.	5V DC	5V DC
Current, Off-State Input, Max.	1 mA	1 mA
Current, On-State Input, Nom.	4.5 mA	4.5 mA
Digital Outputs		
Number of Digital Outputs	8	8
Output Current Rating	0.5 A	0.5 A
Voltage, Off-State Output, Max.	1.2V	1.2V
Leakage Current, Off-State Output, Max	0.1 mA	0.1 mA
Pulse Test Sources		
Number of Pulse Test Sources	4	4
Pulse Test Output Current	0.7 A	0.7 A
Pulse Test Voltage, Off-State Output, Max.	1.2V	1.2V
Pulse Test Output Leakage Current, Max.	0.1 mA	0.1 mA
General		
Dimensions (HxWxD), Metric	99.0 x 90.4 x 131.4 mm	99.0 x 113.0 x 131.4 mm
Dimensions (HxWxD), Imperial	3.90 x 3.56 x 5.18 in.	3.90 x 4.48 x 5.18 in.
Weight, Metric	470 g	575 g
Weight, Imperial	1.03 lb	1.27 lb

Typical SmartGuard 600 System Architectures



SmartGuard 600 controller (1752-L24BBB) on a DeviceNet network.

RSNetWorx™ for DeviceNet™ Software Description

RSNetWorx™ for DeviceNet™ software is the premier configuration software for your Open DeviceNet Vendor Association DeviceNet network; it provides configuration management and diagnostic features, and it is one of the most advanced DeviceNet network management software packages available today. RSNetWorx Software for DeviceNet Network helps you achieve maximum productivity with your DeviceNet installations.

You can quickly define the devices on your DeviceNet network and the input/output exchanges that take place through this simple software interface.

RSNetWorx for DeviceNet software supports configuration of DeviceNet Safety devices. A Safety Device Verification Wizard guides you through the verification and configuration locking process and provides a report listing the configuration information for all of the safety devices on the network.

RSNetWorx Software for DeviceNet contains the editor used to program the SmartGuard 600 controller. Once you have configured your network containing a SmartGuard 600 controller, you launch the editor, which lets you write function block programs. No additional programming software is needed!

Cat. No.	Description
9357-DNETL3	RSNetWorx for DeviceNet

Benefits

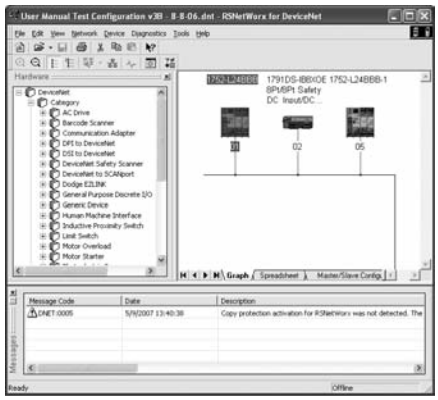
- Define the devices that are present on your network. You can either manually drag/drop devices/modules or go online to a DeviceNet network and let the software determine the devices/modules that are present.
- Define configuration settings for devices on the DeviceNet network through a convenient property page interface.
- Define the input/output information exchanges that you want to take place on the DeviceNet network.
- Access a comprehensive product tutorial to help you get the most value from the software as quickly as possible.
- Receive troubleshooting hints whenever error messages are presented, making you more productive.
- Configure and exchange data with DeviceNet Safety Scanner and DeviceNet Safety I/O nodes.
- Verify and lock safety devices for use in high-integrity safety systems.

System Requirements

RSNetWorx software can be used with these operating systems:

- Microsoft Windows Vista
- Microsoft Windows XP
- Microsoft Windows 2000

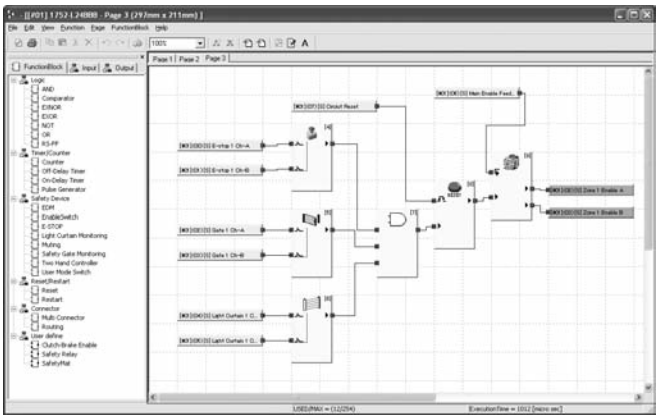
RSNetWorx for DeviceNet Software Examples



Use RSNetWorx for DeviceNet software to configure all of your DeviceNet devices, including SmartGuard 600 controllers and Guard I/O modules.



The Properties page for the SmartGuard 600 controller allows you to configure all of its parameters including I/O tags, I/O discrepancy times, connections to Guard I/O modules, and data that can be read by standard controllers or HMIs.



By clicking on the 'Logic' tab on the Properties dialog, RSNetWorx for DeviceNet software launches the editor for the SmartGuard 600 controller where you create your program using safety instructions, basic logic, timers, and counters. You also have the ability to create your own instructions.

Guard I/O™ Modules



When the SmartGuard 600 controller needs additional safety I/O points, you can control and monitor your safety device with Guard I/O. When used with SmartGuard controllers, Guard I/O communicates on DeviceNet using CIP Safety protocol. As a proven technology, Guard I/O detects failures at the I/O and field device level, while enhancing operator protection.

CompactBlock Guard I/O modules are available in IP20 (in-cabinet) form factor. ArmorBlock Guard I/O modules are IP67 (on-machine) form factor. POINT Guard I/O provides maximum I/O density in minimal panel space (used in conjunction with a 1734-PDN adapter on a DeviceNet network).

For more information on Guard I/O see page 5-137.

System Overview



The GuardPLC system is a state-of-the-art safety system offering fast safety PLCs, optimum controller throughput, and a reliable safety network.

The GuardPLC system meets the worldwide standard for programmable controls, complying with many of the latest global safety standards and the worldwide standard for functional safety in programmable electronic systems. The GuardPLC system can be used without restriction in applications up to Safety Integrity Level 3 (SIL 3) according to IEC 61508 and PLe/Category 4, according to ISO 13849-1.

The GuardPLC system consists of four main components:

- Packaged controller and associated integrated I/O
- Safety Communication via GuardPLC Ethernet networks
- Distributed I/O modules for GuardPLC Ethernet networks
- Programming and configuration software

Benefits

Benefits resulting from the use of safety PLCs and safety networks include:

- Greater integration and flexibility of machine controls.
- Capability for better and easier diagnostics when intelligence is provided to the standard control level
- Faster and easier maintenance
- Reduction in the cost of installation, commissioning, and reconfiguring
- Reduction in design and hardware costs, compared to using safety relays alone for logic
- Potential for throughput performance improvement in more complex systems

GuardPLC Safety Control Systems

	 GuardPLC 1600 5-125	 GuardPLC 1800 5-127	 GuardPLC Distributed I/O 5-129
Description	A cost-effective safety PLC offering a built-in 4-port Ethernet switch, digital I/O, and flexible communication options for connecting devices.	Analog inputs and high-speed counters allow the GuardPLC 1800 to sense temperature, pressure, speed, and motion.	Distributed safety I/O blocks provide exceptional flexibility in configuring the right mix of I/O in the right place.
Memory	• 250kB user program • 250kB application data	• 250kB user program • 250kB application data	—
Digital I/O	• 20 inputs • 8 outputs	• 24 inputs • 8 outputs	• 16 inputs only • 16 outputs only • 8 inputs and 8 outputs • 16 inputs and 8 outputs • 20 inputs and 8 outputs
Other I/O	—	• 8 analog inputs • 2 high-speed counters	• 8 analog inputs • 8 relay outputs
Embedded Ethernet	4-port switch	4-port switch	2-port switch
Other Communications	• EtherNet/IP • GuardPLC Ethernet • Modbus RTU Slave or PROFIBUS DP Slave • ASCII (RS-485)	• EtherNet/IP • GuardPLC Ethernet • Modbus RTU Slave or PROFIBUS DP Slave • ASCII (RS-485)	• GuardPLC Ethernet
Programming Software	All GuardPLC controllers are programmed with RSLogix Guard PLUS! programming software.		

GuardPLC™ Safety Control Systems

Overview

Communication

GuardPLC safety controllers communicate on a Safe Ethernet communications network called GuardPLC Ethernet. The network is certified by TÜV for use in safety applications up to SIL 3 and PLe/Category 4, and can be used for distributed safety I/O and peer-to-peer communications between GuardPLC controllers, as well as programming using RSLogix Guard PLUS! software. And because it's Ethernet, you use standard category 5 cables, switches and routers.

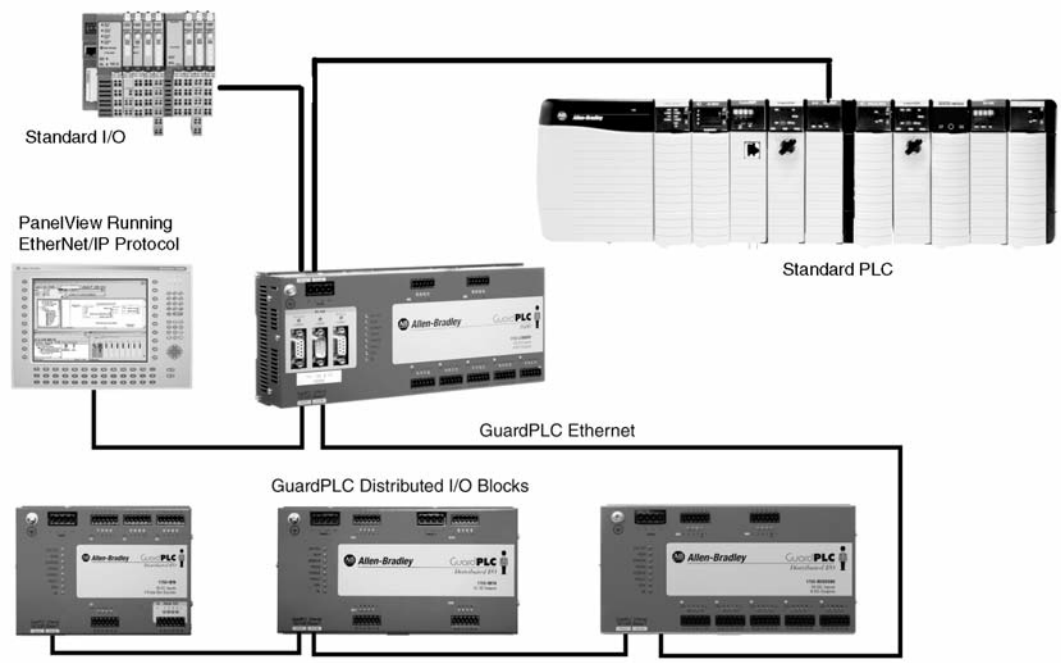
Using GuardPLC distributed I/O, you can place your safety I/O where your safety field devices are located, reducing wiring costs. Peer-to-peer communications allow GuardPLC controllers running their own programs to interlock with each other for applications that need to link one manufacturing cell to others.

NetLinx Integration

The ever-increasing demand for both enhanced plant productivity and improved workplace safety has fueled a trend toward integrated safety control and standard control systems. Control system users now expect their safety systems to possess all of the efficiencies and conveniences of their standard controls. Today's modern manufacturing plants will not accept safety systems that compromise productivity. Both machine builders and end users expect that the cost of implementing and maintaining a safety system will continue to drop without reducing the level of protection to the user.

The first level of integrating your GuardPLC controller into your standard control system is at the information network level. The GuardPLC 1600 and 1800 controllers let you to accomplish this easily with embedded EtherNet/IP protocol. Able to run EtherNet/IP protocol at the same time as safety-rated GuardPLC Ethernet protocol, the GuardPLC controller uses EtherNet/IP protocol to communicate status about the safety control system to other standard devices such as PLCs (ControlLogix®, FlexLogix™, CompactLogix™, SLC™ 500 or PLC-5®), HMIs (PanelView™, PanelView Plus, VersaView®) and others. The GuardPLC controller can even control standard I/O, like Flex I/O and Point I/O, on an EtherNet/IP network. This capability lets you integrate your GuardPLC on the EtherNet/IP network already running in your plant.

GuardPLC Typical Configuration



GuardPLC 1600 Controller



The GuardPLC 1600 controller is a mainstream, cost-effective safety PLC that provides onboard digital I/O, a built-in 4-port Ethernet switch, and flexible communication options for connection to HMIs and to standard PLCs.

Benefits

- 28 safety digital I/O points – designed specifically for interfacing with safety components such as e-stops, light curtains, etc.
- Embedded 4-port Ethernet switch – eliminates the need for external networking hardware, reducing system cost.
- EtherNet/IP for easy integration with standard PLCs and HMIs.
- Modbus RTU slave and PROFIBUS DP slave communication options – allow the controller to connect to standard PLCs and HMI devices, and an RS-485 port is available for ASCII communication (read only).
- Expandability – use GuardPLC Distributed I/O to cost-effectively expand your safety system.
- Removable terminal blocks – make swapping controllers an efficient task so operations can be up and running again quickly in the event of a failure.

Typical Applications

- Perimeter guarding for robot / weld cells
- Perimeter guarding for packaging machines
- Press controls
- Semiconductor tools
- Material handling systems

Product Design

The GuardPLC 1600 controller features a built-in four-port Ethernet switch and digital I/O (20 safety rated inputs and eight safety rated outputs). 100M GuardPLC Ethernet comes standard, plus for flexibility in connecting to HMI devices and standard PLCs, the controller includes EtherNet/IP, Modbus RTU Slave or PROFIBUS DP Slave, an RS-485 port for ASCII communications.

At 10 ms throughput, this controller is one of the fastest safety PLCs in the industry. Its exceptionally high mean time between failures helps increase the safety and reliability of your system. Removable terminal blocks make swapping controllers a quick task so operations can be up and running again quickly in the event of failure.

Features

- 28 digital I/O points: 20 inputs, 8 outputs
- Use GuardPLC Distributed I/O to expand safety system
- EtherNet/IP, RS-485 port for ASCII communication (read only)
- Embedded 4-port Ethernet switch eliminates the need for external networking hardware
- Modbus RTU slave and PROFIBUS DP slave communication options to connect to standard PLCs and HMI devices
- Certified by TÜV for use in applications to SIL 3 according to IEC 61508 and PLe/Category 4, according to ISO 13849-1
- Programmed with RSLogix Guard PLUS! Software
- DIN rail mounting
- Cost-effective safety control system

Specifications

General Specifications

The following specifications are common to all GuardPLC products unless indicated.

Temperature, operating	0…60 °C (32…140 °F)
Temperature, nonoperating	-40…85 °C (-40…185 °F) without backup battery
Relative Humidity	95%
Vibration	1 g @ 10…150 Hz
Shock, operating	15 g

Certifications

(When product is marked.)

Certifications	GuardPLC 1600, GuardPLC 1800, and 1753 I/O
c-UL-us	c-UL Listed Industrial Control Equipment.
CE	Compliant for all applicable directives.
C-Tick	C-Tick compliant with all applicable acts
Functional Safety	certified by TÜV up to SIL 3, and PLe/Cat. 4

GuardPLC 1600 Controller Specifications

Cat. No.	1753-L28BBBM	1753-L28BBBP
Application Memory	250 KB	
User Program Memory	250 Kbytes	
Available User Memory	500	
Current Consumption	8 A with maximum load 0.5 A idle current (controller only)	
Operating Voltage Range	24V DC, -15% to +20%, $w_{ss} \leq 15\%$∗	
Communication Ports	4 Ethernet 10/100BaseT ports 1 9-pin D-shell RS-485 port (Modbus Slave) 1 9-pin D-shell RS-485 port (GuardPLC ASCII) 1 9-pin D-shell Comm port (unused)	4 Ethernet 10/100BaseT ports 1 9-pin D-shell RS-485 port (PROFIBUS DP Slave) 1 9-pin D-shell RS-485 port (GuardPLC ASCII) 1 9-pin D-shell Comm port (unused)
Ethernet Port	4 x RJ-45, 10/100BaseT (with 100 Mbit/s) with integrated switch	
EtherNet/IP Communication Rate	10/100 Mbps	
Enclosure Protection	IP20	
Digital Inputs		
Number of Digital Inputs	20 safety❄	
Voltage, On-State Input, Max.	30V DC	
Voltage, On-State Input, Nom.	24V DC	
Digital Outputs		
Number of Digital Outputs	8 safety❄	
Current, On-State Output, per Channel	Channels 1…3; 5…7: 0.5 A @ 60 °C (140 °F) Channels 4 and 8: 1 A @ 60 °C (140 °F); 2 A @ 50 °C (122 °C)	
Voltage, On-State Output, Max.	26.8V DC	
Voltage, On-State Output, Min.	18.4V DC	
Voltage, On-State Output, Nom.	24V DC	
General		
Dimensions (HxWxD), Metric	114 x 257 x 78 mm‡	
Dimensions (HxWxD), Imperial	4.49 x 10.1 x 3.07 in‡	

∗ Requires a power supply with protective separation conforming to IEC 61131-2 requirements.
❄ Not electrically isolated.
‡ Height includes latch; width includes housing screws; depth includes grounding bolt and connectors.

GuardPLC 1800 Controller



The GuardPLC 1800 controller takes all the features of the GuardPLC 1600 controller, then adds analog inputs and high-speed counters for specialized applications such as emergency shut down, flame control, and amusement park ride control.

Benefits

- 32 safety digital I/O points – designed specifically for interfacing with safety components such as e-stops and light curtains.
- 8 safety-rated analog inputs – for sensing temperature, pressure, etc.
- 2 safety-rated high-speed counters – for sensing speed, flow, and motion.
- Embedded 4-port Ethernet switch – eliminates the need for external networking hardware.
- Supports EtherNet/IP protocol for easy integration with standard PLCs and HMIs.
- Modbus RTU slave and PROFIBUS DP slave communication options – lets the controller connect to standard PLCs and HMI devices, and an RS-485 port is available for ASCII communication (read only).
- Expandability – Use GuardPLC Distributed I/O to expand your safety system.
- Removable terminal blocks – make swapping controllers an efficient task so operations can be up and running again quickly in the event of a failure.

Typical Applications

- Emergency shutdown
- Burner management systems
- Perimeter guarding for robot / weld cells
- Perimeter guarding for packaging machines

Product Design

The GuardPLC 1800 controller has the same features as the GuardPLC 1600 controller with additional I/O, including analog I/O and high-speed counters for specialty applications. Built-in I/O includes 24 digital inputs, 8 digital outputs, 8 analog inputs, plus 2 high-speed counters. With GuardPLC distributed I/O you can place additional safety I/O where your safety field devices are located, reducing wiring costs.

The GuardPLC 1800 offers a built-in four-port Ethernet switch and 100M GuardPLC Ethernet comes standard. For flexibility in connecting to HMI devices and standard PLCs, the controller includes EtherNet/IP, Modbus RTU Slave or PROFIBUS DP Slave, an RS-485 port for ASCII communications.

At 10 ms throughput, this controller is one of the fastest safety PLCs in the industry. Its exceptionally high mean time between failures helps increase the safety and reliability of your system. Removable terminal blocks make swapping controllers a quick task so operations can be up and running again quickly in the event of failure.

Features

- 32 digital I/O points: 24 inputs, 8 outputs
- 8 analog inputs
- 2 high-speed counters
- EtherNet/IP for easy integration with standard PLCs and HMIs.
- Modbus RTU slave and PROFIBUS DP slave communication options – allow the controller to connect to standard PLCs and HMI devices, and an RS-485 port is available for ASCII communication (read only).
- Programmed with RSLogix Guard PLUS! software
- Certified by TÜV for use in applications to SIL 3 according to IEC 61508 and PLe/Category 4, according to ISO 13849-1
- DIN rail mounting

Specifications

General Specifications

The following specifications are common to all GuardPLC products unless indicated.

Temperature, operating	0…60 °C (32…140 °F)
Temperature, nonoperating	-40…85 °C (-40…185 °F) without backup battery
Relative Humidity	95%
Vibration	1 g @ 10…150 Hz
Shock, operating	15 g

Certifications

(When product is marked.)

Certifications	GuardPLC 1600, GuardPLC 1800, and 1753 I/O
c-UL-us	c-UL Listed Industrial Control Equipment.
CE	Compliant for all applicable directives.
C-Tick	C-Tick compliant with all applicable acts
Functional Safety	certified by TÜV up to SIL 3, and PLe/Cat. 4

GuardPLC 1800 Controller Specifications

Cat. No.	1753-L32BBBM8A	1753-L32BBBP8A
Application Memory	250 KB	
User Program Memory	250 Kbytes	
Available User Memory	500	
Current Consumption	9 A with maximum load 0.75 A idle current (controller only)	
Operating Voltage Range	24V DC, -15% to +20%, w_{ss} ≤ 15%✶	
Communication Ports	4 Ethernet 10/100BaseT ports 1 9-pin D-shell RS-485 port (Modbus Slave) 1 9-pin D-shell RS-485 port (GuardPLC ASCII) 1 9-pin D-shell Comm port (unused)	4 Ethernet 10/100BaseT ports 1 9-pin D-shell RS-485 port (PROFIBUS DP Slave) 1 9-pin D-shell RS-485 port (GuardPLC ASCII) 1 9-pin D-shell Comm port (unused)
Ethernet Port	4 RJ-45	
EtherNet/IP Communication Rate	10/100 Mbps	
Enclosure Protection	IP20	
Digital Inputs		
Number of Digital Inputs	24 safety❄	
Voltage, On-State Input, Max.	30V DC	
Voltage, On-State Input, Nom.	24V DC	
Digital Outputs		
Number of Digital Outputs	8 safety❄	
Current, On-State Output, per Channel	Channels 1…3; 5…7: 0.5 A @ 60 °C (140 °F) Channels 4 and 8: 1 A @ 60 °C (140 °F); 2 A @ 50 °C (122 °C)	
Voltage, On-State Output, Max.	Supply Voltage (L+)	
Voltage, On-State Output, Min.	Supply Voltage (L+) minus 2V	
Voltage, On-State Output, Nom.	24V DC	
Counters		
Number of Counters	2 safety❄	
Counter Resolution, Bits	24 bits	
Counting Frequency (kHz), Max.	100	
Inputs per Counter	3 (A, B, Z)	
Analog Inputs		
Number of Analog Inputs	8 safety‡	
Input Resolution	12-bit	
Input Signal Range	0…10V DC (nominal); -0.1…11.5V DC (service value) 0…20 mA (nominal); 0.4…23 mA (service value)§	
Accuracy	0.1% @ 25 °C (77 °F) 0.5% @ 60 °C (140 °F)	
Safety Accuracy	± 2%	
General		
Dimensions (HxWxD), Metric	114 x 257 x 81 mm♣	
Dimensions (HxWxD), Imperial	4.49 x 10.1 x 3.19 in♣	

✶ From a power supply with protective separation conforming to IEC 61131-2 requirements.
❄ Not electrically isolated.
‡ Unipolar, not electrically isolated.
§ With 500 Ω shunt.
♣ Height including latch; width including housing screws; depth including grounding bolt and shield plate.

Distributed Safety I/O for GuardPLC Ethernet



Take advantage of all the benefits of traditional distributed I/O with GuardPLC distributed safety I/O, available for all GuardPLC systems.

GuardPLC distributed I/O modules provide considerable flexibility in configuring the right mix of I/O in the right place. The 16 digital input module offers 4 pulse test source terminals, allowing users to pulse test all 16 digital inputs from the I/O module and providing PLe/Category 4 capable safety circuitry while retaining all the advantages of distributed I/O. The 16 digital output module is rated for 2A on every other output point, limiting the need for additional interposing safety relays for additional current and therefore saving on machine costs.

The safety relay output module can provide dry contact enable signals as well as high current AC or DC outputs. The 8 input/8 output and 16 input/8 output digital combination modules feature both positive and negative switching outputs, for applications that use diverse outputs. The analog input module lets you distribute analog inputs for more process-oriented safety applications.

All I/O modules include GuardPLC 100 Mbps Ethernet, which provides one of the fastest safety networks and machine stop times in the industry. The built-in two-port Ethernet switches make connecting I/O modules to the GuardPLC controller as easy as daisy-chaining Ethernet cable from I/O module to controller.

Benefits

- Place the I/O where the devices reside.
- Reduce wiring costs and the time necessary to wire the machine or cell.
- Reduce machine or cell start up time.
- Increase machine and cell reliability.

Digital Safety I/O Module Specifications

Cat. No.	1753-IB16	1753-IB8XOB8	1753-IB16XOB8	1753-IB20XOB8	1753-OB16
Description	GuardPLC Digital Input Module	GuardPLC Digital Combination Module	GuardPLC Digital Combination Module	GuardPLC Digital Combination Module	GuardPLC Digital Output Module
Operating Voltage Range	24V DC, -15%…+20%, w_{ss} 15%✶	24V DC, -15%…+20%, w_{ss} 15%✶	24V DC, -15%…+20%, w_{ss} 15%✶	24V DC, -15%…+20%, w_{ss} 15%✶	24V DC, -15%…+20% w_{ss} 15%✶
Digital Inputs					
Number of Digital Inputs	16 safety❄	8 safety❄	16 safety❄	20 safety❄	—
Voltage, On-State Input, Nom.	24V DC	24V DC	24V DC	24V DC	—
Digital Outputs					
Number of Digital Outputs	—	8 positive-switching and 2 negative-switching safety ❄	8 positive-switching and 8 negative-switching safety ❄	8 safety❄	16 safety❄
Current, On-State Output, per Channel	—	L+ Channels 1…3, 5…7: 0.5 A @ 60 °C (140 °F) L+ Channels 4 and 8: 1 A @ 60 °C (140 °F), 2 A @ 40 °C (104 °F) L- Channels 1 and 2: 1 A @ 60 °C (140 °F), 2 A @ 40 °C (104 °F)	Channels 2, 4, 5 and 7: 0.5 A @ 60 °C (140 °F) Channels 1 and 8: 1 A @ 60 °C (140 °F), 2 A @ 40 °C (104 °F) Channels 3 and 6: 1 A @ 60 °C (140 °F)	Channels 1…3, 5…7: 0.5 A @ 60 °C (140 °F) Channels 4 and 8: 1 A @ 60 °C (140 °F), 2 A @ 50 °C (122 °F)	1 A @ 60 °C (140 °F) 2 A @ 40 °C (104 °F)
Voltage, On-State Output, Max.	—	Supply Voltage (L+)	Supply Voltage (L+)	Supply Voltage (L+)	Supply Voltage (L+)
Pulse Test Sources					
Number of Pulse Test Sources	4❄	2❄	2❄	—	—
General					
Temperature, operating	0…60° C (32…140° F)	0…60°C (32…140°F)	0…60°C (32…140°F)	0…60°C (32…140°F)	0…60 °C (32…140 °F)
Temperature, nonoperating	-40…85 °C (-40…185 °F)	-40…85 °C (-40…185 °F)	-40…85 °C (-40…185 °F)	-40…85 °C (-40…185 °F)	-40…85 °C (-40…185 °F)
Dimensions (HxWxD), Metric	114 x 152 x 78 mm‡	114 x 152 x 78 mm‡	114 x 205 x 100 mm‡	114 x 207 x 78 mm‡	114 x 207 x 78 mm‡
Dimensions (HxWxD), Imperial	4.49 x 5 99 x 3.07 in‡	4.49 x 6.00 x 3.07 in‡	4.49 x 8.08 x 3.94 in‡	4.49 x 8.16 x 3.07 in‡	4.49 x 8.16 x 3.07 in‡

✶ Requires a power supply with protective separation, conforming to IEC 61131-2 requirements.
❄ Not electrically isolated.
‡ Height including latch; width including housing screws; depth including grounding bolt and connectors.

Digital Relay Safety Output Module Specifications

Cat. No.	1753-OW8
Description	GuardPLC Digital Relay Output Module
Number of Outputs	8 safety relay
Operating Voltage Range	24V DC, -15%…+20% w_{ss} 15%✶
Switching Voltage	5…250 V AC/ DC
Switching Current	• UL: 24V DC @ 1A resistive load, 250V AC @ 6 A general purpose • TUV: up to 240VA (for V AC), up to 30V DC @ 90 W, up to 70V DC @ 35 W, up to 127V DC @ 30 W
Service Life, Mechanical	≥10^6 switching cycles
Temperature, operating	0…60 °C (32…140 °F)
Temperature, nonoperating	-40…+85 °C (-40…+185 °F)
Dimensions (HxWxD), Metric	114 x 207 x 98 mm❄
Dimensions (HxWxD), Imperial	4.49 x 8.16 x 3.86 in❄

‡ External fusing adapted.
✶ Requires a power supply with protective separation, conforming to IEC 61131-2 requirements.
❄ Height including latch; width including housing screws; depth including grounding bolt and connectors.

Analog Safety I/O Module Specifications

Cat. No.	1753-IF8XOF4
Description	GuardPLC Analog Combination Module
Operating Voltage Range	24V DC, -15%…+20%, w_{ss} 15%✶
Number of Safety Analog Inputs	8
Input Signal Range	Nominal: 0…+10V DC or 0…20 mA (with shunt) Service: -0.1…+11.5V DC or -0.4…23 mA (with shunt)
Input Impedance	Analog Input: >2 MΩ
Input Resolution	12 bit
Accuracy	0.5%
Number of Analog Outputs (Standard)	4‡
Output Signal Range	4…20 mA 0…20 mA
Output Impedance	Current Output: 600 Ω max.
Temperature, operating	0…60°C (32…140°F)
Temperature, nonoperating	-40…85 °C (-40…185 °F)
Dimensions (HxWxD), Metric	114 x 207 x 111 mm❄
Dimensions (HxWxD), Imperial	4.49 x 8.16 x 4.37 in❄

‡ Non-safety-related with common safety switch-off.
✶ Requires a power supply with protective separation, conforming to IEC 61131-2 requirements.
❄ Height including latch; width including housing screws; depth including grounding bolt, connectors, and shield plate.

RSLogix Guard PLUS! Programming Software

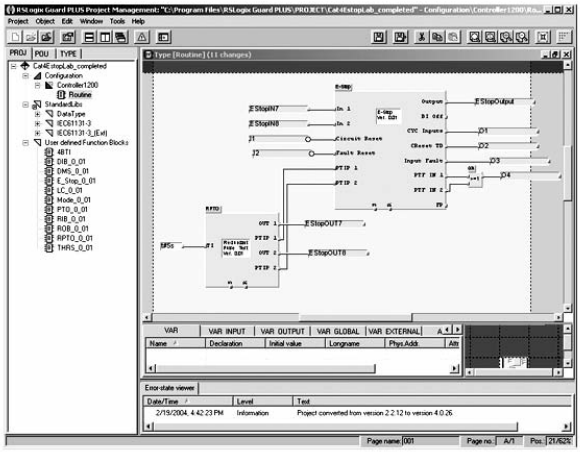
Development and testing of programs for all GuardPLC systems is done with RSLogix Guard PLUS! programming software, an easy to use yet highly powerful programming software. RSLogix Guard PLUS! software is project-based, meaning you can store programs for multiple controllers in one project.

RSLogix Guard PLUS! is based on graphical function blocks. Simply design your logic using pre-defined elements such as AND-gates, OR-gates, numerical functions, etc., then connect inputs and outputs using the mouse.
RSLogix Guard PLUS! software offers unlimited data tags, program pages, and function blocks for maximum flexibility.

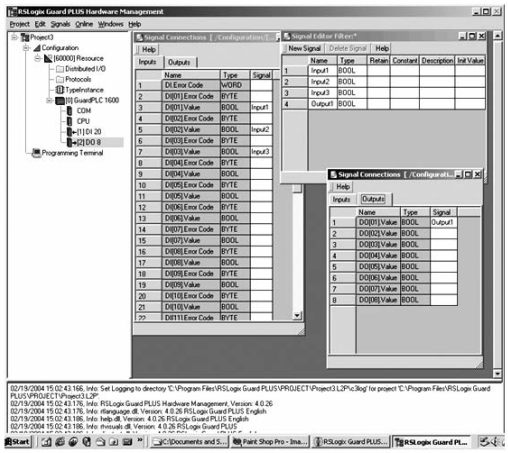
Once RSLogix Guard PLUS! software has been configured for the chosen controller, input and output variables are defined in a tag list to establish the link between hardware and software in a manner similar to that used by ControlLogix controllers and RSLogix 5000 programming software.

To save time and decrease development effort, the offline program simulation allows you to test your program without downloading it to a GuardPLC controller. Online program monitoring allows you to view your logic inside the controller to see which parts are logically true and false and to troubleshoot as necessary.

RSLogix Guard PLUS! Programming Software Examples



Use the project management screen to write a program, perform offline program simulation, and view the program running online.



The hardware management screen within RSLogix Guard PLUS! lets you configure the hardware of your GuardPLC system, create tags, and then drag them into your program.

Benefits

- Ease of use – program your safety control system using pre-defined graphical elements and a "drag and drop" palette.
- Tag-based system – define program variables to suit specific application and use variable names.
- Offline program simulation – test your program without using the controller.
- Online program monitoring – eases troubleshooting by viewing logic inside of GuardPLC controllers.
- Unlimited program pages and unlimited variables – configure program to suit specific needs.
- User-defined function blocks with library function – create your own specific instructions.
- Project-based controller linkage – store programs from multiple controllers in one project; ideal for cells that contain multiple GuardPLC controllers.
- Safety certified function blocks – save programming and configuration time by using function blocks that are already certified for use in safety applications.

System Requirements

Requirements to install RSLogix Guard PLUS! programming software on a personal computer.

Requirements	Minimum	Recommended
Personal Computer	Pentium III, 500 MHz	Pentium IV, 1.2 GHz
Operating System	Windows NT/2000	Windows NT/2000/XP
RAM	256 MB	512 MB
Free Hard Disk Space	at least 200 MB plus space for user programs	at least 200 MB plus space for user programs
Resolution	1024 x 768/256 colors	1280 x 1024/true color

GuardPLC™ Safety Control Systems

RXLogix Guard PLUS! Programming Software/GuardPLC Hand-held Terminal

RSLogix Guard PLUS! Programming Software

You can install RSLogix Guard PLUS! programming software on a local drive only (not a network).

Cat. No.	Description
1753-PCS-USB	RSLogix Guard PLUS! for all GuardPLC controllers. USB hardlock.
1753-PCS-PAR	RSLogix Guard PLUS! for all GuardPLC controllers. Parallel port hardlock.

Certified Function Blocks for RSLogix Guard PLUS!

GuardPLC Certified Function Blocks are additional, application-specific instructions that can be used in your GuardPLC controller's application program. Certified by TÜV, these function blocks make application development, debugging, and troubleshooting quicker and easier. Certified Function Blocks are sold in suites or libraries that contain several blocks for specific applications.

Cat. No.	Description
1753-CFBBASIC	Basic Suite of Certified Function Blocks. Includes: E-stop. Diverse Input, Light Curtain, Two-hand Run Station, Enable Pendant, Redundant Output, and Pulse Test Output.

GuardPLC OPC Server Software

GuardPLC OPC Server software allows a Windows-based PC to read data from and write data to the GuardPLC controller across the GuardPLC Ethernet network. For example, a VersaView computer could be running the GuardPLC OPC server and RSView software, then could display status information from the GuardPLC controller, such as which e-stop has been pressed, which gate is open, or which light curtain has been interrupted.

Cat. No.	Description
1753-OPC	GuardPLC OPC Server software

GuardPLC Hand-held Terminal



The GuardPLC Hand-held Terminal is a maintenance tool that lets you commission new GuardPLC controllers and Distributed I/O modules by downloading configuration data and the application program. Store all of the programs for a project on a multimedia memory card, and connect to any GuardPLC device on the Ethernet network. The hand-held terminal is ideal for a downtime event that requires quick replacement of a GuardPLC controller or DIO block, helping to get production up and running again.

1753-HHT Specifications

Operating Voltage Range	2.4…3.0V DC
Current Consumption	Approximately 360 mA (display illumination off) Approximately 560 mA (display illumination max)
Batteries	2 AA rechargeable batteries NiMH 2000 mAh or standard batteries
Operating Time, Min. with NiMH 2000 mAh batteries	Approximately 3 hours
Battery Charger, Supply Voltage	12V
Battery Charger, Current Input	≤ 0.83 A
Battery Charger, Charging Current	Approximately 1 A
Battery Charger, Trickle Charge	25 mA
Temperature, operating	5…55 °C (41…131 °F)
Temperature, nonoperating	-40…70 °C (-40…158 °F)
Relative Humidity	5…90% noncondensing
Vibration	5 g @ 10…500 Hz
Shock, operating	15 g
Dimensions (HxWxD), Metric	16.5 x 9 x 3 cm
Dimensions (HxWxD), Imperial	6.5 x 3.4 x 1.2 in
Weight, Metric	300 g
Weight, Imperial	0.66 lb

GuardLogix Integrated Safety System Overview



A GuardLogix® controller is a full-function Logix processor that also provides safety control. The GuardLogix system is a dual processor solution that uses a primary controller and a safety partner to achieve SIL 3, PLe. A major benefit of this system is that it is a single project, with safety and standard control together. The GuardLogix system is a 1oo2 safety architecture that provides unmatched safety and ease of use.

Just like other Logix processors during development, safety and standard have the same rules. Online editing, forcing, even multiple users are all allowed. Once the project is tested and ready for final validation, you set the Safety Task to a SIL 3 integrity level, which is then enforced by the GuardLogix controller. When safety memory is locked and protected, the safety logic cannot be modified. On the standard side of the GuardLogix controller, all functions operate like a regular Logix controller, motion, drive, sequential, even process. Thus, online editing, forcing, and other activities are all allowed, while safety is securely isolated.

With this level of integration, safety memory can be read by standard logic and external devices, such as HMIs or other controllers, eliminating the need to condition safety memory for use elsewhere. The result is easy, system-wide integration and the ability to display safety status on displays or marquees. Use Guard I/O modules for field device connectivity on Ethernet or DeviceNet networks. For safety interlocking between GuardLogix controllers, use Ethernet or ControlNet networks. Multiple GuardLogix controllers can share safety data for zone-to-zone interlocking, or a single GuardLogix controller can use remote distributed safety I/O between different cells/areas.

Environmentals and Certifications

GuardLogix Controllers Environmental Specifications

	1756 GuardLogix Controllers	1768 Compact GuardLogix Controllers∗
Operating temperature	0…60 °C (32…140 °F)	0…60 °C (32…140 °F)
Storage temperature	-40…85 °C (-40…185 °F)	-40…85 °C (-40…185 °F)
Relative humidity	5…95% noncondensing	5…95% noncondensing
Vibration	2 g at 10…500 Hz	5 g at 10…500 Hz
Operating shock	30 g	30 g
Nonoperating shock	50 g	50 g

∗ 1768 Compact GuardLogix controller specification and certification listings are preliminary.

GuardLogix Controllers Certifications

Certifications: UL, c-UL-us, CE, CSA, C-Tick, FM, ATEX, certified by TÜV for Functional Safety.

When product is marked. See the Product Certification link at www.ab.com/certification/ce to Declarations of Conformity, Certificates, and other certification details. For safety and SIL certification details, see www.rockwellautomation.com/products/certification/safety/index.html.

GuardLogix Controllers

Cat. No.	Description	User Memory		Module Expansion Capacity‡
		Standard Tasks and Components	Safety Task and Components	
1756-L61S	GuardLogix safety controller	2 MB	1 MB	Not applicable
1756-L62S		4 MB	1 MB	
1756-L63S		8 MB	3.75 MB	
1756-LSP	GuardLogix safety partner∗	—	—	
1768-L43S	Compact GuardLogix safety controller	2 MB	0.5 MB	1768 Modules: 2 1769 Modules: 16
1768-L45S		3 MB	1 MB	1768 Modules: 4 1769 Modules: 30

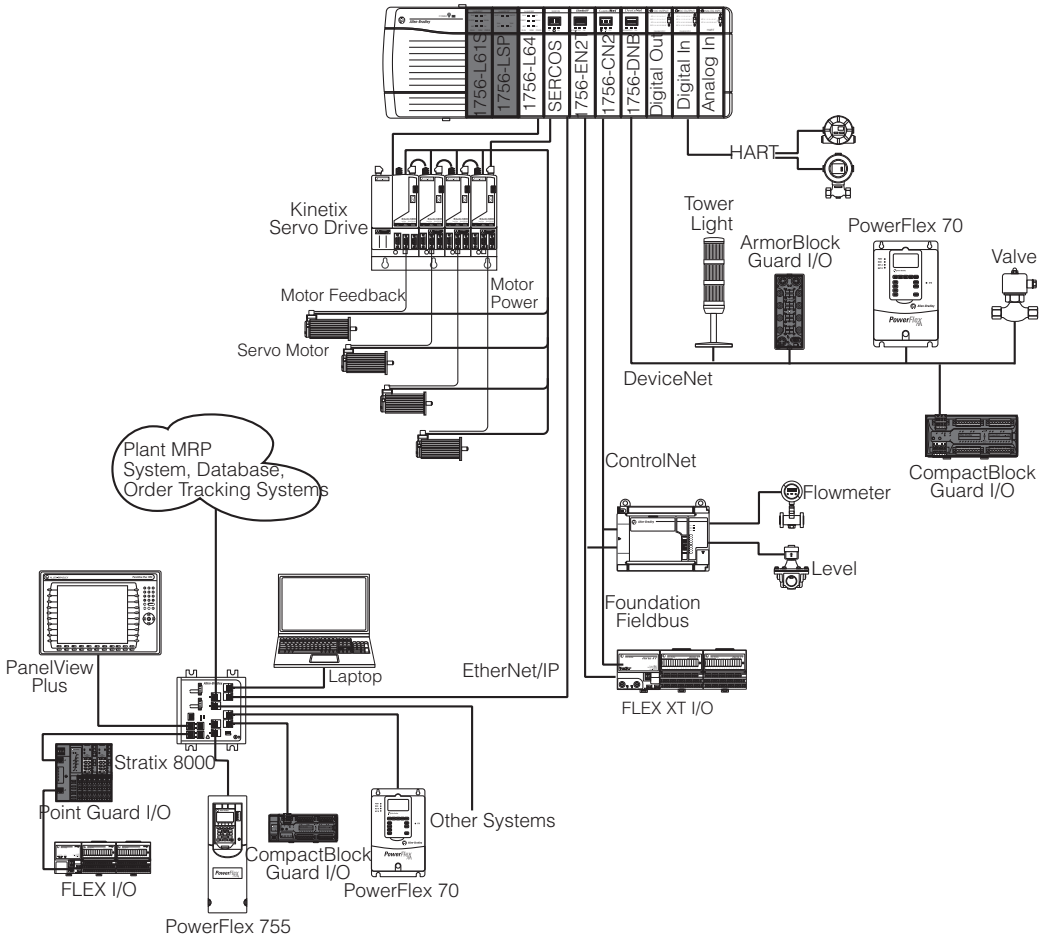
∗ A safety partner is required for each 1756 GuardLogix controller.
‡ You can install any combination of motion and network modules in a 1768 system. A maximum of two network modules may be installed in a 1768 system.

Features

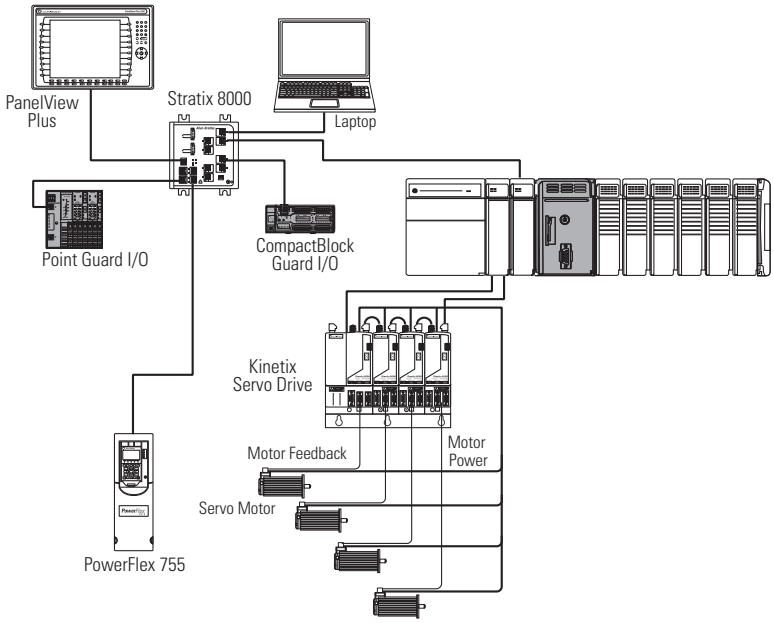
In addition to the standard features of a Logix controller, GuardLogix controllers have these safety-related features.

Feature	1756-L61S, 1756-L62S, 1756-L63S, 1756-LSP	1768-L43S, 1768-L45S	
Communication options	Standard and safety • EtherNet/IP • ControlNet • DeviceNet	Standard • EtherNet/IP • ControlNet • DeviceNet	Safety • EtherNet/IP • ControlNet
Network connections, per network module	• 256 EtherNet/IP; 128 TCP (1756-EN2x) • 128 EtherNet/IP; 64 TCP (1756-ENBT) • 100 ControlNet (1756-CN2/A) • 40 ControlNet (1756-CNB)	• 128 EtherNet/IP; 64 TCP (1768-ENBT) • 48 ControlNet (1768-CNB)	
Controller redundancy	Not supported		
Programming languages	Standard control—all languages Safety control—relay ladder		

Example Configuration—1756 GuardLogix System



Example Configuration—1768 Compact GuardLogix System



Standard Components in a GuardLogix System

Virtually all standard components are approved for use in GuardLogix safety systems. For specific series or version supported, see www.rockwellautomation.com/products/certification/safety/index.html.

For control that is not SIL 3 related, other 1756 series I/O modules can be used with 1756 GuardLogix controllers and 1768 or 1769 I/O modules can be used with 1768 Compact GuardLogix controllers. These modules must be certified to the Low Voltage and EMC Directives. Refer to www.ab.com/certification/ce to find the certificate for the Programmable Control – ControlLogix or CompactLogix Product Families.

Accessories

Replacement Batteries

	1756-BA2
Description	Lithium battery (0.59 g)
GuardLogix controllers	1756-L61S, 1756-L62S, 1756-L63S

Industrial CompactFlash Cards

CompactFlash cards offer nonvolatile memory (flash) to permanently store a user program and tag data on a controller. You install the 1784 CompactFlash card in a socket on the controller. You can manually trigger the controller to save to or load from nonvolatile memory or configure the controller to load from nonvolatile memory on power up.

1756 and 1768 GuardLogix controllers support user program storage or retrieval by using a CompactFlash card with version 18 or later of RSLogix 5000 software.

	1784-CF64	1784-CF128
Memory	64 MB	128 MB
Weight, approx.	14.2 g (0.5 oz)	

Software

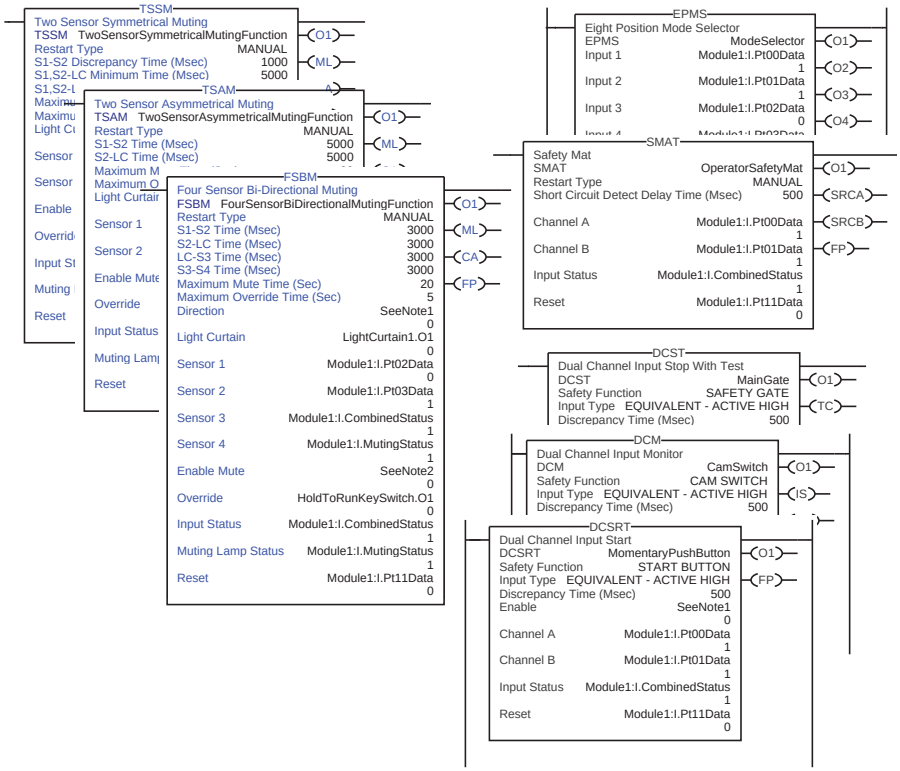
GuardLogix controllers use RSLogix™ 5000 programming software, the standard development environment for all Allen-Bradley Logix controllers. RSLogix 5000 software manages safety, so you don't have to manually manage the separation of standard and safety memory, or worry about partitioning logic to isolate safety.

FactoryTalk Suite from Rockwell Software extends the Rockwell Automation Integrated Architecture™ by providing an information tier of software applications and services for production and performance management. Tight integration with the Rockwell Automation Logix control platform, as well as connectivity to third-party and legacy systems can help deliver a seamless flow of high-fidelity data across your enterprise.

Safety-certified Instructions in RSLogix 5000 Software

All instructions available for use within the safety task are certified safety instructions. Choose from standard relay ladder safety instructions and safety application instructions, including:

- 49 safety-certified instructions
  - Subset of standard ladder logic instruction set
- Safety-certified application instructions
  - Dual channel suite - 6 instructions
  - Metalforming suite - 10 instructions
  - Muting suite - 3 instructions
  - Safety mat



Safety application instructions provide unmatched ease of use for complex safety functions like muting, safety gate control, metalforming, and more.

Guard I/O™ Modules

Overview

Guard I/O™ Modules Overview

Control and monitor your safety devices with Guard I/O. When used with Rockwell Automation safety controllers, Guard I/O communicates on EtherNet/IP or DeviceNet using CIP Safety protocol. As an effective technology, Guard I/O detects failures at the I/O and field device level, while helping enhance operator protection.

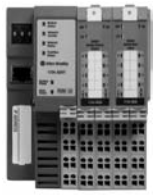
CompactBlock Guard I/O modules are available in IP20 (in-cabinet) form factor. ArmorBlock Guard I/O modules are IP64, IP65, or IP67 (on-machine) form factor (as marked on the product label) . POINT Guard I/O provides maximum I/O density in minimal panel space.

Guard I/O modules offer the following advantages when implementing a safety control system:

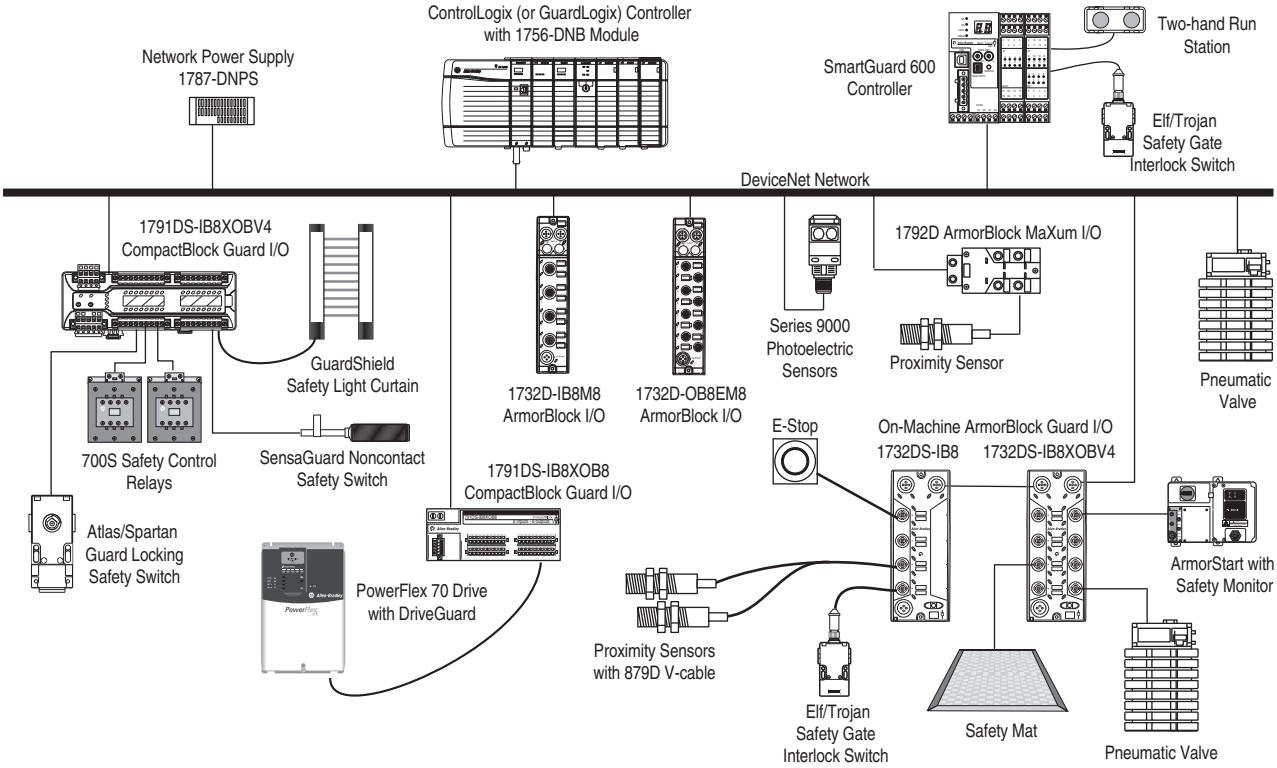
- **Reduced engineering** — Onboard, Guard I/O has self-diagnostics, hardware testing, and field circuit testing (short-circuit, wire break, discrepancy) with no additional programming required.
- **Cost-reduced hardware options** — Helps increase ability to safely shutdown an application without additional safety relays.
- **Space-savings** — Monitor and control more safety devices using less panel space.
- **Use of existing network infrastructures** — Connect to standard and safety I/O over one DeviceNet or EtherNet/IP network.
- **Flexibility and easy migration to EtherNet/IP** — The same Guard I/O modules for both DeviceNet and EtherNet/IP networks lets you re-use engineering designs.
- **High safety level** — certified by TÜV for Functional Safety up to SIL 3 and PLe/Category 4.

Common Guard I/O Module features:

- Integrated pulse test outputs for testing safety circuitry like e-stops and gate switches, for use in applications up to Performance Level e/Category 4. These outputs can also be used independently for standard output control or voltage source to sensors.
- Safety outputs, with integrated pulse testing for use in applications up to PLe, Cat.4.
- Ability to detect at each I/O point:
  - short-circuit to 24V DC or 0V
  - wire breakage
  - discrepancy of dual channel circuitry, due to mechanical alignment or a failure
- All Guard I/O modules have common circuit functionality, operation, programming, troubleshooting, and diagnostics.
- Built in diagnostic LEDs for I/O circuitry and power status.
- I/O point status available to any controller.
- EDS file or Logix 5000 profile compatible.
- Removable and keyed terminal blocks.
- Common power and I/O wiring across Guard I/O modules on DeviceNet and EtherNet/IP networks (1791DS-IB16/1791ES-IB16 and 1791DS-IB8XOBV4/1791ES-IB8XOBV4).
- Safety input power source separate from safety output power source.
- Removable and insertable under power, when following appropriate safety practices.
- Electronic overcurrent protection of all outputs.

	 CompactBlock Guard I/O Modules	 ArmorBlock Guard I/O Modules	 POINT Guard I/O Modules
Description	Cost-effective block I/O for use in an enclosure.	Cost-effective block I/O with IP64, IP65, or IP67 protection (as indicated on the product label) for use on the machine.	Cost-effective I/O modules provide maximum I/O density in minimum panel space.
Digital Safety Inputs	Up to 16 channels	Up to 8 channels	Up to 8 channels
Digital Safety Outputs	Up to 8 channels	Up to 4 channels	Up to 8 channels
Safety Relays	Up to 4 channels (1791DS)	No	No
High Current Capacity Outputs	Up to 2 amps per channel	Up to 2 amps per channel	Up to 1 amp per channel
Use in Hazardous Areas	UL Listed for Class I, Division 2 Group A,B,C,D	No	UL Listed for Class I, Division 2 Group A,B,C,D; ATEX
DeviceNet			
Interface Module	1756-DNB, 1753-DNSI, 1752	1756-DNB, 1753-DNSI, 1752	1734-PDN
Bulletin Number	1791DS	1732DS	1734
EtherNet/IP			
Interface Module	1756-ENBT, 1756-EN2T, 1756-EN2F	Not available	1734-AENT, 1734-AENTR
Bulletin Number	1791ES	Not available	1734

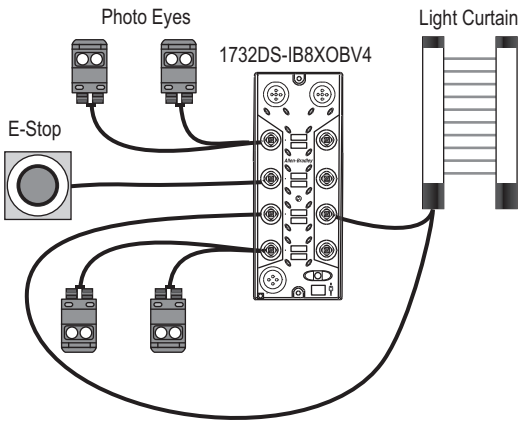
Typical Configurations

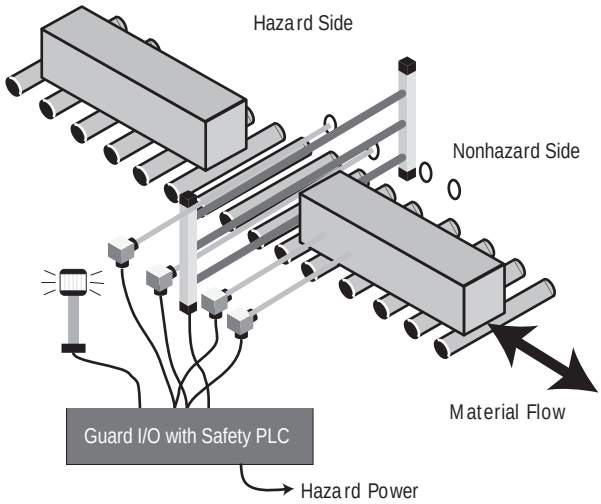


The above example network shows how almost any 24V DC safety-rated or standard sensor can be wired to any Guard I/O module to monitor the machine's status.

Choosing Your I/O Hardware

Guard I/O module options are available to minimize associated safety hardware. Additionally, installation costs, wiring time, and commissioning time can be further reduced when using ArmorBlock Guard I/O, as shown in the example below with a light curtain muting application.





A variety of CompactBlock Guard I/O is available to suit most every need.

- **1791DS-IB8XOB8 Module.** This module has up to 8 single channel safety inputs and 8 single channel safety outputs. It is often the universally chosen Guard I/O hardware for almost every application. Whether you need single or dual channel safety input or safety output circuits, the 1791DS–IB8XOB8 module is a good choice.
- **1791DS-IB4XOW4 Module.** This module has up to 4 single channel safety inputs and 4 single channel (replaceable) safety relay outputs. This module is often chosen for AC actuators or specialty safety interface applications. Whether you need single or dual-channel safety input or safety output circuits, the 1791DS-IB4XOW4 module is a good choice.
- **1791DS-IB8XOBV4 or 1791ES-IB8XOBV4 Modules.** These modules have up to 8 single channel safety inputs and 4 dual channel sink/source safety outputs, also know as bipolar or two-pole switching. They are often chosen for safety actuators that require more than 0.5 amps. For example, the control of press safety valves or control of the solenoid on a guard-locking switch like the Atlas or Trojan safety products. Whether you need single or dual channel safety input circuits and dual channel safety outputs, the 1791DS-IB8XOBV4 or 1791ES-IB8XOBV4 module will suit most any application.
- **1791DS-IB16 or 1791ES-IB16 Modules.** These modules have up to 16 single channel safety inputs. They are the universal choice of Guard I/O hardware when an application calls for the monitoring of many safety devices in one central location. When your safety application requires 2 safety mats, 2 run stations with 2 e-stops, or any similar configuration, these modules are an excellent and economical choice for every programmable safety system.

CompactBlock™ Guard I/O™



Description

CompactBlock Guard I/O provides all the advantages of traditional distributed I/O for safety systems. Distributed safety I/O reduces wiring costs and startup time for machines and cells, as compared to in-chassis I/O. You can use Guard I/O with any safety controller that communicates on DeviceNet or EtherNet/IP networks using CIP Safety, for the control and monitoring of safety circuits. Guard I/O detects circuit failures at each I/O point while providing detailed diagnostics directly to the controller. With CIP Safety you can easily integrate safety and standard control systems by using safety and standard messages on the same wire.

Several Guard I/O blocks are available with a variety of features:

- The 1791DS CompactBlock Guard I/O family consists of 24V DC digital I/O modules that communicate on DeviceNet networks.
- The 1791ES CompactBlock Guard I/O family consists of 24V DC digital I/O modules that communicate on EtherNet/IP networks.

Benefits

- TÜV Certified as a system with GuardLogix, GuardPLC 1600 and 1800, and SmartGuard 600 controllers
- Supports both standard and safety control
- I/O point-level and other detailed fault diagnostics are available to the PLC or HMI, with the self testing inputs and outputs
- EDS (RSNetWorx for DeviceNet) or RSLogix 5000 profile configuration
- Certified by TÜV for Functional Safety up to SIL 3 according to IEC 61508, and Category 4, PLe according to ISO 13849-1
- Supports single and dual channel devices on inputs and outputs
- Additional standard solid-state outputs that can be configured as pulse test sources, outputs for standard PLC control, 24V DC sources, or for muting lamp control and monitoring
- DIN Rail mounting for easy installation
- Compatible with Guardmaster and similar safety devices

CompactBlock Guard I/O DeviceNet Safety Module Specifications

Cat. No.	1791DS-IB12	1791DS-IB16	1791DS-IB8XOB8	1791DS-IB8XOBV4	1791DS-IB4XOW4
Description	24V DC Input Module on DeviceNet Networks	24V DC Input Module on DeviceNet Networks	24V DC Input/Solid-State Output Module on DeviceNet Networks	24V DC Input/Output Module on DeviceNet Networks	24V DC Input / Relay Output Module for DeviceNet Networks
Current Consumption	110 mA @ 24V DC	85 mA @ 24V DC	110 mA @ 24V DC	85 mA @ 24V DC	110 mA @ 24V DC
Operating Voltage Range	20.4…26.4V DC (24V DC, -15…+10%)	19.2…28.8V DC (24V DC, -20…+20%)	20.4…26.4V DC (24V DC, -15…+10%)	19.2…28.8V DC (24V DC, -20…+20%)	20.4…26.4V DC (24V DC, -15…+10%)
Digital Inputs					
Number of Inputs (single-channel)	12 safety	16 safety	8 safety	8 safety	4 safety
Input Type	current sinking	current sinking	current sinking	current sinking	current sinking
Voltage, On-State Input, Min.	11 V DC	11 V DC	11 V DC	11V DC	11V DC
Voltage, Off-State Input, Max.	5V DC	5V DC	5V DC	5V DC	5V DC
Current, On-State Input, Min.	6 mA	3.3 mA	6 mA	3.3 mA	6 mA
Digital Outputs					
Number of Outputs	—	—	8 single-channel, safety solid-state	4 dual channel, safety solid-state	4 single-channel, safety relay
Output Type	—	—	current sourcing	current sourcing/current sinking	relay
Output Current Rating	—	—	0.5 A per point	2.0 A continuous	2 A max. per contact
Output Leakage Current, Max.	—	—	0.1 mA	± 1.0 mA	—
Service Life, Electrical	—	—	—	—	100 000 operations, min.
Short Circuit Protection	—	—	Yes	Yes	No
Standard Pulse Test Outputs					
Number of Pulse Test Sources	4	16	4	8	4
Pulse Test Output Current	0.7 A per point	0.7 A per point	0.7 A per point	0.7 A per point	0.7 A per point
Short Circuit Protection	Yes	Yes	Yes	Yes	Yes
General					
Temperature, operating	-10…55° C (14…131 °F)	-20°C…+60°C (-4°F…+140°F)	-10…55° C (14…131 °F)	-20°C…+60°C (-4°F…+140°F)	-10…55° C (14…131 °F)
Relative Humidity	5…95% noncondensing	5…95% noncondensing	10…95% noncondensing	5…95% noncondensing	10…85% noncondensing
Vibration	5 g @ 57…150 Hz	5 g @ 10…500 Hz	5 g @ 57…150 Hz	5 g @ 10…500 Hz	5 g @ 57…150 Hz
Shock, operating	15 g	30 g	15 g	30 g	10 g
Enclosure Protection	IP20	IP20	IP20	IP20	IP20
Dimensions (HxWxD), Metric	68 x 170 x 72 mm∗	81 x 170 x 76 mm∗	68 x 170 x 72 mm∗	81 x 170 x 76 mm∗	95 x 170 x 83 mm∗
Certifications‡	UL, CE, C-Tick, CSA, UL Class I Div 2 Hazardous, UL NRGF, ODVA Conformance, certified by TÜV for Functional Safety up to SIL 3 and Cat. 4, PLe	UL, CE, C-Tick, CSA, UL Class I Div 2 Hazardous, ODVA Conformance, certified by TÜV for Functional Safety up to SIL 3 and Cat. 4, PLe	UL, CE, C-Tick, CSA, UL Class I Div 2 Hazardous, UL NRGF, ODVA Conformance, certified by TÜV for Functional Safety up to SIL 3 and Cat. 4, PLe	UL, CE, C-Tick, CSA, UL Class I Div 2 Hazardous, ODVA Conformance, certified by TÜV for Functional Safety up to SIL 3 and Cat. 4, PLe	UL, CE, C-Tick, CSA, UL NRGF, ODVA Conformance, TÜV certified for functional safety up to SIL 3 and Cat. 4, PLe

∗ Includes DIN latch and connectors.
‡ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.
All specifications are subject to change. Refer to product installations instructions.

CompactBlock Guard I/O EtherNet/IP Safety Module Specifications

Cat. No.	1791ES-IB16	1791ES-IB8XOBV4
Description	24V DC Input Module on EtherNet/IP	24V DC Input/Output Module on EtherNet/IP
Current Consumption	250 mA @ 24V DC	250 mA @ 24V DC
Operating Voltage Range	19.2…28.8V DC (24V DC, -20…+20%)	19.2…28.8V DC (24V DC, -20…+20%)
Digital Inputs		
Number of Inputs	16 single channel; 8 dual channel	8 single channel; 4 dual channel
Input Type	current sinking	current sinking
Voltage, On-State Input, Min.	11 V DC	11 V DC
Voltage, Off-State Input, Max.	5V DC	5V DC
Current, On-State Input, Min.	3.3 mA	3.3 mA
Digital Outputs		
Number of Outputs	0	4 dual channel
Output Type	—	Current sourcing/current sinking - bipolar pair
Output Current Rating	—	2.0 A continuous
Short Circuit Protection	Yes	Yes
Standard Pulse Test Outputs		
Number of Pulse Test Sources	16 current sourcing	8 current sourcing
Pulse Test Output Current	0.7 A per point	0.7 A per point
Short Circuit Protection	Yes	Yes
General		
Temperature, operating	-20…60° C (-4…140° F)	-20…60° C (-4…140° F)
Relative Humidity	5…95% noncondensing	5…95% noncondensing
Vibration	5 g at 10…500 Hz	5 g at 10…500 Hz
Shock, operating	30 g	30 g
Enclosure Protection	IP20	IP20
Dimensions (HxWxD), Metric	80 x 196 x 77 mm∗	80 x 196 x 77 mm∗
Certifications‡	cULus, CE, C-Tick, CSA, UL Class I Div 2 Hazardous, UL NRGF, ODVA Conformance, certified by TÜV and UL for Functional Safety up to SIL 3 and Cat. 4, PLe	cULus, CE, C-Tick, CSA, UL Class I Div 2 Hazardous, UL NRGF, ODVA Conformance, certified by TÜV and UL for Functional Safety up to SIL 3 and Cat. 4, PLe

∗ Includes terminal block.
‡ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.

All specifications are subject to change. Refer to product installations instructions.

ArmorBlock® Guard I/O™



Description

ArmorBlock® Guard I/O™ provides all the advantages of traditional distributed I/O for safety systems, but has an IP64, IP65, or IP67 package (as marked on the product label) that can be mounted directly on your machine. On-machine safety I/O reduces wiring time and startup costs for safety controller applications by eliminating electrical boxes and simplifying cable installation. The ArmorBlock family provides industrially hardened I/O blocks that you can mount directly on equipment near sensors or actuators. Wiring the I/O to the sensors and actuators is easy using pre-wired quick disconnect cables.

You can use Guard I/O with any safety controller that communicates on DeviceNet using CIP Safety for the control and monitoring of safety circuits. Guard I/O detects circuit failures at each I/O point while providing detailed diagnostics directly to the controller. With CIP Safety, you can easily integrate safety and standard control systems by using safety and standard messages on the same wire.

The 1732DS ArmorBlock Guard I/O family consists of 24V dc digital I/O modules that communicate on DeviceNet networks. The I/O connectors are sealed M12 micro style while the network and auxiliary power connectors are sealed mini style. Plus, the ArmorBlock Guard I/O uses the same input and output M12 pin configuration as standard ArmorBlock and Maxum.

Benefits

- IP64, IP65, or IP67 rated for direct mounting on machine without an enclosure (rating is marked on the product label)
- Compact footprint
- Quick disconnect dual-channel M12 I/O connectors allow a single cable connected between ArmorBlock Guard I/O and a dual-channel safety device (See the following table of Allen-Bradley Guardmaster safety devices)
- TÜV certified as a system with GuardLogix, GuardPLC1600/1800, SmartGuard 600 controllers
- Supports both standard and safety control
- Supports single and dual-channel devices on inputs and outputs
- I/O point-level and other detailed fault diagnostics are available to the PLC or HMI with self-testing inputs and outputs
- EDS (RSNetWorx for DeviceNet) or RSLogix 5000 profile configuration
- Certified by TÜV and UL for Functional Safety up to SIL 3 according to IEC 61508, and PLe/Category 4, according to ISO 13849-1
- Additional standard solid-state outputs can be configured as pulse test sources, outputs for standard PLC control, 24V dc sources, or muting lamp control and monitoring

Specifications

Cat. No.	1732DS-IB8	1732DS-IB8XOBV4
Description	24V DC Input Module for DeviceNet Networks	24V DC Input/Output Module on DeviceNet Networks
Current Consumption	85 mA @ 24V DC	
I/O Operating Voltage Range	19.2V…28.8 V DC (24V DC, -20…+20%)	
Digital Inputs		
Number of Inputs	8 safety single-channel or 4 safety dual-channel	
Input Type	current sinking	
Voltage, On-State Input, Min.	11V DC	
Voltage, Off-State Input, Max.	5V DC	
Current, On-State Input, Min.	3.3 mA	
Digital Outputs		
Number of Outputs	—	4 safety solid-state
Output Type	—	dual channel, current sourcing/current sinking pair
Output Current Rating	—	2.0 A max per point
Short Circuit Protection	—	Yes
Standard Pulse Test Outputs		
Number of Pulse Test Sources	8	
Pulse Test Output Current	0.7 A per point	
Short Circuit Protection	Yes	
General		
Temperature, operating	-20°…+60°C (-4°C…+140°F)	
Relative Humidity	10…95% non-condensing	
Vibration	0.76 mm @ 10…500 Hz	
Shock, operating	30 g	
Enclosure Protection	IP64, IP65, or IP67 as marked on the product label	
Dimensions (HxWxD), Metric	179 x 70 x 68.7 mm∗	
Dimensions (HxWxD), Imperial	7.05 x 2.76 x 2.71 in∗	
Weight, Metric	600 g	
Weight, Imperial	1.2 lb	
Certifications❄	UL, CE, C-Tick, CSA, UL NRGF, ODVA Conformance, certified by TÜV for Functional Safety up to SIL 3 and PLe/Cat. 4	

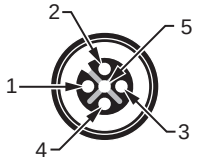
∗ Includes terminal block.
❄ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.
All specifications are subject to change. Refer to product installations instructions.

Safety Products that Connect Directly to ArmorBlock Guard I/O with a Single 5-Pin Micro (M12) Patchcord*

Product Family	Actuator Type	Cat. No. (with M12)	Catalog Page
Elf	Flat	440K-E2NNFPS	3-11
	Semi-flexible	440K-E2NNAPS	3-11
Cadet	Flat	440K-C2NNFPS	3-15
	Semi-flexible	440K-C2NNAPS	3-15
Trojan T15	Standard	440K-V2NNSPS	3-19
	Fully-flexible	440K-V2NNBPS	3-19
Trojan T15-GD2	GD2 Standard	440K-V2NNGPS	3-19
Trojan T5	Standard	440K-T2NBSPS	3-23
	Fully-flexible	440K-T2NBBPS	3-23
Trojan T5-GD2	GD2 Standard	440K-T2NBGPS	3-23
MT-GD2, Case Color Red with Snap-acting Contacts	None	440K-M2NBNDS	3-29
	None	440K-M2NANDS	3-29
MT-GD2, Case Color Yellow, Snap-acting Contacts	None	440K-M2NANYS	3-29
Sprite	Solid - 50xØ10 mm	440H-S2NNPPS	3-91
	Pre-bored - 30xØ16 mm	440H-S2NNHPS	3-91
Ensign	Solid - 50xØ10 mm	440H-E2NNPPS	3-95
	Pre-bored - 30xØ16 mm	440H-E2NNHPS	3-95
Lifeline3	N/A	440E-D2NNNYS	[S-3503977]
Lifeline4	N/A	440E-L2NNNYS	4-11
Emergency Stop	N/A	800F-1YMQ53V	4-43
Safety Mats	N/A	440F-MxxxHxNN	2-94

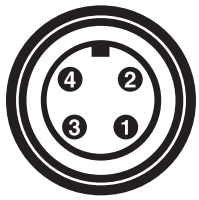
* Only the 2 N.C. safety contacts of the safety switches are connected to the 5-pin micro (M12) connector.

1732DS ArmorBlock Guard I/O Micro Connector Pin Assignments

Input Configuration			Output Configuration	
Pin	Signal	Female	Pin	Signal
1	Test Output n+1		1	Output +24V dc Power
2	Safe Input n+1		2	Output n+1 (Sinking)
3	Input Common		3	Output Power Common
4	Safe Input n		4	Output n (Sourcing)
5	Test Output n		5	Output Power Common

1732DS ArmorBlock Guard I/O Mini Connector Pin Assignments

ArmorBlock Guard I/O DeviceNet Configuration			
Pin	Signal	Male	Female
1	Drain		
2	V+ (Red)		
3	V- (Black)		
4	CAN_H (White)		
5	CAN_L (Blue)		

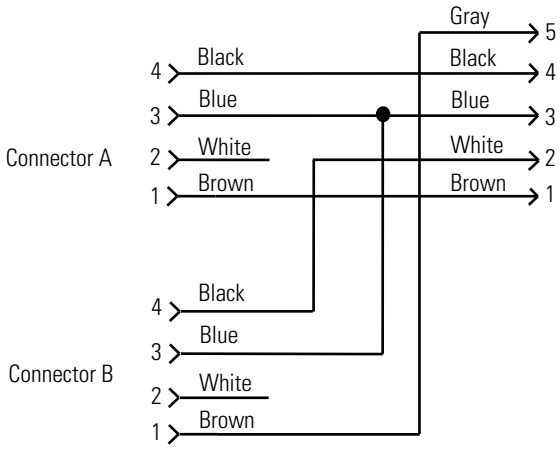
ArmorBlock Guard I/O Power Configuration		
Pin	Signal	Male
1	Output +24V dc Power (Red)	
2	Input +24V dc Power (Green)	
3	Input Power Common (White)	
4	Output Power Common (Black)	

ArmorBlock Guard I/O Recommended Compatible Cables and Connectors*

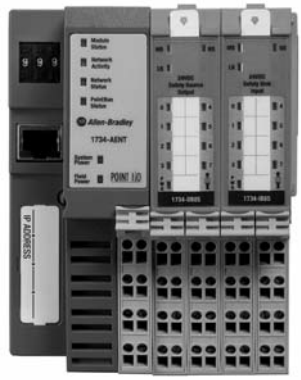
Description		Cat. No.
	DC Micro (M12) Male Cordset	889D-M5AC-❄
	DC Micro Style Patchcord	889D-F5ACDM-‡
	DC Micro V-Cable for Single-Channel Sensors	879D-F4ACD5M-§
	M12 Single-Channel Splitter	879D-F4D5M
	M12 Terminal Chamber—Straight Male	871A-TS5-DM
	M12 Terminal Chamber—Right Angle Male	871A-TR5-DM

* All cables must use 5-pin connections for ArmorBlock Guard I/O M12 input compatibility.
❄ Replace symbol with 0M3 (0.3 m), 2 (2 m), or 5 (5 m) for standard cable length.
‡ Replace symbol with 1 (1 m), 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable length.
§ Replace symbol with 0M3 (0.3 m), 1 (1 m), 2 (2 m), or 5 (5 m) for standard cable length.

Single Channel Wiring (879D-F4ACD5M and 1485P-PID5-RR4)



POINT Guard I/O™



Description

POINT Guard I/O™ modules are safety-rated I/O modules designed to fit into the standard POINT I/O system, offering automation and safety functionality in a maximum density I/O solution. They are ideal for use is applications requiring safety and automation control. They communicate by using CIP Safety protocol over EtherNet/IP for GuardLogix controllers or DeviceNet for SmartGuard safety controllers. The application of CIP Safety protocol allows simultaneous transmission of safety and automation control and diagnostic data over one CIP network.

POINT Guard I/O and POINT I/O can be controlled by one GuardLogix controller for both safety and automation control through one node. If separate safety control is required, a GuardLogix controller can be used with POINT Guard I/O for safety control and a ControlLogix controller can be used with POINT I/O for automation control. No changes are required to the POINT I/O system.

This solution is ideal for applications requiring maximum I/O density in minimum panel space. The advanced solid-state design allows for module replacement in minutes and helps reduce the need for special maintenance or training.

POINT Guard I/O is designed for use with industrial equipment and is especially suited for robotic, point-of-operation, guard-monitoring, and distributed control applications.

Benefits

- Mix safety inputs and outputs with standard POINT I/O, all with one node
- Maximum I/O density in minimum panel space
- Simple to add to existing panels using POINT I/O
- I/O point-level diagnostics quickly identify problems and reduce downtime
- Easy configuration by using RSLogix 5000 with full support of IP addressing
- Optimize installations by assigning individual test output for safety input device
- Connect single and dual-channel safety devices on inputs and outputs
- Certified by TÜV for Functional Safety up to SIL 3 according to IEC 61508, and PLe/Category 4, according to ISO 13849-1
- Muting lamp control and monitoring on selected test pulse outputs

Networking with POINT Guard I/O™

POINT Guard I/O™ modules are used in the POINT I/O platform and can communicate safety messages via network adapters to connect to EtherNet/IP or DeviceNet networks. Use these adapters for network communication.

Network	System	Adapter✶
EtherNet/IP	GuardLogix	1734-AENT
		1734-AENTR
DeviceNet	SmartGuard 600	1734-PDN

✶ Not compatible with 1734-ADN, 1734-ADNX, 1734-AP, or 1734-ACNR adapters.

Specifications

Cat. No.	1734-IB8S	1734-OB8S
Description	Point I/O 24V DC 8 Input Safety Module	Point I/O 24V DC 8 Output Safety Module
PointBus Current (mA), Max.	175	190
Operating Voltage Range	19.2…28.8V DC	19.2…28.8V DC
Digital Inputs		
Number of Inputs	8	—
Input Type	Current Sinking	—
Voltage, On-State Input, Min.	11V DC	—
Voltage, Off-State Input, Max.	5V DC	—
Current, On-State Input, Min.	3.3 mA	—
Input Delay Time, Off to On	16.2 ms max	—
Input Delay Time, On to Off	—	—
Digital Outputs		
Number of Outputs	—	8
Output Type	—	Current Sourcing
Output Current Rating, Max.	—	1 A max per point
Leakage Current, Off-State Output, Max	—	0.1 mA
Output Delay Time, Off to On, Max.	—	6.2 ms‡
Output Delay Time, On to Off, Max.	—	6.2 ms§
Short Circuit Protection	—	Yes, Electronic
Overcurrent Detection	—	Yes
Standard Pulse Test Outputs		
Number of Pulse Test Sources	4	—
Pulse Test Output Current	0.7A per point	—
Pulse Test Output Leakage Current, Max.	0.1 mA	—
Short Circuit Protection	Yes	—
General		
Temperature, operating	-20…55 °C (-4…131 °F)	
Temperature, nonoperating	-40…85 °C (-40…185 °F)	
Relative Humidity	5…95% noncondensing	
Vibration	5 g at 10…500 Hz	
Shock, operating	30 g	
Enclosure Protection	IP20	
Dimensions (HxWxD), Metric	77.0 x 25.0 x 55.0 mm✶	
Dimensions (HxWxD), Imperial	3.03 x 0.98 x 2.17 in✶	
Weight, Metric	62.4 g	
Weight, Imperial	2.2 oz	
Certifications❄	CE, C-Tick, CSA, ODVA Conformance, certified by TÜV for Functional Safety up to SIL 3 and PLe/Cat. 4	

Note: All specifications are subject to change. Refer to product installations instructions.
✶ Includes terminal block.
❄ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.
‡ Off/on delay is time from a valid ouput "on" signal to output energization.
§ On/off delay is time from a valid output "off" signal to output deenergization.

Notes

Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

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Safety ArmorStart® Distributed Motor Controllers

Bulletin 280D/281D

280D/281D ArmorStart Distributed Motor Controller — Safety Version



Description

The Bulletin 280/281 ArmorStart Distributed Motor Controller is an integrated, pre-engineered, starter for full-voltage and reversing applications. The ArmorStart offers a robust IP67/NEMA Type 4 enclosure design, which is suitable for water wash-down environments. The modular plug-and-play design offers simplicity in wiring the installation. The quick disconnects for the I/O, communications, and motor connection reduce the wiring time and eliminate wiring errors. The ArmorStart offers as standard, four DC inputs and two relay outputs to be used with sensors and actuators respectively, for monitoring and controlling the application process. The ArmorStart's LED status indication and built-in diagnostics capabilities allows ease of maintenance and troubleshooting. The optional Hand/Off/Auto (HOA) keypad allows for local start/stop control at the ArmorStart Distributed Motor Controller.

The Bulletin 280/281 ArmorStart Distributed Motor Controller offers short-circuit protection per UL 508 and IEC 60947. The ArmorStart is rated for local-disconnect service by incorporating the Bulletin 140 Motor Protector as the local-disconnect, eliminating the need for additional components. The ArmorStart Distributed Motor Controllers are suitable for group motor installations.

Safety ArmorStart

The safety version of the ArmorStart provides a safety solution integrated into DeviceNet Safety installations. The Bulletin 280/281 Safety ArmorStart achieves Category 4 functionality by using redundant contactors. The Safety ArmorStart offers a quick connects via the gland plate to the 1732DS-IB8XOBV4 safety I/O module. The Bulletin 1732DS Safety I/O inputs will monitor the status of the safety rated contactors inside the ArmorStart. The Bulletin 1732DS Safety I/O outputs to provide 24V DC power for control power to the ArmorStart.

Note: The Bulletin 280/281 Safety ArmorStart is suitable for safety applications up to Safety Category 4 PLe (TÜV assessment per ISO 13849-1:2008). TÜV compliance letter is available upon request.

Note: For additional information regarding the 1732DS-IB8XOBV4 safety I/O module, see publication 1791DS-UM001*-EN-P.

Features

- On-Machine™ starting solution
- Full-voltage and reversing
- Horsepower range 0.5…10 Hp (0.37…7.5 kW)
- Robust IP67/NEMA Type 4 enclosure rating
- Modular plug and play design
- Quick disconnect connections for I/O, communications, motor, and three-phase power
- Gland plate entry: conduit entrance or ArmorConnect® power media
- Four inputs and two outputs (expandable with ArmorPoint)
- LED status indication
- DeviceNet™ communications
- DeviceLogix™ component technology
- Peer-to-peer communication (ZIP)
- Factory installed option:
  – Hand/Off/Auto (HOA) keypad configuration

Certifications

cULus (File No. E3125, Guides NLDX, NLDX7)

Standards Compliance

UL 508	CSA C22.2, No. 14
EN/IEC 60947-1	CCC

CE Marked per Low Voltage Directive 73/23/EEC and EMC Directive 89/336/EEC

Mode of Operation

Full-Voltage Start

This method is used in applications requiring across-the-line starting. Full in-rush current and locked-rotor torque are realized. The ArmorStart Bulletin 280 offers full-voltage starting, and the Bulletin 281 offers full-voltage starting for reversing applications.

Description of Features

Inputs

The inputs are single keyed (two inputs per connector), which are sourced from DeviceNet power (24V DC), with LED status indication.

Outputs

Two dual-key relay output connectors are supplied as standard. The outputs are sourced from the control voltage power, which is 24V DC with LED status indication.

Overload Protection

The Bulletin 280/281 ArmorStart Distributed Motor Controller incorporates, as standard, electronic motor overload protection. This overload protection is accomplished electronically with an I^2t algorithm. The ArmorStart's overload protection is programmable via the communication network providing the user with flexibility. The overload trip class can be selected for class 10, 15, or 20 protection. Ambient insensitivity is inherent in the electronic design of the overload.

Gland Plate Entrance

The ArmorStart product offers two different methods for connecting incoming three-phase power to the device. One method offered is the traditional conduit entrance which provides a 1 in. conduit hole opening for wiring three-phase power. The second method offers connectivity to the ArmorConnect power media. A factory-installed receptacle is provided for connectivity to both three-phase power media.

Motor Cable

With every Bulletin 280/281 ArmorStart Distributed Motor Controller, a 3-meter unshielded 4-conductor cordset is provided with each unit as standard.

LED Status Indication

The LED Status Indication provides four status LEDs and a Reset button. The LEDs provide status indication for the following:

- **POWER LED**
  The LED is illuminated solid green when control power is present and with the proper polarity
- **RUN LED**
  This LED is illuminated solid green when a start command and control power are present
- **NETWORK LED**
  This bicolor (red/green) LEDs indicates the status of the communication link
- **FAULT LED**
  Indicates Controller Fault (trip) condition
- The "Reset Button" as a local trip reset.

Fault Diagnostics

Fault diagnostics capabilities built in the ArmorStart Distributed Motor Controller help you pinpoint a problem for easy troubleshooting and quick re-starting.

- Short Circuit
- Overload
- Phase Loss
- Control Power Loss
- Control Power Fuse Detection
- I/O Fault
- Output Power Fuse Detection
- Overtemperature
- Phase Imbalance
- DeviceNet Power Loss
- EEPROM Fault
- Hardware Fault

Cat. No. Explanation

Examples given in this section are for reference purposes. This basic explanation should not be used for product selection; not all combinations will produce a valid catalog number.

280	D	–	F	12S	–	10	C	–	CR	–	Option 1
a	*b*		*c*	*d*		*e*	*f*		*g*		*h*

a

Bulletin Number	
Code	Description
280	Full Voltage Starter
281	Reversing Starter

b

Communications	
Code	Description
D	DeviceNet™

c

Enclosure Type	
Code	Description
F	Type 4 (IP67)

d

Contactor Size/Control Voltage	
Code	Description
12S	24V DC
23S	

∗ See Accessories on page 6-4 for extended motor cable lengths.

e

Short Circuit Protection (Motor Circuit Protector)	
Code	Description
10	10 A Rated Device
25	25 A Rated Device

f

Overload Selection Current Range	
Code	Description
B	0.5…2.5 A
C	1.1…5.5 A
D	3.2…16 A

g

Control and 3-Phase Power Connections/Motor Cable Connection (CR: Conduit/Round Media) or (RR: Round/Round Media)				
Code		Description		
		Control Power	3-Phase Power	Motor Cable
CR	blank	Conduit Entrance	Conduit Entrance	3 m, unshielded cordset male 90°
CR	W ∗	Conduit Entrance	Conduit Entrance	No cable
RR	blank	Round Media (Male Receptacle)	Round Media (Male Receptacle)	3 m, unshielded cordset male 90°
RR	W ∗	Round Media (Male Receptacle)	Round Media (Male Receptacle)	No cable

h

Option 1	
Code	Description
3	Hand/Off/Auto Selector Keypad
3FR	Hand/Off/Auto Selector Keypad with Forward/Reverse

Product Selection

Full-voltage starters — IP67/NEMA Type 4 with conduit entrance and DeviceNet communications, Up to 460V AC

	kW		Hp			24V DC Control Voltage
Current Rating [A]	230V AC, 50 Hz	400V AC, 50 Hz	200V AC, 60 Hz	230V AC, 60 Hz	460V AC, 60 Hz	Cat. No.
0.5…2.5	0.37	0.75	0.5	0.5	1	280D-F12S-10B-CR
1.1…5.5	1.1	2.2	1	1	3	280D-F12S-10C-CR
3.2…16	4	7.5	3	5	10	280D-F23S-25D-CR

Full-voltage starters — IP67/NEMA Type 4 with quick disconnects for ArmorConnect power media and DeviceNet communications, Up to 460V AC

	kW		Hp			24V DC Control Voltage
Current Rating [A]	230V AC, 50 Hz	400V AC, 50 Hz	200V AC, 60 Hz	230V AC, 60 Hz	460V AC, 60 Hz	Cat. No.
0.5…2.5	0.37	0.75	0.5	0.5	1	280D-F12S-10B-RR
1.1…5.5	1.1	2.2	1	1	3	280D-F12S-10C-RR
3.2…16	4	7.5	3	5	10	280D-F23S-25D-RR

Reversing starters — IP67/NEMA Type 4 with conduit entrance and DeviceNet communications, Up to 460V AC

	kW		Hp			24V DC Control Voltage
Current Rating [A]	230V AC, 50 Hz	400V AC, 50 Hz	200V AC, 60 Hz	230V AC, 60 Hz	460V AC, 60 Hz	Cat. No.
0.5…2.5	0.37	0.75	0.5	0.5	1	281D-F12S-10B-CR
1.1…5.5	1.1	2.2	1	1	3	281D-F12S-10C-CR
3.2…16	4	7.5	3	5	10	281D-F23S-25D-CR

Reversing starters — IP67/NEMA Type 4 with quick disconnects for ArmorConnect power media and DeviceNet communications, Up to 460V AC

	kW		Hp			24V DC Control Voltage
Current Rating [A]	230V AC, 50 Hz	400V AC, 50 Hz	200V AC, 60 Hz	230V AC, 60 Hz	460V AC, 60 Hz	Cat. No.
0.5…2.5	0.37	0.75	0.5	0.5	1	281D-F12S-10B-RR
1.1…5.5	1.1	2.2	1	1	3	281D-F12S-10C-RR
3.2…16	4	7.5	3	5	10	281D-F23S-25D-RR

Options – Factory Installed

Description				Cat. No. Modification
	Hand/Off/Auto Selector Keypad			-3
	Hand/Off/Auto Selector Keypad with Forward/Reverse Function			-3FR
	Supplied without motor cable		**Enclosure Rating** IP67	-CRW
	Connectivity to ArmorConnect Power Media supplied without motor cable	**Short Circuit Protection Rating** 10 A 25 A	**Enclosure Rating** IP67	-RRW

Accessories

Sealing Caps

Description	For Use With	Cat. No.
Plastic Sealing Cap (M12)∗	Input I/O Connection	1485A-M12
AC Micro Aluminum Sealing Cap - External∗	Output I/O Connection	889A-RMCAP

∗ To achieve IP67 rating, sealing caps must be installed on all unused I/O connections.

Cables

Description	Cable Rating	Length [m (ft)]	Cat. No.
Extended Motor Cable Cordsets			
90° M22 Motor Cordset	IP67/NEMA Type 4	6 (19.6)	280-MTR22-M6
		14 (45.9)	280-MTR22-M14
90° M35 Motor Cordset	IP67/NEMA Type 4	6 (19.6)	280-MTR35-M6
		14 (45.9)	280-MTR35-M14

DeviceNet Media ♣

Description		Length [m (ft)]	Cat. No.
			Sealed
	KwikLink pigtail drops are Insulation Displacement Connector (IDC) with integral Class 1 round cables for interfacing devices or power supplies to flat cable.	1 (3.3)	1485P-P1E4-B1-N5
		2 (6.5)	1485P-P1E4-B2-N5
		3 (9.8)	1485P-P1E4-B3-N5
		6 (19.8)	1485P-P1E4-B6-N5
	DeviceNet Mini- T-Port Tap	Left Keyway	**1485P-P1N5-MN5KM**
		Right Keyway	1485P-P1N5-MN5NF

Description		Connector	Cat. No.
	Grey PVC Thin Cable	Mini Straight Female Mini Straight Male	1485G-P❄N5-M5
		Mini Straight Female Mini Right Angle Male	1485G-P❄W5-N5
		Mini Right Angle Female Mini Straight Male	1485G-P❄M5-Z5
		Mini Right Angle Female Mini Straight Male	1485G-P❄W5-Z5
	Thick Cable	Mini Straight Female Mini Straight Male	1485C-P‡N5-M5
		Mini Straight Female Mini Right Angle Male	1485C-P‡W5-N5
		Mini Right Angle Female Mini Straight Male	1485C-P‡M5-Z5
		Mini Right Angle Female Mini Straight Male	1485C-P‡W5-Z5

Description		Length [m (ft)]	Cat. No.
	DeviceNet Configuration Terminal Used to interface with objects on a DeviceNet network, includes 1 m communications cable	1 (3.3)	193-DNCT
	Communication cable, color-coded bare leads	1 (3.3)	193-CB1
	Communication cable, microconnector (male)	1 (3.3)	193-CM1
	Panel Mount Adapter/Door Mount Bezel Kit	—	193-DNCT-BZ1

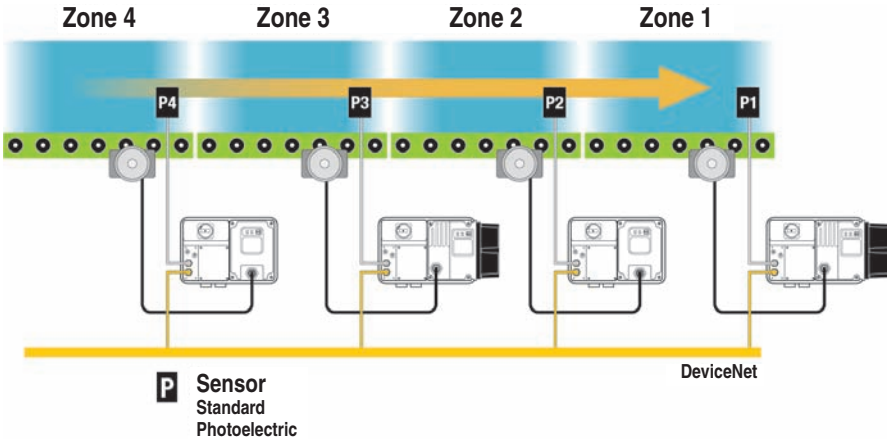
♣ See publication M116-CA001_-EN-P for complete cable selection information.
❄ Replace symbol with desired length in meters (Example: **1485G-P1N5-M5** for a 1 m cable). Standard cable lengths: 1, 2, 3, 4, 5, and 6 m.
‡ Replace symbol with desired length in meters (Example: **1485C-P1N5-M5** for a 1 m cable). Standard cable lengths: 1, 2, 3, 4, 5, 6, 8, 10, 12, 18, 24, and 30 m.

Sensor Media ⌘

Description		ArmorStart I/O Connection	Pin Count	Connector	Cat. No.
	DC Micro Patchcord	Input	5-pin	Straight Female Straight Male	889D-F4ACDM-➢
				Straight Female Right Angle Male	889D-F4ACDE-➢
	DC Micro V-Cable	Input	5-pin	Straight Female	879D-F4ACDM-➢
				Right Angle Male	879D-R4ACM-➢
	AC Micro Patchcord	Output	3-pin	Straight Female Straight Male	889R-F3AERM-➢
				Straight Female Right Angle Male	889R-F3AERE-➢

⌘ See the On-Machine Connectivity catalog for complete cable selection information.
➢ Replace symbol with desired length in meters (Example: **889D-F4ACDM-1** for a 1 m cable). Standard cable lengths: 1, 2, 5, and 10 m.
NOTE: Stainless steel versions may be ordered by adding an **S** to the cat. no. (Example: **889DS-F4ACDM-1**)

Peer-to-Peer Communications



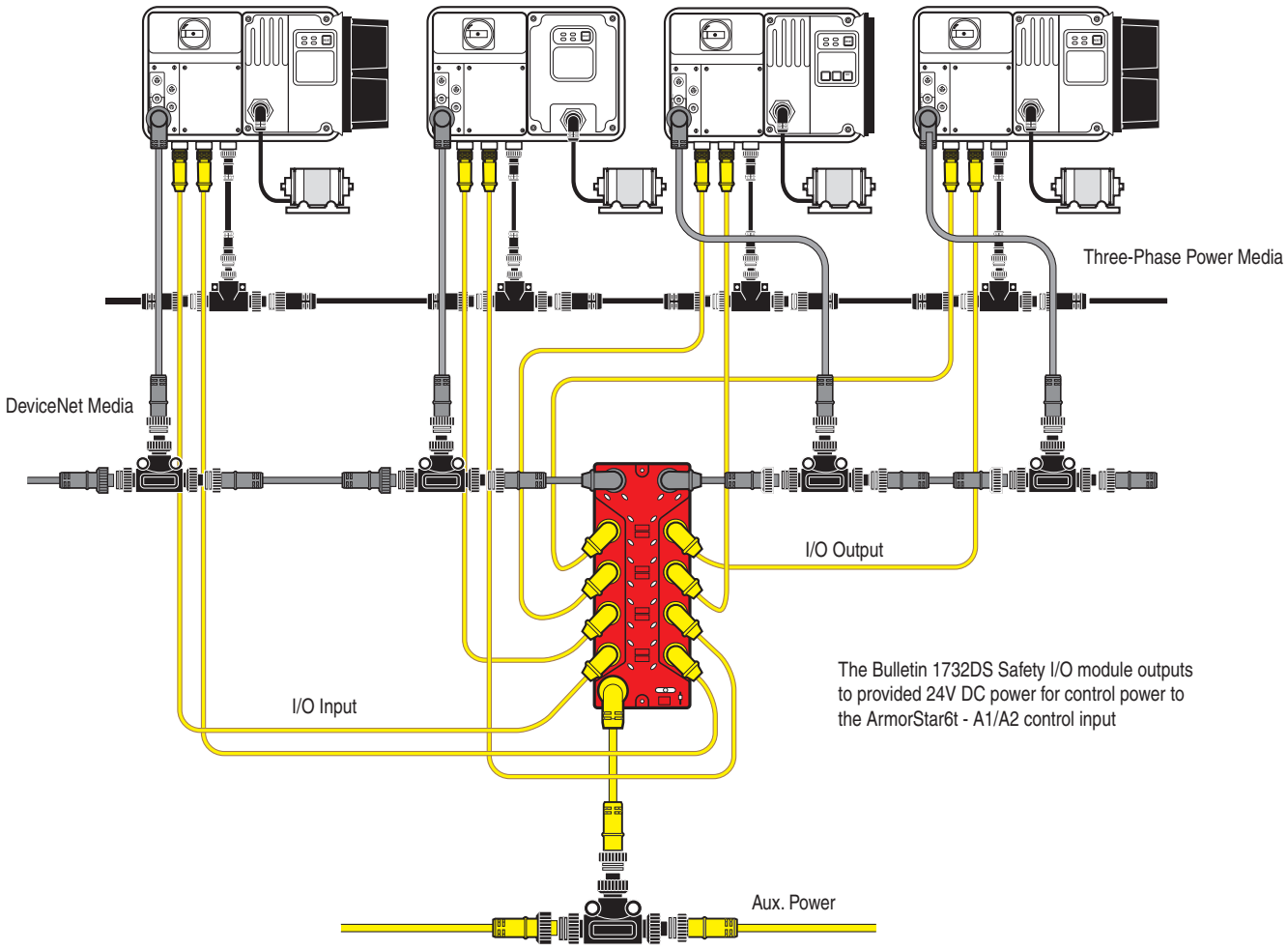
The Zone Control capabilities of ArmorStart Distributed Motor Controller is ideal for large horsepower (0.5…10 Hp) motored conveyors. The ArmorStart Distributed Motor Controllers have built-in DeviceNet Communications, DeviceLogix technology, and the added Zone Interlocking Parameters (ZIP) which allows one ArmorStart to consume data directly from up to four other DeviceNet nodes without going through the network scanner. These direct communications between conveyor zones are beneficial in a merge, diverter, and accumulation conveyor applications.

Safety I/O Module and TÜV Requirements

ArmorStart Safety-Related Parts

Each ArmorStart Safety Distributed motor controller is intended to be combined with the 1732DS-IB8XOBV4 safety I/O module to form a subsystem that is part of the overall machine stop function. The motor controllers are connected to the safety I/O module through specified cable assemblies. The combination of one of these controllers, the safety module, and the specified interconnecting cables are referred to as the ArmorStart Safety-Related Parts. The part numbers for each of these components is specified below. The combination of these components is shown in Figure E.1. The safety I/O module and PLC program must be configured as outlined. See configuration of Safety I/O Module and PLC program.

Catalog Number	Description
280…S* * - denotes safety version of Bulletin 280	Bulletin 280 Distributed Motor Controller – controller is full-voltage, non-reversing
281…S* * - denotes safety version of Bulletin 281	Bulletin 281 Distributed Motor Controller – controller is full-voltage, reversing
284…S* * - denotes safety version of Bulletin 284	Bulletin 284 Distributed Motor Controller – controller is variable-frequency AC drive
1732DS-IB8XOBV4	Guard I/O DeviceNet Safety Module
889D-F4HJDM-*, 889D-F4AEDM-* or equivalent * - denotes length	• SM cable assembly - Interconnecting cable assembly between safety module input and ArmorStart controller connector labeled “SM”. Assembly provides contactor position feedback. • A1/A2 cable assembly - Interconnecting cable assembly between safety module output and ArmorStart controller connector labeled “A1/A2”. Assembly provides output contactor coil power and controller power supply.



The Bulletin 1732DS Safety I/O module inputs will monitor the status of the safety-related contactors inside the ArmorStart - SM safety monitor input

ArmorBlock® Guard I/O™ Modules

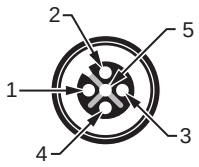
	Description	Cat. No.
	ArmorBlock Guard I/O provides all the advantages of traditional distributed I/O for safety systems, but has an IP67 package that can be mounted directly on your machine. On-machine safety I/O reduces wiring time and startup costs for safety controller applications by eliminating electrical boxes and simplifying cable installation. The ArmorBlock family provides industrially hardened I/O blocks that you can mount directly on equipment near sensors or actuators. Wiring the I/O to the sensors and actuators is easy using pre-wired quick disconnect cables. You can use Guard I/O with any safety controller that communicates on DeviceNet using CIP Safety for the control and monitoring of safety circuits. Guard I/O detects circuit failures at each I/O point while providing detailed diagnostics directly to the controller. With CIP Safety, you can easily integrate safety and standard control systems by using safety and standard messages on the same wire. The 1732DS ArmorBlock Guard I/O family consists of 24V DC digital I/O modules that communicate on DeviceNet networks. The I/O connectors are sealed M12 micro style while the network and auxiliary power connectors are sealed mini style. Plus, the ArmorBlock Guard I/O uses the same input and output M12 pin configuration as standard ArmorBlock and Maxum®.	1732DS-IB8XOBV4

Specifications

Description	24V DC Input/Output Module on DeviceNet Networks
Current Consumption	85 mA @ 24V DC
I/O Operating Voltage Range	19.2V…28.8 V DC (24V DC, -20…+20%)
Digital Inputs	
Number of Inputs	8 safety single-channel or 4 safety dual-channel
Input Type	current sinking
Voltage, On-State Input, Min.	11V DC
Voltage, Off-State Input, Max.	5V DC
Current, On-State Input, Min.	3.3 mA
Digital Outputs	
Number of Outputs	4 safety solid-state
Output Type	dual channel, current sourcing/current sinking pair
Output Current Rating	2.0 A max per point
Short Circuit Protection	Yes
Standard Pulse Test Outputs	
Number of Pulse Test Sources	8
Pulse Test Output Current	0.7 A per point
Short Circuit Protection	Yes
General	
Temperature, operating	-20…+60 °C (-4…+140 °F)
Relative Humidity	10…95% non-condensing
Vibration	0.76 mm @ 10…500 Hz
Shock, operating	30 g
Enclosure Protection	IP67
Dimensions (HxWxD), Metric	179 x 70 x 68.7 mm∗
Dimensions (HxWxD), Imperial	7.05 x 2.76 x 2.71 in.∗
Weight, Metric	600 g
Weight, Imperial	1.2 lb
Certifications❄	UL, CE, C-Tick, CSA, UL NRGF, ODVA Conformance, TÜV certified for functional safety up to SIL 3 and Cat. 4, PLe

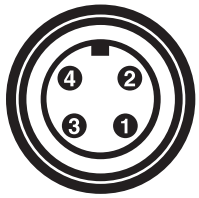
∗ Includes terminal block.
❄ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.
All specifications are subject to change. Refer to product installations instructions.

1732DS ArmorBlock Guard I/O Micro Connector Pin Assignments

Input Configuration		Female	Output Configuration	
Pin	Signal		Pin	Signal
1	Test Output n+1		1	Output +24V DC Power
2	Safe Input n+1		2	Output n+1 (Sinking)
3	Input Common		3	Output Power Common
4	Safe Input n		4	Output n (Sourcing)
5	Test Output n		5	Output Power Common

1732DS ArmorBlock Guard I/O Mini Connector Pin Assignments

ArmorBlock Guard I/O DeviceNet Configuration			
Pin	Signal	Male	Female
1	Drain		
2	V+ (Red)		
3	V- (Black)		
4	CAN_H (White)		
5	CAN_L (Blue)		

ArmorBlock Guard I/O Power Configuration		
Pin	Signal	Male
1	Output +24V DC Power (Red)	
2	Input +24V DC Power (Green)	
3	Input Power Common (White)	
4	Output Power Common (Black)	

ArmorBlock Guard I/O Recommended Compatible Cables and Connectors∗

Description		Cat. No.
	DC Micro (M12) Male Cordset	889D-F4HJ-❄
	DC Micro Style Patchcord	889D-F4HJDM-‡
	M12 Terminal Chamber—Straight Male	871A-TS4-DM
	M12 Terminal Chamber—Right Angle Male	871A-TR4-DM

∗ All cables must use 5-pin connections for ArmorBlock Guard I/O M12 input compatibility.
❄ Replace symbol with 0M3 (0.3 m), 2 (2 m), or 5 (5 m) for standard cable length.
‡ Replace symbol with 1 (1 m), 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable length.

Specifications

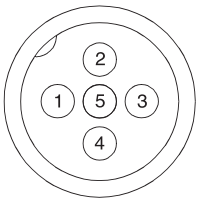
Electrical Ratings			UL/NEMA	IEC
Power Circuit	Rated Operation Voltage		380Y/220…480Y/277V AC	380Y/220…480Y/277V AC
	Rate Insulation Voltage		600V	
	Rated Impulsed Voltage		4 kV	
	Dielectric Withstand		2200V AC	2500V AC
	Operating Frequency		50/60 Hz	
	Utilization Category		—	AC-3
	Protection Against Shock		—	IP2X
	Rated Operating Current Max.		2.5 A	
			5.5 A	
			16 A	
Control Circuit	Rated Operation Voltage		24V DC (+10%, -15%) A2 (should be grounded at voltage source)	
	Rate Insulation Voltage		250V	
	Rated Impulsed Voltage		—	4 kV
	Dielectric Withstand		1500V AC	2000V AC
	Overvoltage Category		—	III
	Operating Frequency		50/60 Hz	
Short Circuit Protection	SCPD Performance Type 1 Sym. Amps RMS @ 480Y/277V	**Current Rating**		
		0.5…2.5 A	65 kA	
		1.1…5.5 A		
		3.2…16 A	30 kA	
	SCPD List		Size per NEC Group Motor	—

Power Requirements			
	Units	**Without HOA**	**With HOA**
Control Voltage	Volts	24V DC	
Contactor (Pick Up)	Amps	1.09	
Contactor (Hold In)	Amps	0.30	
Total Control Power (Pick Up)	VA (W)	(26 W)	
Total Control Power (Hold In)	VA (W)	(7.2 W)	
External Devices powered by Control Voltage			
Outputs (2) (1 A max. each)	Amps	2	2
Total Control (Pick Up) with max outputs	VA (W)	(65 W)	(73 W)
Total Control (Hold In) with max outputs	VA (W)	(50 W)	(58 W)

Input Ratings	Rated Operation Voltage	24V DC	
	Input On-State Voltage Range	10…26V DC	
	Input On-State Current	3.0 mA @ 10V DC	
		7.2 mA @ 24V DC	
	Input Off-State Voltage Range	0…5V DC	
	Input Off-State Current	<1.5 mA	
	Input Filter — Software Selectable		
	Off to On	Settable from 0…64 ms in 1 ms increments	
	On to Off	Settable from 0…64 ms in 1 ms increments	
	Input Compatibility	N/A	IEC 1+
	Number of Inputs	4	
	Sensor Source		
	Voltage Status Only	11…25V DC from DeviceNet	
	Current Available	50 mA max. per input, 200 mA total	
Output Ratings (Sourced from Control Circuit)	Rated Operation Voltage	240V AC/30V DC	240V AC/30V DC
	Rate Insulation Voltage	250V	250V
	Dielectric Withstand	1500V AC	2000V AC
	Operating Frequency	50/60 Hz	50/60 Hz
	Type of Control Circuit	Electromechanical relay	
	Type of Current	AC/DC	
	Conventional Thermal Current Ith	Total of both outputs ≤ 2 A	
	Type of Contacts	Normally open (N.O.)	
	Number of Contacts	2	
ArmorPoint Ratings	Backplane Current Load	400 mA	

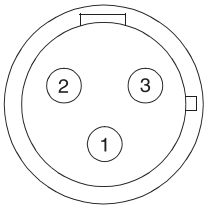
		UL/NEMA	IEC
Environmental	Operating Temperature Range	-20…+40 °C (-4…+104 °F)	
	Storage and Transportation Temperature Range	–25….+85 °C (–13…+185 °F)	
	Altitude	2000 m	
	Humidity	5…95% (non-condensing)	
	Pollution Degree	3	
	Enclosure Ratings	NEMA 4/12/13	IP67
	Approximate Shipping Weight	6.8 kg (15 lb)	
Mechanical	**Resistance to Shock**		
	Operational	15 G	
	Non-Operational	30 G	
	Resistance to Vibration		
	Operational	1 G, 0.15 mm (0.006 in.) displacement	
	Non-Operational	2.5 G, 0.38 mm (0.015 in.) displacement	
	Power and Ground Terminals		
	Wire Size	Primary terminal: (#16 …#10 AWG) Secondary terminal: (#18 …#10 AWG)	Primary terminal: 1.5…5.3 mm^2 Secondary terminal: 0.8…5.3 mm^2
	Tightening Torque	Primary terminal: 10.8 lb•in Secondary terminal: 4.5 lb•in	Primary Terminal: 1.2 N•m Secondary terminal: 0.5 N•m
	Wire Strip Length	9 mm (0.35 in.)	
Other Rating	**EMC Emission Levels**		
	Conducted Radio Frequency Emissions	Class A	
	Radiated Emissions	Class A	
	EMC Immunity Levels		
	Electrostatic Discharge	4 kV contact and 8 kV Air	
	Radio Frequency Electromagnetic Field	10V/m	
	Fast Transient	2 kV	
	Surge Transient	1 kV $_{L-L}$, 2 kV $_{L-N}$ (earth)	
	Overload Characteristics		
	Overload Current Range	0.5…2.5 A	
		1.1…5.5 A	
		3.2…16 A	
	Trip Classes	10, 15, 20	
	Trip Rating	120% of FLC setting	
	Number of poles	3	
	DeviceNet Specifications		
	DeviceNet Supply Voltage Rating	Range 11…25V DC, 24V DC nominal	
	DeviceNet Input Current	167 mA @ 24V DC - 4.0 W	
		364 mA @ 11V DC - 4.0 W	
	External Devices powered by DeviceNet	Sensors inputs 4 x 50 mA - total 200 mA	
	Total w/max Sensor Inputs (4)	367 mA @ 24V DC - 8.8 W	
	DeviceNet Input Current Surge	15 A for 250 µs	
	DeviceNet Communications		
	Baud Rates	125, 250, 500 kbps	
	Distance Maximum	500 m (1630 ft) @ 125 kbps	
		200 m (656 ft) @ 250 kbps	
		100 m (328 ft) @ 500 kbps	
	Certifications	cULus (File No. E3125) UL 508 EN/IEC 60947-4-1 CE Marked per Low Voltage Directive 73/23/EEC and EMC Directive 89/336/EEC	

External Connections for Input Connector



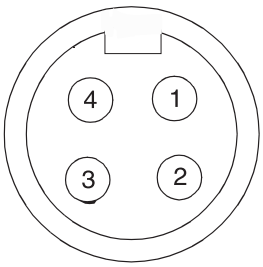
Pin 1: +V Out
Pin 2: Input
Pin 3: Comm
Pin 4: Input
Pin 5: NC (No Connection)

External Connections for Output Connector



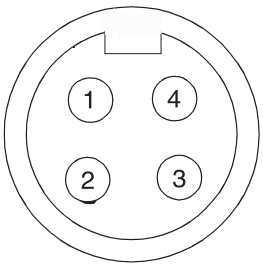
Pin 1: PE
Pin 2: Return
Pin 3: Relay Out

External Connections for Motor Connector (≤ 3 Hp @ 460V AC)



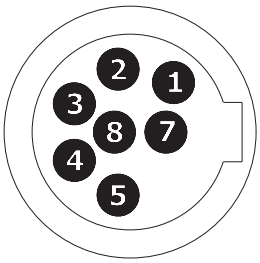
Pin 1: T1 - Black
Pin 2: T2 - White
Pin 3: T3 - Red
Pin 4: Ground - Green/Yellow

External Connections for Motor Connector (> 3 Hp @ 460V AC)



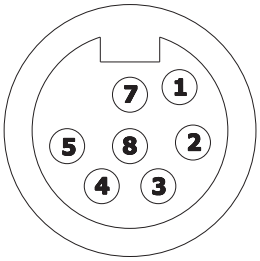
Pin 1: T1 - Black
Pin 2: Ground - Green/Yellow
Pin 3: T3 - Red
Pin 4: T2 - White

External Connections for ArmorPoint Interface (IN)



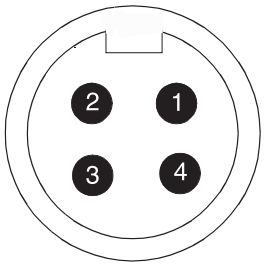
Pin 1: CAN High
Pin 2: Common
Pin 3: +5V
Pin 4: CAN Low
Pin 5: Enable In
Pin 7: Common
Pin 8: PE

External Connections for ArmorPoint Interface (OUT)



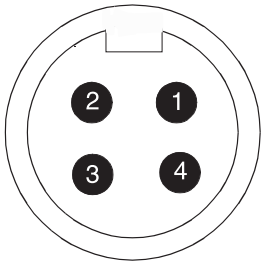
Pin 1: CAN High
Pin 2: Common
Pin 3: +5V
Pin 4: CAN Low
Pin 5: Enable Out
Pin 7: Common
Pin 8: NC (No Connection)

Safety Monitor Input (SM1/SM2)



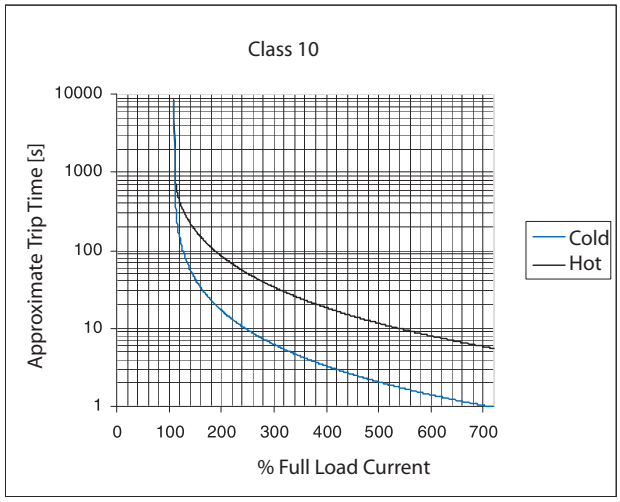
Pin 1: SM2 - White
Pin 2: SM1 - Brown
Pin 3: NC (No Connection)
Pin 4: NC (No Connection)

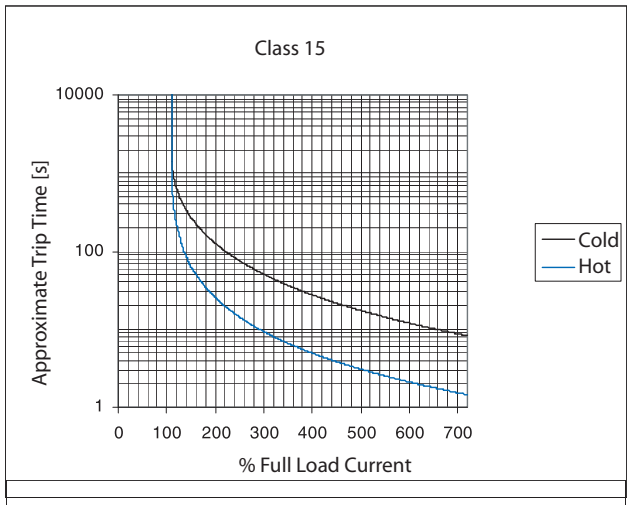
External Connections for Safety Input Power (A1/A2)

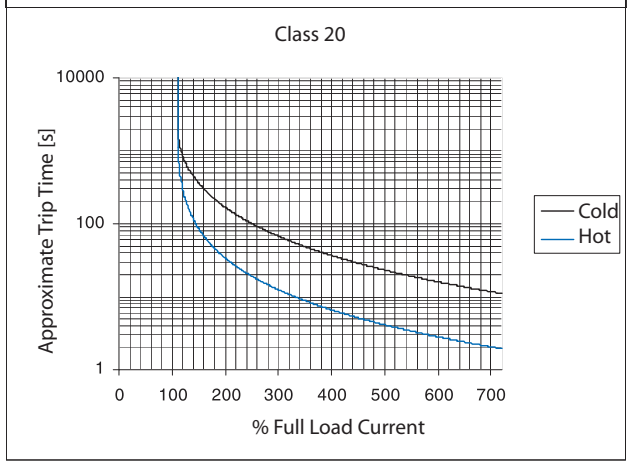


Pin 1: M - White
Pin 2: A1 - Brown
Pin 3: P - Black
Pin 4: A2 - Blue

Overload Curves



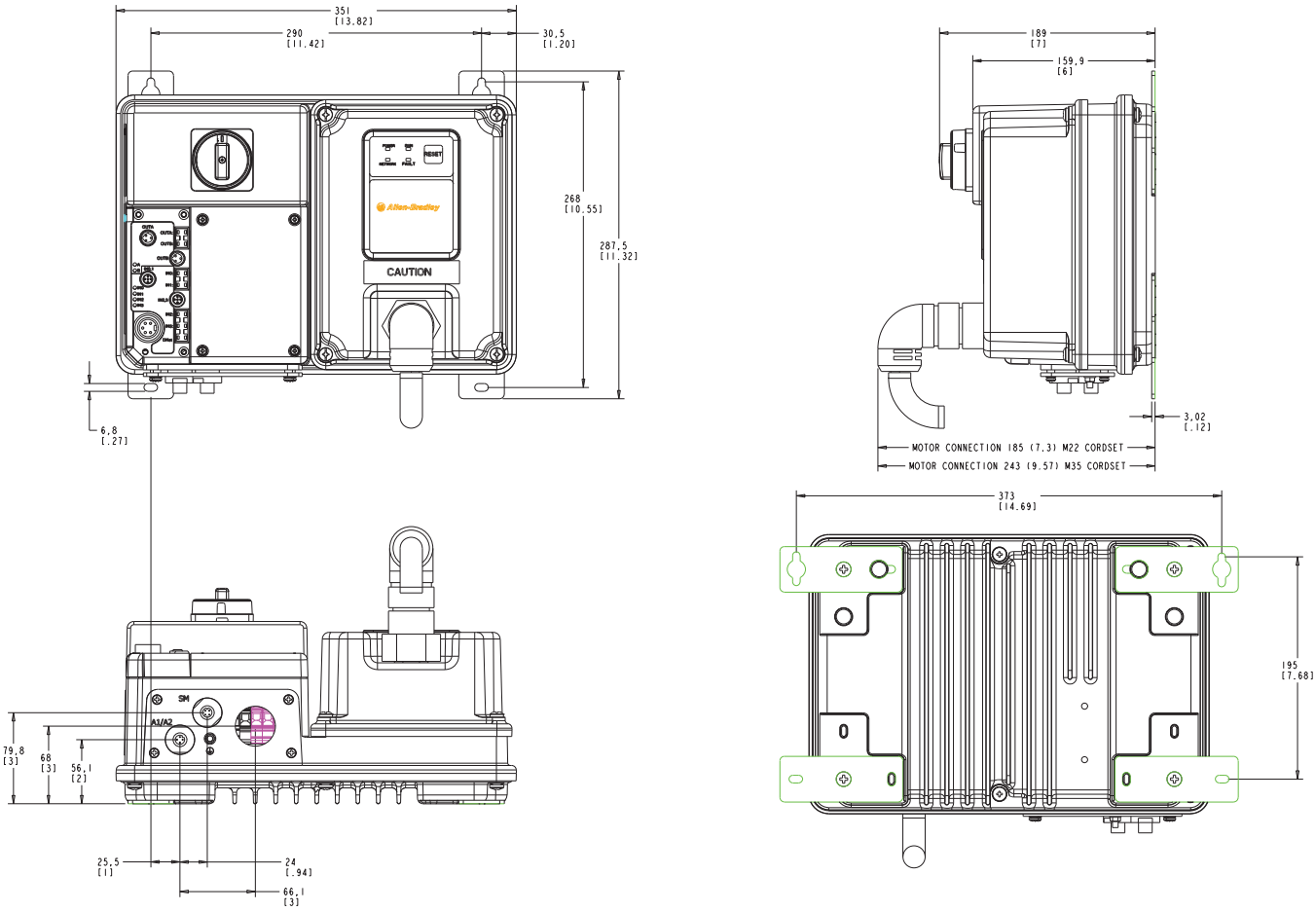




Approximate Dimensions

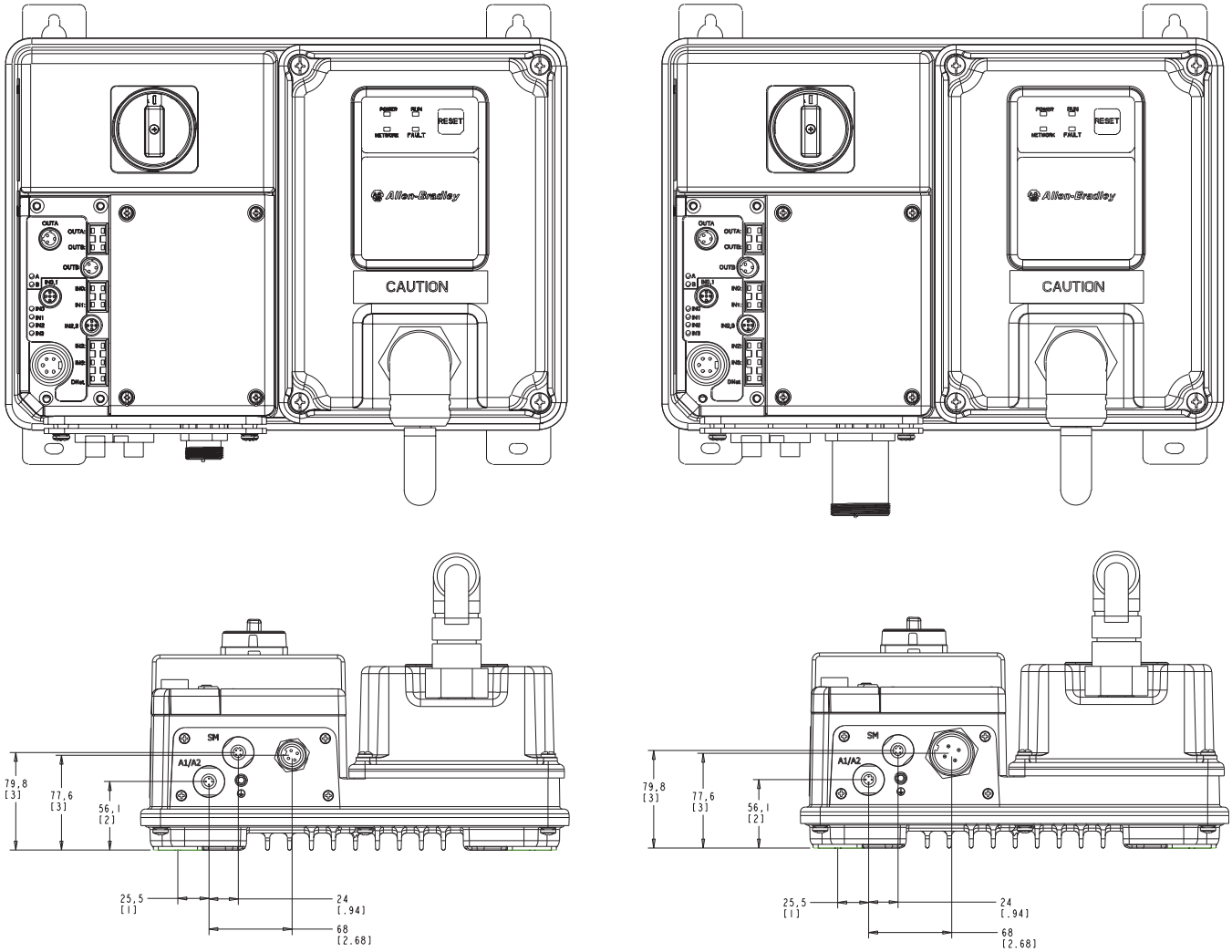
Dimensions for IP67/NEMA Type 4 with Conduit Entrance

Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.



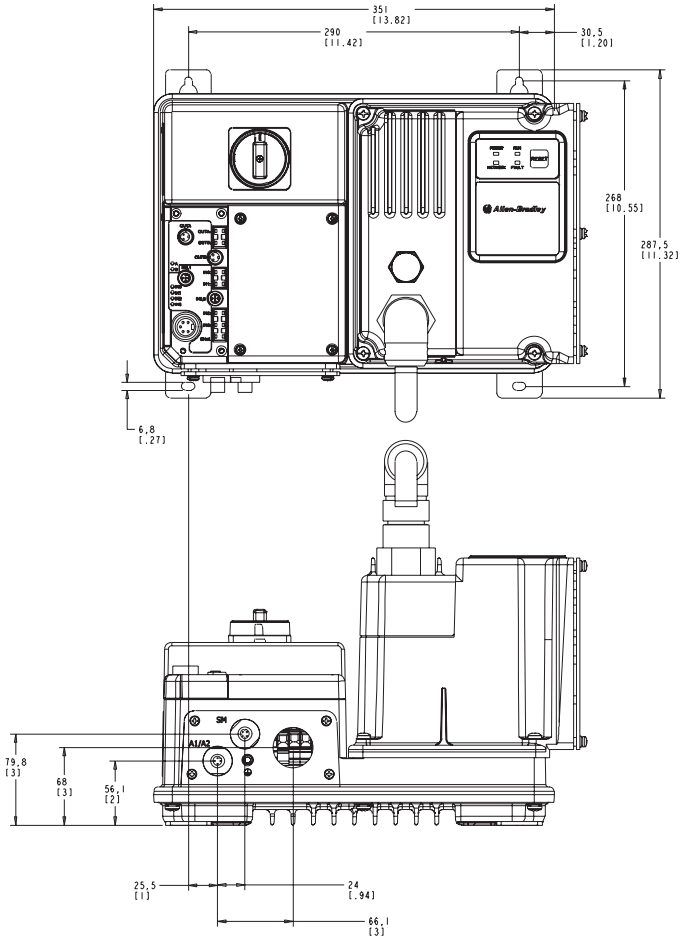
Dimensions for IP67/NEMA Type 4 with ArmorConnect Connectivity

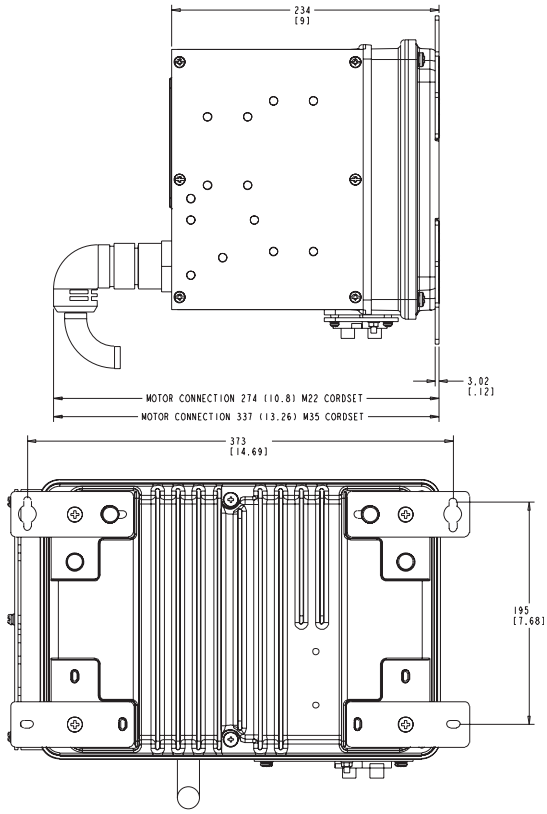
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.



Dimensions for Reversing, IP67/NEMA Type 4 with Conduit Entrance

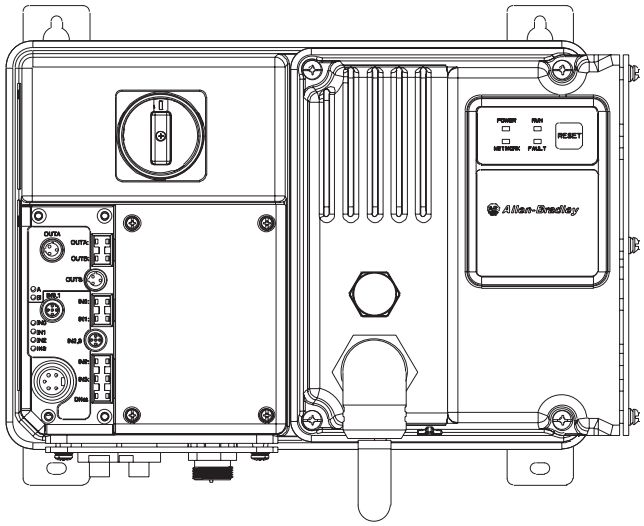
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

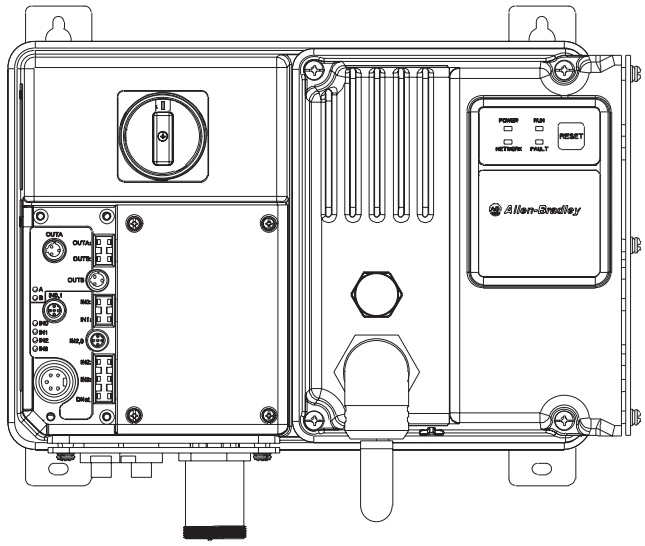


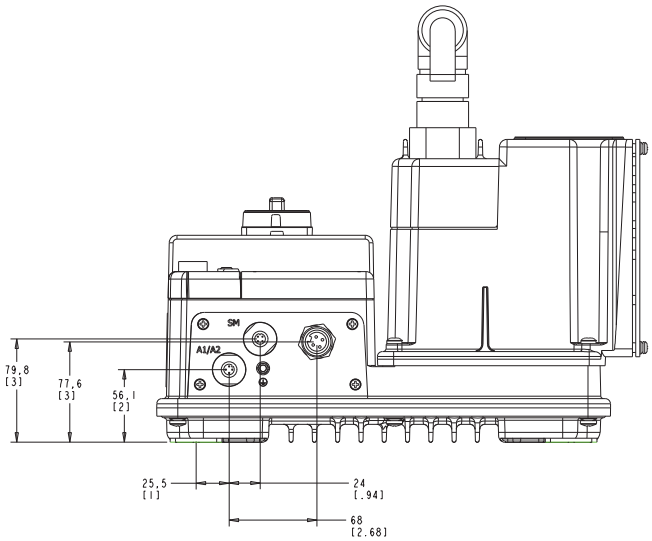


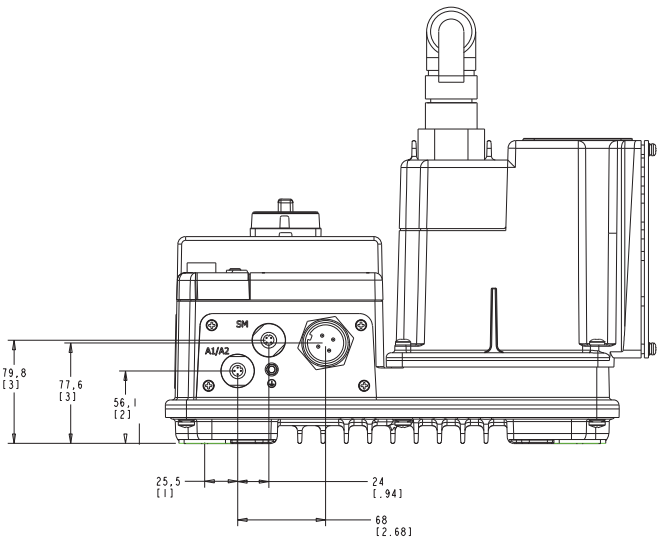
Dimensions for Reversing, IP67/NEMA Type 4 with ArmorConnect Connectivity

Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.









Safety ArmorStart® Distributed Motor Controllers

Bulletin 284D

Bulletin 284D ArmorStart Distributed Motor Controller - Safety Version



Description

The Bulletin 284 ArmorStart Distributed Motor Controller is an integrated, pre-engineered starter for variable frequency AC drive applications. The ArmorStart offers a robust IP67/NEMA Type 4 enclosure design, which is suitable for water wash-down environments. The modular plug-and-play design offers simplicity in wiring the installation. The quick disconnects for the I/O, communication, and motor connection reduce the wiring time and eliminate wiring errors. The ArmorStart offers, as standard, four DC inputs and two relay outputs to be used with sensors and actuators respectively, for monitoring and controlling the application process. The ArmorStart's LED status indication and built-in diagnostics capabilities allows ease of maintenance and troubleshooting. The optional Hand/Off/Auto (HOA) keypad allows for local start/stop control at the ArmorStart Distributed Motor Controller.

The Bulletin 284 ArmorStart Distributed Motor Controller offers short circuit protection per UL 508C and IEC 60947-1. The ArmorStart is rated for local-disconnect service by incorporating the Bulletin 140 Motor Protector as the local-disconnect, eliminating the need for additional components. The ArmorStart Distributed Motor Controllers are suitable for group motor installations.

Safety ArmorStart

The safety version of the ArmorStart provides a safety solution integrated into DeviceNet Safety installations. The Bulletin 284 Safety ArmorStart achieves Category 4 functionality by using redundant contactors. The Safety ArmorStart offers a quick connects via the gland plate to the 1732DS-IB8XOBV4 safety I/O module. The Bulletin 1732DS Safety I/O inputs will monitor the status of the safety rated contactors inside the ArmorStart. The Bulletin 1732DS Safety I/O outputs to provide 24V DC power for control power to the ArmorStart.

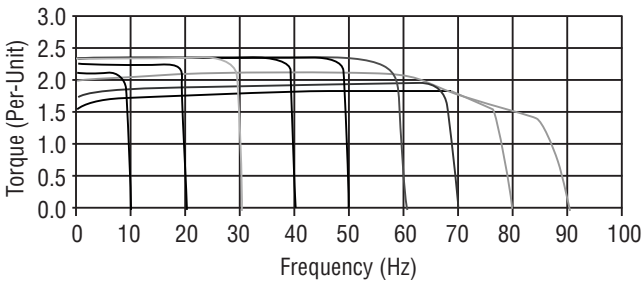
Note: The Bulletin 284 Safety ArmorStart is suitable for safety applications up to Safety Category 4 PLe (TÜV assessment per ISO 13849-1:2008). TÜV compliance letter is available upon request.

Note: For additional information regarding the 1732DS-IB8XOBV4 safety I/O module, see publication 1791DS-UM001*-EN-P.

Mode of Operation

Sensorless Vector Control (SVC)

Sensorless vector control provides exceptional speed regulation and very high levels of torque across the entire speed range of the drive.



ArmorStart with Sensorless Vector Control — 3 Hp, High Speed

Additional Features

- Eight Preset Speeds
- Skip Frequency
- Flying Start
- Auto Restart
- Process Control Loop (PID)
- Step Logic Functionality
- Timer/Counter Functions

Features

- On-Machine starting solution
- Variable frequency AC drive using PowerFlex® technology
- Horsepower range 0.5…5 Hp (0.4…3.3 kW)
- Robust IP67/NEMA Type 4 enclosure rating
- Modular plug and play design
- Quick disconnect connections for I/O, communications, motor, and three-phase power
- Four inputs and two outputs (expandable with ArmorPoint)
- LED status indication
- DeviceNet communications
- DeviceLogix component technology
- Peer-to-peer communications (ZIP)
- Factory installed options:
  - EMI filter
  - Dynamic brake connector
  - Hand/Off/Auto (HOA) keypad configuration
  - Source brake contactor
  - Shielded motor cable
  - Output contactor
  - Hand/Off/Auto (HOA) Keypad Configuration
  - EMI Filter
  - Dynamic Brake Connector
  - Output Contactor
  - Control Brake Contactor
  - Source Brake Contactor
  - Shielded Motor Cable
  - Safety Monitor
  - 0…10V Analog Input

Standards Compliance

UL 508C
CSA C22.2, No. 14
EN/IEC 60947-1, EN 50178, EN 61800-3
CE Marked per Low Voltage Directive 73/23/EEC and EMC Directive 89/336/EEC

Certifications

cULus (File No. E207834, Guide NMMS, NMMS7)

Description of Features

Overload Protection

The Bulletin 284 ArmorStart Distributed Motor Controller incorporates, as standard, electronic motor overload protection. This overload protection is accomplished electronically with an I^2t algorithm. The ArmorStart's overload protection is programmable via the communication network providing the user with flexibility. The overload trip class allows for class 10 overload protection. Ambient insensitivity is inherent in the electronic design of the overload.

Gland Plate Entrance

The ArmorStart product offers two different methods for connecting incoming three-phase power to the device. One method offered is the traditional conduit entrance which provides a 1 in. conduit hole opening for wiring three-phase power. The second method offers connectivity to the ArmorConnect power media. A factory installed receptacle is provided for connectivity to three-phase power media.

Motor Cable

With every Bulletin 284 ArmorStart Distributed Motor Controller, a 3 m unshielded 4-conductor cordset is provided with each unit as standard. If the optional EMI filter is selected, a 3 m shielded 4-conductor cordset is provided with each unit as standard.

LED Status Indication

The LED Status Indication provides four status LEDs and a Reset button. The LEDs provide status indication for the following:

- **POWER LED**
  The LED is illuminated solid green when control power is present and with the proper polarity
- **RUN LED**
  This LED is illuminated solid green when a start command and control power are present
- **NETWORK LED**
  This bicolor (red/green) LEDs indicates the status of the communication link
- **FAULT LED**
  Indicates Controller Fault (trip) condition
- The "Reset Button" as a local trip reset.

Inputs

The inputs are single keyed (two inputs per connector), which are sourced from DeviceNet power (24V DC), with LED status indication.

Outputs

Two dual-key relay output connectors are supplied as standard. The outputs are sourced from the control voltage power, which is 24V DC with LED status indication.

Fault Diagnostics

Fault diagnostics capabilities built into the Bulletin 284 ArmorStart Distributed Motor Controller help you pinpoint a problem for easy troubleshooting and quick re-starting.

- Short Circuit
- Overload
- Phase Short
- Ground Fault
- Stall
- Control Power Loss
- Control Power Fuse Protection
- I/O Fault
- Overcurrent
- Brake Fuse Protection
- Overtemperature
- Output Fuse Protection
- DeviceNet Power Loss
- Internal Communication Fault
- DC Bus Fault
- EEPROM Fault
- Hardware Fault
- Restart Retries
- Miscellaneous Fault

Factory Installed Options

HOA Selector Keypad with Jog Function

The HOA Selector Keypad with Jog Function allows for local start/stop control with capabilities to JOG and to Forward/Reverse motor direction.

EMI Filter

The EMI Filter option is required if the Bulletin 284 ArmorStart Distributed Motor requires to be CE compliant. If the EMI Filter is selected, a 3–meter shielded 4–conductor cordset is provided as standard. This option is only available with sensorless vector control.

Dynamic Brake Connector

A 3 m, 3-pin cable for connection to a dynamic brake module is provided as standard when this option is selected. See Accessories on page 6-22 for available dynamic brake modules.

Source Brake Contactor

An internal contactor is used to switch the electromechanical motor brake on/off. The motor brake is powered from the main power circuit. A customer accessible 3.0 A fuse is provided to protect the brake cable. A 3-meter, 3-pin cable for connection to the motor, is provided as standard when this option is selected.

Shielded Motor Cable

A 3-meter shielded 4-conductor cordset is provided instead of the 3-meter unshielded 4-conductor cordset. If the EMI Filter is selected, a 3-meter shielded 4-conductor cordset is provided as standard.

Cat. No. Explanation

Examples given in this section are for reference purposes. This basic explanation should not be used for product selection; not all combinations will produce a valid catalog number.

284	D	–	F	V	D2P3	S	–	10	–	CR	–	Option 1	–	Option 2	–	Option 3
a	*b*		*c*	*d*	*e*	*f*		*g*		*h*		*i*		*j*		*k*

a

Bulletin Number	
Code	Description
284	VFD Starter

b

Communications	
Code	Description
D	DeviceNet™

c

Enclosure Type	
Code	Description
F	Type 4 (IP67)

d

Torque Performance Mode	
Code	Description
V	Sensorless Vector Control and Volts per Hertz

e

Output Current	
Code	Description
D1P4	1.4 A, 0.4 kW, 0.5 Hp
D2P3	2.3 A, 0.75 kW, 1.0 Hp
D4P0	4.0 A, 1.5 kW, 2.0 Hp
D6P0	6.0 A, 2.2 kW, 3.0 Hp
D7P6	7.6 A, 3.3 kW, 5.0 Hp

f

Control Voltage	
Code	Description
S	24V DC

g

Short Circuit Protection (Motor Circuit Protector)	
Code	Description
10	10 A Rated Device
25	25 A Rated Device

h

Control and 3-Phase Power Connections / Motor Cable Connection (CR: Conduit/Round Media) or (RR: Round/Round Media)				
Code		Description		
		Control Power	3-Phase Power	Motor Cable
CR	blank	Conduit Entrance	Conduit Entrance	3 m, unshielded cordset male 90°
CR	N	Conduit Entrance	Conduit Entrance	3 m, shielded cordset male 90°
CR	W ∗	Conduit Entrance	Conduit Entrance	No cable
RR	blank	Round Media (Male Receptacle)	Round Media (Male Receptacle)	3 m, unshielded cordset male 90°
RR	N	Round Media (Male Receptacle)	Round Media (Male Receptacle)	3 m, shielded cordset male 90°
RR	W ∗	Round Media (Male Receptacle)	Round Media (Male Receptacle)	No cable

∗ See Accessories on page 6-21 for extended motor and brake cable lengths.

i

Option 1	
Code	Description
3	Hand/Off/Auto Selector Keypad with Jog Function

j

Option 2		
Code		Description
DB1	blank	Connectivity to IP67 DB Resistor
SB	blank	Source Brake Contactor
SB	W ∗	No cable

k

Option 3	
Code	Description
EMI	EMI Filter

Product Selection

IP67/NEMA Type 4 with conduit entrance, DeviceNet communications, Sensorless Vector Control, and Volts per Hertz torque performance, Up to 480V AC

Input Voltage	3-Phase kW Rating	3-Phase Hp Rating	Output Current	24V DC Control Voltage Cat. No.
380…480V, 50/60 Hz 3-Phase	0.4	0.5	1.4	284D-FVD1P4S-10-CR
	0.75	1	2.3	284D-FVD2P3S-10-CR
	1.5	2	4	284D-FVD4P0S-10-CR
	2.2	3	6	284D-FVD6P0S-25-CR
	3	5	7.6	284D-FVD7P6S-25-CR

IP67/NEMA Type 4 with quick disconnects for ArmorConnect power media, DeviceNet communications, Sensorless Vector Control, and Volts per Hertz torque performance, Up to 480V AC

Input Voltage	3-Phase kW Rating	3-Phase Hp Rating	Output Current	24V DC Control Voltage Cat. No.
380…480V, 50/60 Hz 3-Phase	0.4	0.5	1.4	284D-FVD1P4S-10-RR
	0.75	1	2.3	284D-FVD2P3S-10-RR
	1.5	2	4	284D-FVD4P0S-10-RR
	2.2	3	6	284D-FVD6P0S-25-RR
	3	5	7.6	284D-FVD7P6S-25-RR

Options – Factory Installed

Description				Cat. No. Modification
	Hand/Off/Auto Selector Keypad			-3
	EMI Filter			-EMI
	Shielded motor cable		**Enclosure Rating**	-CRN
	Supplied without motor cable		IP67	-CRW
	Supplied with source brake cable			-SB
	Supplied without source brake cable			-SBW
	Dynamic Brake Connector			-DB1
	Connectivity to ArmorConnect Power Media supplied with shielded motor cable	**Short Circuit Protection Rating**	**Enclosure Rating**	-RRN
		10 A	IP67	
		25 A		
	Connectivity to ArmorConnect Power Media supplied without motor cable	10 A		-RRW
		25 A		

Accessories

Sealing Caps

Description	For Use With	Cat. No.
Plastic Sealing Cap (M12)✶	Input I/O Connection	1485A-M12
AC Micro Aluminum Sealing Cap - External✶	Output I/O Connection	889A-RMCAP

✶ To achieve IP67 rating, sealing caps must be installed on all unused I/O connections.

Cables

Description	Cable Rating	Length [m (ft)]	Cat. No.
Extended Motor Cable Cordsets			
90° M22 Motor Cordset	IP67/NEMA Type 4	6 (19.6)	280-MTR22-M6
		14 (45.9)	280-MTR22-M14
Shielded Motor Cable Cordsets			
90° M22 Motor Cordset	IP67/NEMA Type 4	6 (19.6)	**284-MTRS22-M6**
90° M22 Motor Cordset	IP67/NEMA Type 4	14 (45.9)	284-MTRS22-M14
Extended Brake Cable Cordsets			
90° M25 Source Brake Cable	IP67/NEMA Type 4	6 (19.6)	285-BRC25-M6
90° M25 Source Brake Cable	IP67/NEMA Type 4	14 (45.9)	285-BRC25-M14

Sensor Media ⌘

Description		ArmorStart I/O Connection	Pin Count	Connector	Cat. No.
	DC Micro Patchcord	Input	5-pin	Straight Female Straight Male	889D-F4ACDM-➤
				Straight Female Right Angle Male	889D-F4ACDE-➤
	DC Micro V-Cable	Input	5-pin	Straight Female	879D-F4ACDM-➤
				Right Angle Male	879D-R4ACM-➤
	AC Micro Patchcord	Output	3-pin	Straight Female Straight Male	889R-F3AERM-➤
				Straight Female Right Angle Male	889R-F3AERE-➤

⌘ See the On-Machine Connectivity catalog for complete cable selection information.
➤ Replace symbol with desired length in meters (Example: 889D-F4ACDM-1 for a 1 m cable). Standard cable lengths: 1, 2, 5, and 10 m.
Note: Stainless steel versions may be ordered by adding an "S" to the cat. no. (Example: 889DS-F4ACDM-1).

DeviceNet Media ♣

Description		Length [m (ft)]	Cat. No.
			Sealed
	KwikLink pigtail drops are Insulation Displacement Connector (IDC) with integral Class 1 round cables for interfacing devices or power supplies to flat cable	1 (3.3)	1485P-P1E4-B1-N5
		2 (6.5)	1485P-P1E4-B2-N5
		3 (9.8)	1485P-P1E4-B3-N5
		6 (19.8)	1485P-P1E4-B6-N5
	DeviceNet Mini- T-Port Tap	Left Keyway	**1485P-P1N5-MN5KM**
		Right Keyway	1485P-P1N5-MN5NF

Description		Connector	Cat. No.
	Gray PVC Thin Cable	Mini Straight Female Mini Straight Male	1485G-P❄N5-M5
		Mini Straight Female Mini Right Angle Male	1485G-P❄W5-N5
		Mini Right Angle Female Mini Straight Male	1485G-P❄M5-Z5
		Mini Right Angle Female Mini Straight Male	1485G-P❄W5-Z5
	Thick Cable	Mini Straight Female Mini Straight Male	1485C-P‡N5-M5
		Mini Straight Female Mini Right Angle Male	1485C-P‡W5-N5
		Mini Right Angle Female Mini Straight Male	1485C-P‡M5-Z5
		Mini Right Angle Female Mini Straight Male	1485C-P‡W5-Z5

Description		Length [m (ft)]	Cat. No.
	DeviceNet Configuration Terminal Used to interface with objects on a DeviceNet network. Includes 1 m communications cable.	1 (3.3)	193-DNCT
	Communication cable, color-coded bare leads	1 (3.3)	193-CB1
	Communication cable, microconnector (male)	1 (3.3)	193-CM1
	Panel Mount Adapter/Door Mount Bezel Kit	—	193-DNCT-BZ1

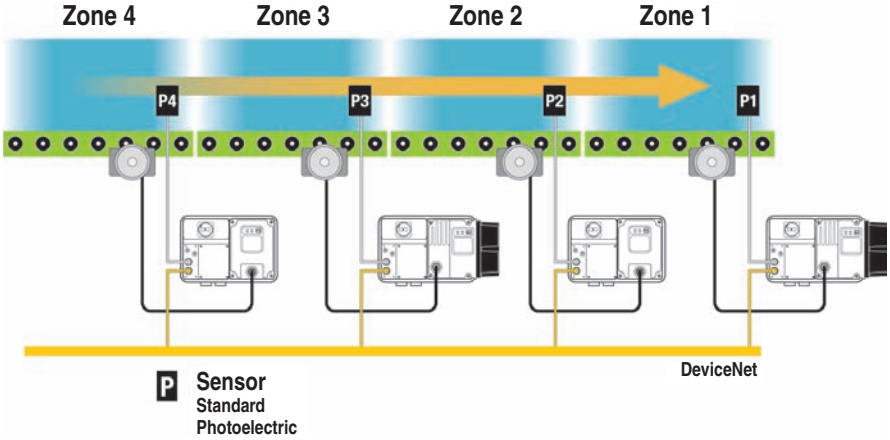
♣ See publication M116-CA001_-EN-P for complete cable selection information.
❄ Replace symbol with desired length in meters (Example: **1485G-P1N5-M5** for a 1 m cable). Standard cable lengths: 1, 2, 3, 4, 5, and 6 m.
‡ Replace symbol with desired length in meters (Example: **1485C-P1N5-M5** for a 1 m cable). Standard cable lengths: 1, 2, 3, 4, 5, 6, 8, 10, 12, 18, 24, and 30 m.

IP67 Dynamic Brake Resistors – 400…480V AC Input Drives

Drive and Motor Size kW (Hp)	Cat. No.	Resistance⌘ [Ω ± 5%]	Continuous Power kW	Max. Energy kJ	Max. Braking Torque % of Motor	Application Type 1		Application Type 2	
						Braking Torque % of Motor	Duty Cycle§ %	Braking Torque % of Motor	Duty Cycle§ %
0.37 (0.5)	284R-360P500-M∗	360	0.086	17	305%	100%	47%	150%	31%
0.75 (1)	284R-360P500-M∗	360	0.086	17	220%	100%	23%	150%	15%
1.5 (2)	284R-360P500-M∗	360	0.086	17	110%	100%	12%	110%	11%
2.2 (3)	284R-120P1K2-M∗	120	0.26	52	197%	100%	24%	150%	16%
4 (5)	284R-120P1K2-M∗	120	0.26	52	124%	100%	13%	124%	10%

∗ Indicates cable length (0.5 m or 1.0 m).
⌘ Always check the resistor ohms against the minimum resistance for the drive being used.
§ The duty cycle listed is based on full speed to zero speed deceleration. For constance regen at full speed, the duty cycle capability is half of the listed value. Application Type 1 represents maximum capability up to 100% braking torque where possible. Application Type 2 represents more than 100% braking torque where possible, up to a mximum of 150%.

Peer-to-Peer Communications



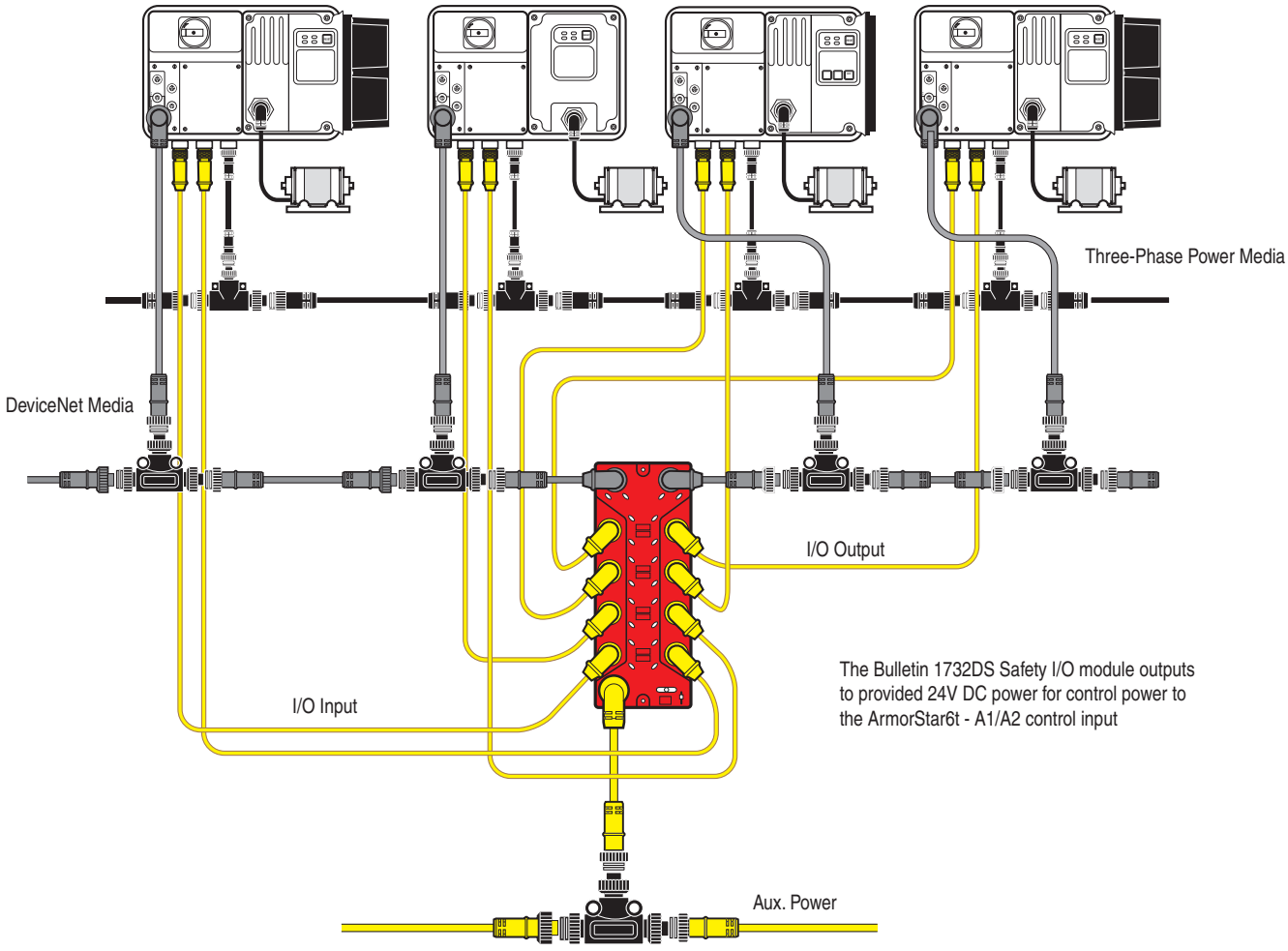
The Zone Control capabilities of ArmorStart Distributed Motor Controller is ideal for large horsepower (0.5…10 Hp) motored conveyors. The ArmorStart Distributed Motor Controllers have built-in DeviceNet Communications, DeviceLogix technology, and the added Zone Interlocking Parameters (ZIP) which allows one ArmorStart to consume data directly from up to four other DeviceNet nodes without going through the network scanner. These direct communications between conveyor zones are beneficial in a merge, diverter, and accumulation conveyor applications.

Safety I/O Module and TÜV Requirements

ArmorStart Safety-Related Parts

Each ArmorStart Safety Distributed motor controller is intended to be combined with the 1732DS-IB8XOBV4 safety I/O module to form a subsystem that is part of the overall machine stop function. The motor controllers are connected to the safety I/O module through specified cable assemblies. The combination of one of these controllers, the safety module, and the specified interconnecting cables are referred to as the ArmorStart Safety-Related Parts. The part numbers for each of these components is specified below. The combination of these components is shown in Figure E.1. The safety I/O module and PLC program must be configured as outlined. See configuration of Safety I/O Module and PLC program.

Catalog Number	Description
280…S* * - denotes safety version of Bulletin 280	Bulletin 280 Distributed Motor Controller – controller is full-voltage, non-reversing
281…S* * - denotes safety version of Bulletin 281	Bulletin 281 Distributed Motor Controller – controller is full-voltage, reversing
284…S* * - denotes safety version of Bulletin 284	Bulletin 284 Distributed Motor Controller – controller is variable-frequency AC drive
1732DS-IB8XOBV4	Guard I/O DeviceNet Safety Module
889D-F4HJDM-*, 889D-F4AEDM-* or equivalent * - denotes length	• SM cable assembly - Interconnecting cable assembly between safety module input and ArmorStart controller connector labeled “SM”. Assembly provides contactor position feedback. • A1/A2 cable assembly - Interconnecting cable assembly between safety module output and ArmorStart controller connector labeled “A1/A2”. Assembly provides output contactor coil power and controller power supply.



The Bulletin 1732DS Safety I/O module inputs will monitor the status of the safety-related contactors inside the ArmorStart - SM safety monitor input

ArmorBlock® Guard I/O™ Modules

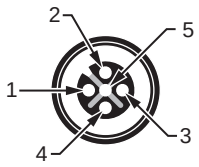
	Description	Cat. No.
	ArmorBlock Guard I/O provides all the advantages of traditional distributed I/O for safety systems, but has an IP67 package that can be mounted directly on your machine. On-machine safety I/O reduces wiring time and startup costs for safety controller applications by eliminating electrical boxes and simplifying cable installation. The ArmorBlock family provides industrially hardened I/O blocks that you can mount directly on equipment near sensors or actuators. Wiring the I/O to the sensors and actuators is easy using pre-wired quick disconnect cables. You can use Guard I/O with any safety controller that communicates on DeviceNet using CIP Safety for the control and monitoring of safety circuits. Guard I/O detects circuit failures at each I/O point while providing detailed diagnostics directly to the controller. With CIP Safety, you can easily integrate safety and standard control systems by using safety and standard messages on the same wire. The 1732DS ArmorBlock Guard I/O family consists of 24V DC digital I/O modules that communicate on DeviceNet networks. The I/O connectors are sealed M12 micro style while the network and auxiliary power connectors are sealed mini style. Plus, the ArmorBlock Guard I/O uses the same input and output M12 pin configuration as standard ArmorBlock and Maxum.	1732DS-IB8XOBV4

Specifications

Description	24V DC Input/Output Module on DeviceNet Networks
Current Consumption	85 mA @ 24V DC
I/O Operating Voltage Range	19.2V…28.8 V DC (24V DC, -20…+20%)
Digital Inputs	
Number of Inputs	8 safety single-channel or 4 safety dual-channel
Input Type	current sinking
Voltage, On-State Input, Min.	11V DC
Voltage, Off-State Input, Max.	5V DC
Current, On-State Input, Min.	3.3 mA
Digital Outputs	
Number of Outputs	4 safety solid-state
Output Type	dual channel, current sourcing/current sinking pair
Output Current Rating	2.0 A max per point
Short Circuit Protection	Yes
Standard Pulse Test Outputs	
Number of Pulse Test Sources	8
Pulse Test Output Current	0.7 A per point
Short Circuit Protection	Yes
General	
Temperature, operating	-20…+60 °C (-4…+140 °F)
Relative Humidity	10…95% non-condensing
Vibration	0.76 mm @ 10…500 Hz
Shock, operating	30 g
Enclosure Protection	IP67
Dimensions (HxWxD), Metric	179 x 70 x 68.7 mm✶
Dimensions (HxWxD), Imperial	7.05 x 2.76 x 2.71 in.✶
Weight, Metric	600 g
Weight, Imperial	1.2 lb
Certifications❄	UL, CE, C-Tick, CSA, UL NRGF, ODVA Conformance, TÜV certified for functional safety up to SIL 3 and Cat. 4, PLe

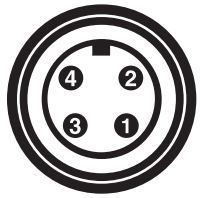
✶ Includes terminal block.
❄ When product is marked. See the Product Certification link at http://www.ab.com/certification for Declarations of Conformity, Certificates, and other certification details.
All specifications are subject to change. Refer to product installations instructions.

1732DS ArmorBlock Guard I/O Micro Connector Pin Assignments

Input Configuration		Female	Output Configuration	
Pin	Signal		Pin	Signal
1	Test Output n+1		1	Output +24V DC Power
2	Safe Input n+1		2	Output n+1 (Sinking)
3	Input Common		3	Output Power Common
4	Safe Input n		4	Output n (Sourcing)
5	Test Output n		5	Output Power Common

1732DS ArmorBlock Guard I/O Mini Connector Pin Assignments

ArmorBlock Guard I/O DeviceNet Configuration			
Pin	Signal	Male	Female
1	Drain		
2	V+ (Red)		
3	V- (Black)		
4	CAN_H (White)		
5	CAN_L (Blue)		

ArmorBlock Guard I/O Power Configuration		
Pin	Signal	Male
1	Output +24V DC Power (Red)	
2	Input +24V DC Power (Green)	
3	Input Power Common (White)	
4	Output Power Common (Black)	

ArmorBlock Guard I/O Recommended Compatible Cables and Connectors✶

Description		Cat. No.
	DC Micro (M12) Male Cordset	889D-F4HJ-❄
	DC Micro Style Patchcord	889D-F4HJDM-‡
	M12 Terminal Chamber—Straight Male	871A-TS4-DM
	M12 Terminal Chamber—Right Angle Male	871A-TR4-DM

✶ All cables must use 5-pin connections for ArmorBlock Guard I/O M12 input compatibility.
❄ Replace symbol with 0M3 (0.3 m), 2 (2 m), or 5 (5 m) for standard cable length.
‡ Replace symbol with 1 (1 m), 2 (2 m), 5 (5 m), or 10 (10 m) for standard cable length.

Specifications

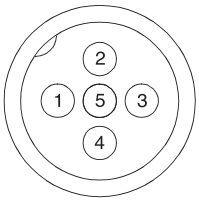
Electrical Ratings		UL/NEMA			IEC		
Power Circuit	Rated Operation Voltage	200…575V			200…500V		
	Rate Insulation Voltage	600V			600V		
	Rated Impulsed Voltage	6 kV			6 kV		
	Dielectric Withstand	2200V AC			2500V AC		
	Operating Frequency	50/60 Hz			50/60 Hz		
	Utilization Category	N/A			AC-3		
	Protection Against Shock	N/A			IP2X		
Control Circuit	Rated Operation Voltage	24V DC (+10%, -15%) A2 (should be grounded at voltage source)					
		120V AC (+10%, -15%) A2 (should be grounded at voltage source)					
		240V AC (+10%, -15%) A2 (should be grounded at voltage source)					
	Rate Insulation Voltage	250V			250V		
	Rated Impulsed Voltage	—			4 kV		
	Dielectric Withstand	1500V AC			2000V AC		
	Overvoltage Category	—			III		
	Operating Frequency	50/60 Hz					
Short Circuit Protection	SCPD performance Type 1	**Current Rating**	**Voltage**	480Y/277V	480/480V	600Y/347V	600V
		10 A	Sym. Amps RMS	65 kA	65 kA	30 kA	30 kA
		25 A		30 kA	30 kA	30 kA	30 kA
	SCPD List	Size per NEC Group Motor			—		

Power Requirements			
	Units	**No Options**	**w/ Brake Contactor**
Control Voltage	Volts	24V DC	
Total Control VA (Pick Up)	VA (W)	(11 W)	(16 W)
Total Control VA (Hold In)	VA (W)	(11 W)	(16 W)
External Devices powered by Control Voltage			
Outputs (2) (1 A max. each)	Amps	2	
Total Control VA (Pick Up) with max outputs	VA (W)	(59 W)	(64 W)
Total Control VA (Hold In) with max outputs	VA (W)	(59 W)	(64 W)

Input Ratings	Rated Operation Voltage	24V DC	
	Input On-State Voltage Range	10…26V DC	
	Input On-State Current	3.0 mA @ 10V DC	
		7.2 mA @ 24V DC	
	Input Off-State Voltage Range	0…5V DC	
	Input Off-State Current	<1.5 mA	
	Input Filter — Software Selectable		
	Off to On	Settable from 0…64 ms in 1 ms increments	
	On to Off	Settable from 0…64 ms in 1 ms increments	
	Input Compatibility	N/A	IEC 1+
	Number of Inputs	4	
	Sensor Source		
	Voltage Status Only	11…25V DC from DeviceNet	
	Current Available	50 mA max. per input, 200 mA total	
Output Ratings (Sourced from Control Circuit)	Rated Operation Voltage	240V AC/30V DC	240V AC/30V DC
	Rate Insulation Voltage	250V	250V
	Dielectric Withstand	1500V AC	2000V AC
	Operating Frequency	50/60 Hz	50/60 Hz
	Type of Control Circuit	Electromechanical relay	
	Type of Current	AC/DC	
	Conventional Thermal Current Ith	Total of both outputs ≤ 2 A	
	Type of Contacts	Normally open (N.O.)	
	Number of Contacts	2	
ArmorPoint Ratings	Backplane Current Load	400 mA	

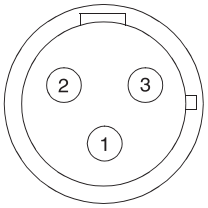
		UL/NEMA	IEC
Environmental	Operating Temperature Range	-20…+40 °C (-4…+104 °F)	
	Storage and Transportation Temperature Range	–25….+85 °C (–13…+185 °F)	
	Altitude	1000 m	
	Humidity	5…95% (non-condensing)	
	Pollution Degree	3	
	Enclosure Ratings	NEMA 4/12/13	IP67
		NEMA 4X	IP69K
	Approximate Shipping Weight	13.6 kg (30 lb)	
Mechanical	**Resistance to Shock**		
	Operational	15 G	
	Non-Operational	30 G	
	Resistance to Vibration		
	Operational	1 G, 0.15 mm (0.006 in.) displacement	
	Non-Operational	2.5 G, 0.38 mm (0.015 in.) displacement	
	Wire Size	Primary terminal: (16 …10 AWG) Secondary terminal: (18 …10 AWG)	Primary terminal: 1.3…5.3 mm^2 Secondary terminal: 0.8…5.3 mm^2
	Tightening Torque	Primary terminal: 10.8 lb•in Secondary terminal: 4.5 lb•in	Primary terminal: (1.2 N•m) Secondary terminal: (0.5 N•m)
	Wire Strip Length	0.35 in. (9 mm)	
	Control and Safety Monitor Inputs		
	Wire Size	(18…10 AWG)	1.0…4.0 mm^2
	Tightening Torque	6.2 lb•in	0.7 N•m
	Wire Strip Length	0.35 in. (9 mm)	
Other Rating	**EMC Emission Levels**		
	Conducted Radio Frequency Emissions	Class A	
	Radiated Emissions	Class A	
	EMC Immunity Levels		
	Electrostatic Discharge	4 kV contact and 8 kV Air	
	Radio Frequency Electromagnetic Field	10V/m	
	Fast Transient	2 kV	
	Surge Transient	1 kV (12) $_{L-L}$, 2 kV (2) $_{L-N}$ (earth)	
	Overload Characteristics		
	Trip Class	10	
	Overload Protection	I^2t overload protection - 150% for 60 s, 200% for 30 s	
	Number of Poles	3	
	DeviceNet Specifications		
	DeviceNet Supply Voltage Rating	Range 11…25V DC, 24V DC nominal	
	DeviceNet Input Current	167 mA @ 24V DC - 4.0 W	
		364 mA @ 11V DC - 4.0 W	
	External Devices powered by DeviceNet	Sensors inputs 4 x 50 mA - total 200 mA	
	Total w/max Sensor Inputs (4)	367 mA @ 24V DC - 8.8 W	
	DeviceNet Input Current Surge	15 A for 250 µs	
	DeviceNet Communications		
	Baud Rates	125, 250, 500 kbps	
	Distance Maximum	500 m (1630 ft) @ 125 kbps	
		200 m (656 ft) @ 250 kbps	
		100 m (328 ft) @ 500 kbps	
	Certifications	cULus (File No. E207834) UL 508C EN/IEC 60947-1, EN 50178, EN 61800-3 CE Marked per Low Voltage Directive 73/23/EEC and EMC Directive 89/336/EEC	

External Connections for Input Connector



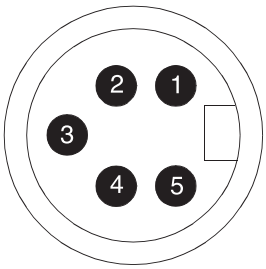
Pin 1: +V Out
Pin 2: Input
Pin 3: Comm
Pin 4: Input
Pin 5: NC (No Connection)

External Connections for Output Connector



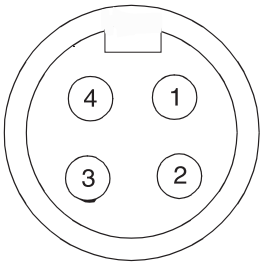
Pin 1: PE
Pin 2: Return
Pin 3: Relay Out

External Connections for DeviceNet Connector



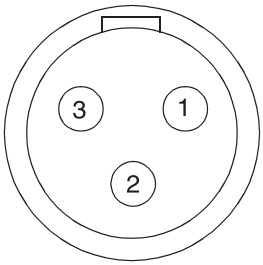
Pin 1: Drain (Not Connected)
Pin 2: +VDNET
Pin 3: -VDNET
Pin 4: CAN_H
Pin 5: CAN_L

External Connections for Motor Connector



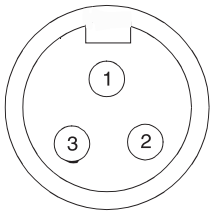
Pin 1: T1 - Black
Pin 2: T2 - White
Pin 3: T3 - Red
Pin 4: Ground - Green/Yellow

External Connections for Brake Contactor Connector



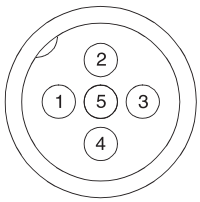
Pin 1: L1 - Black
Pin 2: GND - Green/Yellow
Pin 3: L2 - White

External Connections for Dynamic Brake Connection



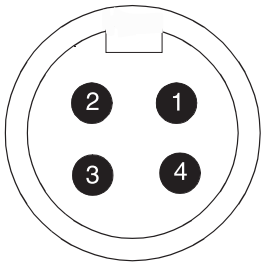
Pin 1: GND - Green/Yellow
Pin 2: BR+ - Black
Pin 3: BR- - White

External Connections for 0...10V Analog Input



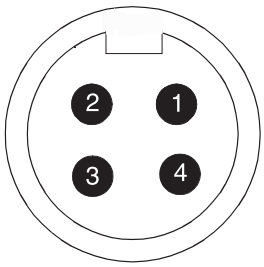
Pin 1: 10VDC
Pin 2: 0...10V Input
Pin 3: Analog Common
Pin 4: Analog Output
Pin 5: NC (No Connection)

Safety Monitor Input (SM1/SM2)



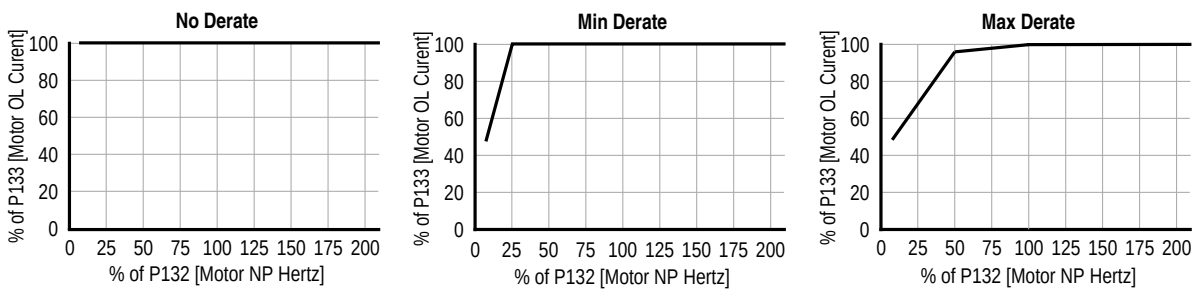
Pin 1: SM2 - White
Pin 2: SM1 - Brown
Pin 3: NC (No Connection)
Pin 4: NC (No Connection)

External Connections for Safety Input Power (A1/A2)



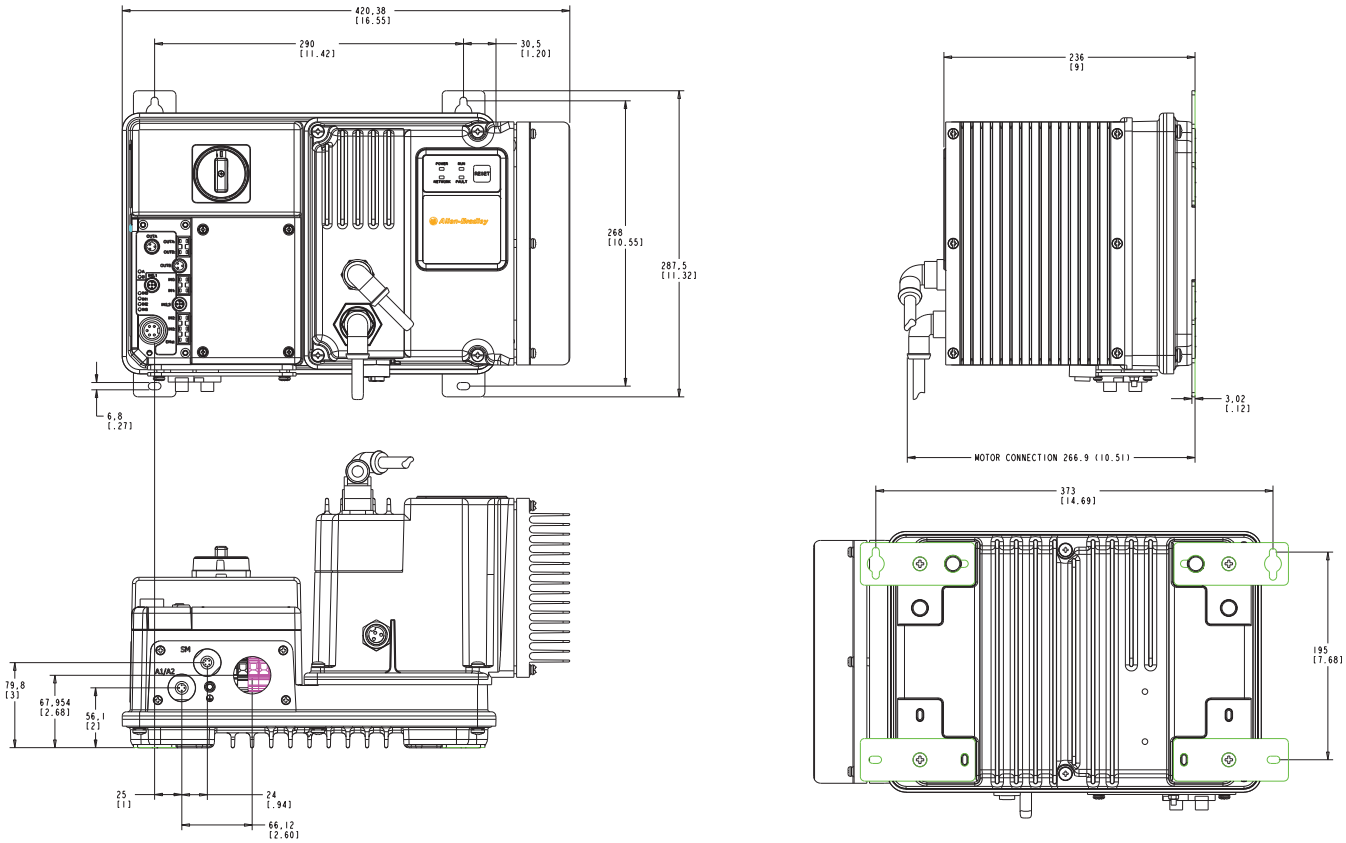
Pin 1: M - White
Pin 2: A1 - Brown
Pin 3: P - Black
Pin 4: A2 - Blue

Overload Curves



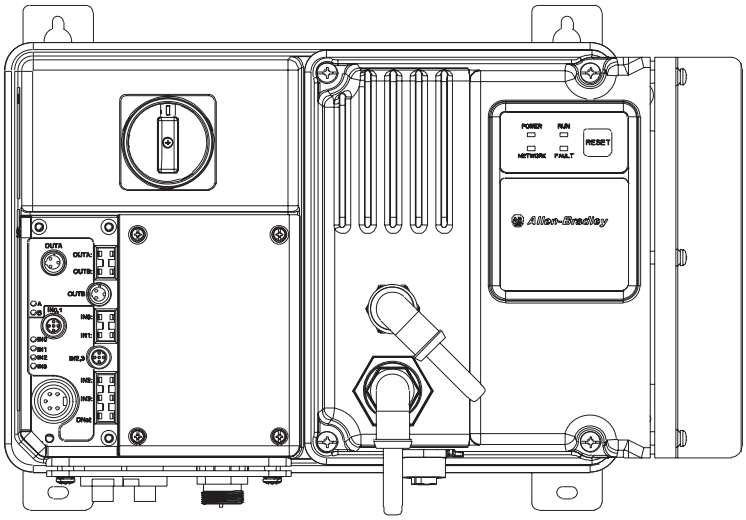
Dimensions for Safety Product, 2 Hp and below @ 460V AC, IP67/NEMA Type 4 with Conduit Entrance

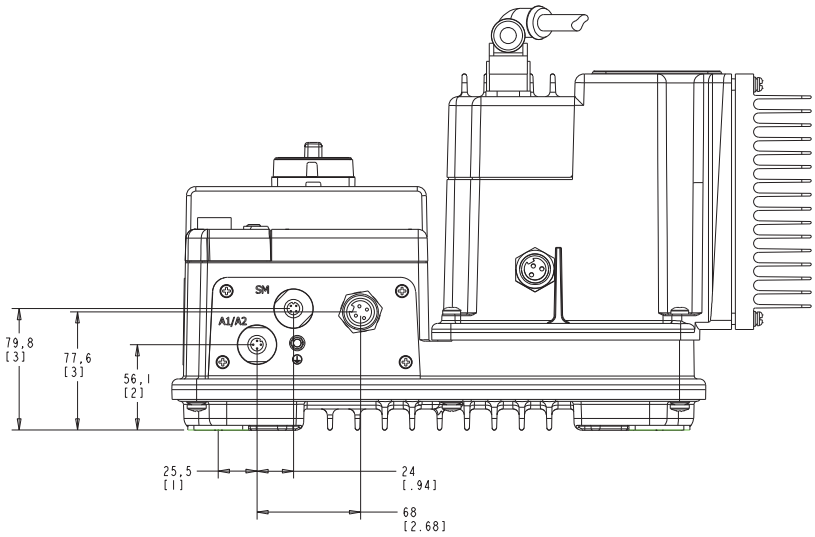
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.



Dimensions for Safety Product, 2 Hp and below @ 460V AC, NEMA Type 4 with ArmorConnect™ Connectivity

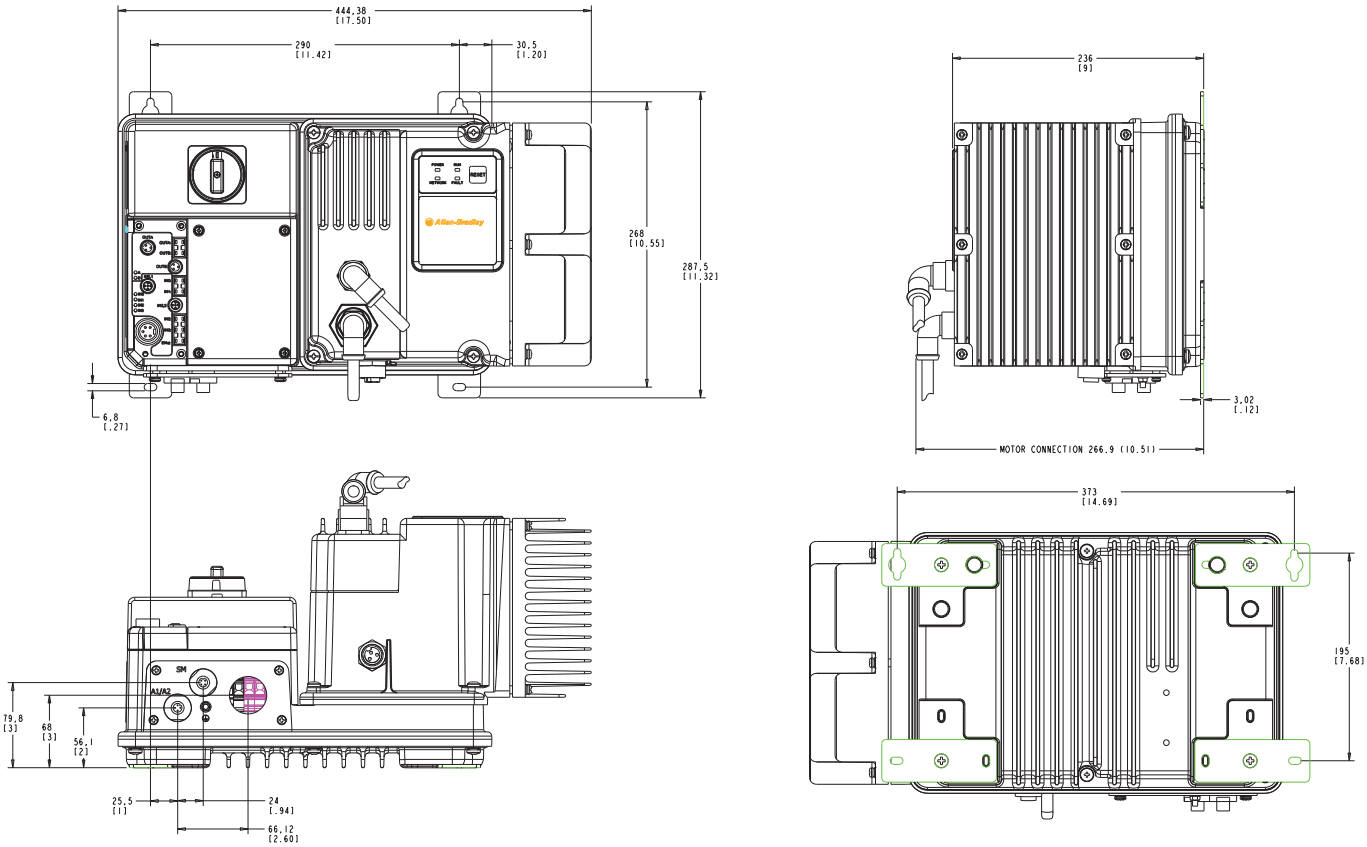
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.





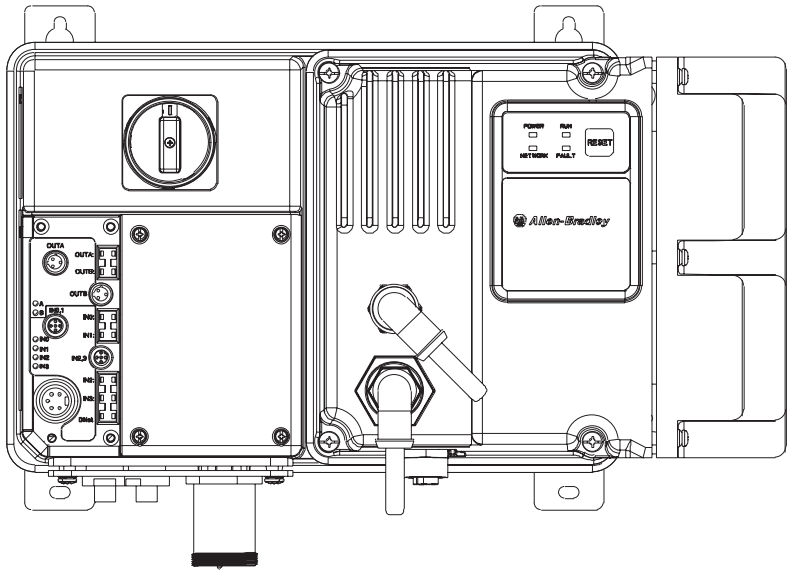
Dimensions for Safety Product, 3 Hp and above @ 460V AC, IP67/NEMA Type 4 with Conduit Entrance

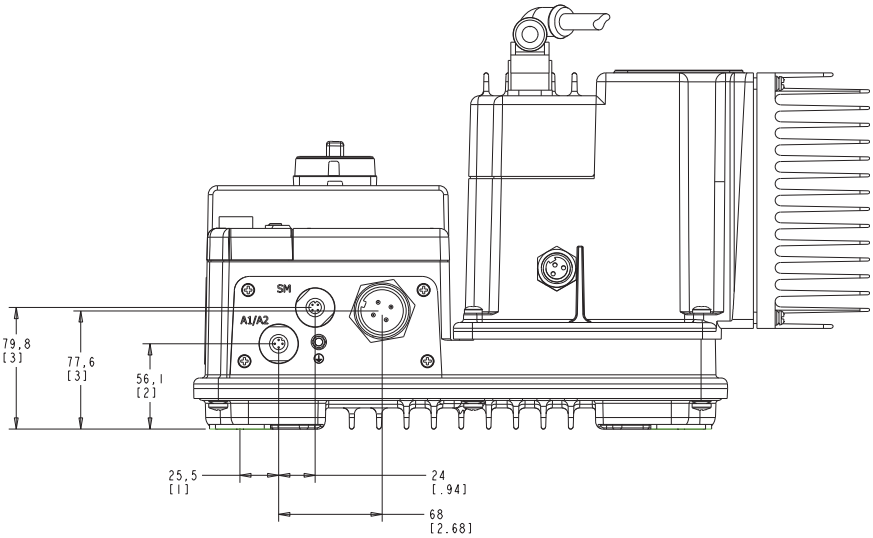
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.



Dimensions for Safety Product, 3 Hp and above @ 460V AC, IP67/NEMA Type 4 with ArmorConnect Connectivity

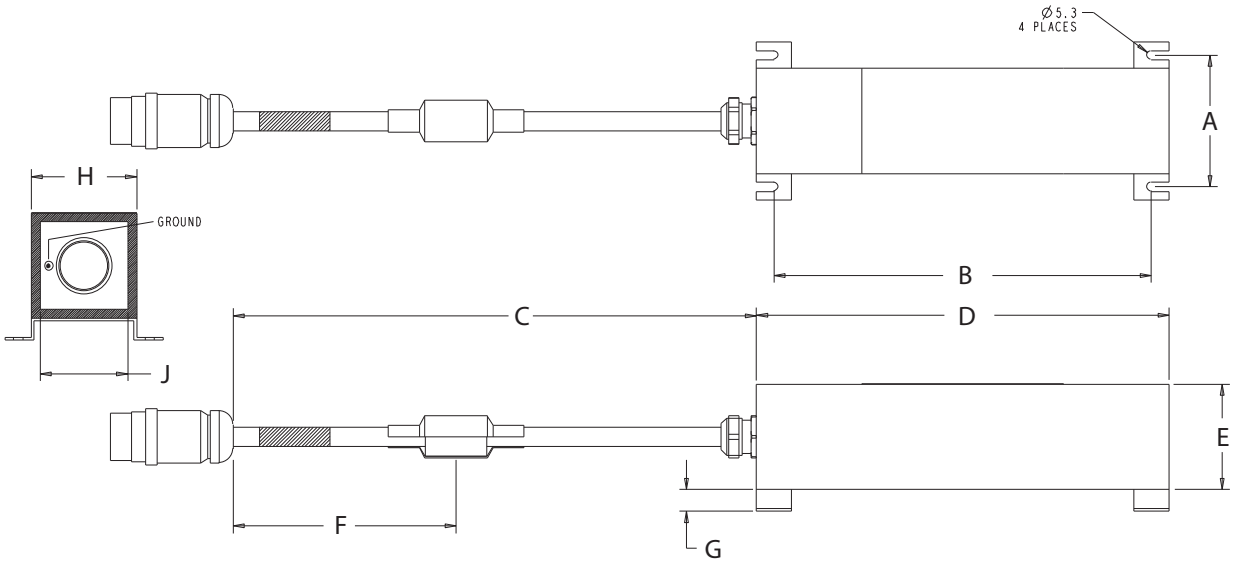
Dimensions in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.





Dynamic Brake Resistors

Dimensions are in millimeters. Dimensions are not intended to be used for manufacturing purposes.



Cat. No.	A	B	C	D	E	F	G	H	J
284R-091P500	75±3	215±5	*	235±5	60±2	127	12.54	60±2	50±1.5
284R-360P500		215±5		235±5					
284R-120P1K2		420±5		440±5					

* Length is user-selectable based on a suffix added to the catalog number. For a length of 500±10 mm, add **-M05** to the end of the catalog number. For a length of 1000±10 mm, add **-M1** to the end of the catalog number.

Help improve machine uptime and reduce wear and tear with safety-rated PowerFlex and Kinetix drives

The requirement for a machine to be placed in a safe state often needs to be done with a high level of confidence. Many times this is necessary to perform routine maintenance, correct a mechanical problem, or in some cases it may happen very frequently as part of the normal machine process cycle (e.g. punch press). Finding a way to do this without removing power from the system and performing a lockout / tagout procedure can improve process up-time, and reduce wear and stress on mechanical and electrical components. Also, providing an efficient way to exercise functional safety can reduce the chances of safety system tampering.

Safe Torque-Off

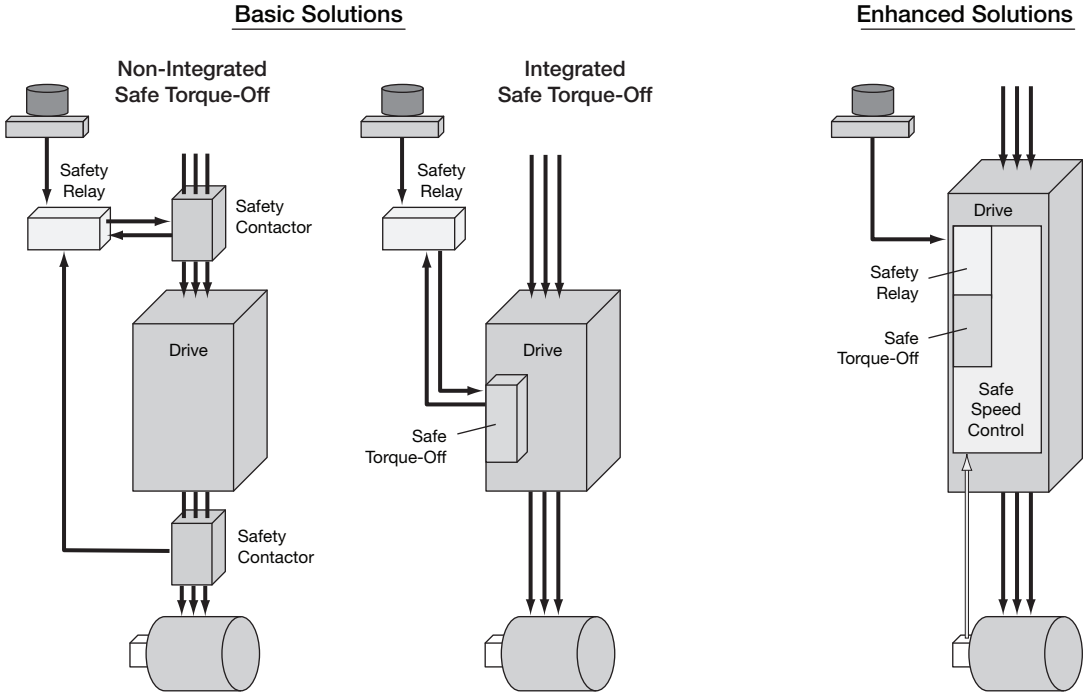
For many drive applications, simple removal of torque is all that is necessary to perform the desired task (e.g. maintenance). This function is referred to as Safe Torque-Off (also known as DriveGuard or GuardMotion), and can be accomplished with the use of a standard drive, along with external safety components (e.g. safety contactors) to place the system in a safe state. Some of the PowerFlex and Kinetix drive products reduce the amount of external safety components by integrating safe torque-off functionality inside the drive. Using the integrated solution simplifies the safety circuit design, and reduces panel space and cost. In either case, whether the function is implemented inside or outside the drive, it can be designed to meet the requirements of relevant safety standards.

Safe Speed Monitor

For applications able to benefit from more advanced safety features, Allen-Bradley offers a Safe Speed Monitor option that uses machine or motor velocity feedback for even greater flexibility in how safety can be deployed. This new offering helps provide safety zone access while there is limited motion. By reducing and monitoring the speed of an application, an operator may safely inspect and perform a process operation or maintenance work without stopping the machine, resulting in reduced downtime and reduced production waste. The Safe Speed Monitor is configurable for following functions:

- Safe Torque-Off
- Stop Categories 0, 1 and 2
- Safe Stop
- Safe Limited Speed
- Safe Maximum Speed
- Safe Maximum Acceleration
- Safe Direction
- Zero Speed Monitoring
- Door Control and Monitoring
- Enabling Switch Input

In addition to the safe monitoring of speed dependent functions, the Safe Speed Monitor integrates the functionality of a safety monitoring relay, providing direct inputs for interfacing door locks, light curtains, E-Stop pushbuttons, enabling switches, and key switches. While this can be accomplished with a standard drive and a separate speed monitoring relay (Allen-Bradley MSR57), select PowerFlex and Kinetix drives are capable of integrating this functionality internally, again simplifying the safety system, and reducing panel space and cost.



Safety Solutions for PowerFlex® Drives

Overview

The Allen-Bradley PowerFlex 40P, 70, 700H, 700L, 700S, 753 and 755 offer certified safety options to help provide integral, cost-effective, and certified protection for AC drive control.

All safety options are available as a kit for user installation.

	PowerFlex 40P	PowerFlex 70	PowerFlex 700H
			
Safe Torque-Off	✓	✓	✓
Safe Speed Functions (speed, accel, direction, etc.)			
Safety Category 3	✓	✓	✓
Safety Category 4			
Performance Level d	✓	✓	✓
Performance Level e			
SIL Claim Level 3			
Stop Categories 0 and/or 1	✓	✓	✓
Stop Category 2			
200…240V Ratings	0.37…7.5 kW (0.5…10 Hp)	0.37…18.5 kW (0.5…25 Hp)	–
380…480V Ratings	0.37…11 kW (0.5…15 Hp)	0.37…37 kW (0.5…50 Hp)	132…1200 kW (200…1900 Hp)
500…600V Ratings	0.75…11 kW (1…15 Hp)	0.37…37 kW (0.5…50 Hp)	160…2000 kW (250…900 Hp)
690V Ratings	–	–	160…2000 kW (150…2400 Hp)
Safe Torque-Off Board *(User Installed)*	20A-DG01	20A-DG02	NA
Safety Category	ISO/EN13849-1 (EN954-1), Category 3	ISO/EN13849-1 (EN954-1), Category 3	NA
Safe Speed Monitor *(User Installed)*	NA	NA	NA
Safety Category	NA	NA	NA
ATEX Safe-Off *(User Installed)*	NA	NA	20C-DG1
Safety Category	NA	NA	EN954-1, Category 5
Motor Control	• Volts per Hertz • Sensorless Vector Control	• Vector Control w/FORCE™ Technology • Volts per Hertz • Sensorless Vector Control	• Volts per Hertz • Sensorless Vector Control

❄ Also available with embedded logix controller - DriveLogix 5730.
‡ Frames 9…13 are functionally approved by TUV, but not certified.

PowerFlex 700S ❄	PowerFlex 700L w/700S Control	PowerFlex 753	PowerFlex 755
			
✓	✓	✓	✓
		✓	✓
✓	✓	✓	✓
		✓	✓
✓	✓	✓	✓
		✓	✓
		✓	✓
✓	✓	✓	✓
		✓	✓
0.75…66 kW (1…100 Hp)	–	–	–
0.75…800 kW (1…1250 Hp) ‡	200…860 kW (300…1150 Hp)	0.75…250 kW (1…350 Hp)	0.75…250 kW (1…350 Hp)
0.75…1500 kW (1…1600 Hp) ‡	345…650 kW (465…870 Hp)	NA	NA
45…1500 kW (50…1600 Hp) ‡	355…657 kW (475…881 Hp)	NA	NA
20D-P2-DG01	20D-P2-DG01	20-750-S	20-750-S
ISO/EN13849-1 (EN954-1), Category 3	ISO/EN13849-1 (EN954-1), Cat. 3	ISO/EN13849-1 (EN954-1), Category 3	ISO/EN13849-1 (EN954-1), Category 3
NA	NA	20-750-S1	20-750-S1
NA	NA	ISO/EN 13849-1 PLe/SIL3 Cat. 4	ISO/EN 13849-1 PLe/SIL3 Cat. 4
NA	NA	NA	NA
NA	NA	NA	NA
• Vector Control w/FORCE™ Technology • Volts per Hertz • Permanent Magnet Motor Control	• Available with PowerFlex 700 Vector Control or PowerFlex 700S Phase II Control Boards	• Vector Control w/FORCE™ Technology • Volts per Hertz • Sensorless Vector Control • Adjustable Voltage Control	• Vector Control w/FORCE™ Technology • Volts per Hertz • Sensorless Vector Control • Permanent Magnet Motor Control

Safety Solutions for PowerFlex® Drives

PowerFlex 40P AC Drive



The PowerFlex 40P AC drive addresses user needs for closed loop control with an option for Category 3 Safe Torque-off in a compact and cost effective design. Based on the popular PowerFlex 40 this drive is designed to meet global OEM and end-user demands for flexibility, space savings and ease of use. This drive is a cost-effective alternative for speed or basic position control of applications such as diverters, smart conveyors, packaging machines, palletizers, drafting machines, ring spinning machines and synthetic fiber spinning machines and shares common options and accessories with the PowerFlex 40.

Ratings	200…240V:	0.37…7.5 kW / 0.5…10 Hp / 2.3…33 A
	380…480V:	0.37…11 kW / 0.5…15 Hp / 1.4…24 A
	500…600V:	0.75…11 kW / 1…15 Hp / 1.7…19 A
Motor Control	• V/Hz control • Sensorless Vector Control	
Communications	Integral RS 485, Common Industrial Protocol	
User Interface	4 digit display, 3 additional LED indicators and scroll/reset button, optional Remote Human Interface Modules (HIM) or PC interface for programming	
Enclosures	IP20, IP30, Flange Mount	
Safety	DriveGuard Safe Torque-Off / EN 954-1 Cat. 3	
Additional Features	• Speed control with and without encoder feedback • Fiber application specific features • StepLogic allows operation as an independent position controller	
Certifications	• UL • CE (240 and 480V Ratings) • cUL • C-Tick • TÜV FS ISO/EN13849-1 (EN954-1) with Safe Torque-Off option	
Options	See page 6-39	

200…240V AC, Three-Phase Drives (50/60 Hz, No Filter)

Drive Ratings				IP20/NEMA Type Open	IP20 Plate Drive	IP20 Flange Mount ∗
kW	Hp	Output Current A	Frame Size	Cat. No.	Cat. No.	Cat. No.
0.4	0.5	2.3	B	22D-B2P3N104	22D-B2P3H204	22D-B2P3F104
0.75	1	5	B	22D-B5P0N104	22D-B5P0H204	22D-B5P0F104
1.5	2	8	B	22D-B8P0N104	22D-B8P0H204	22D-B8P0F104
2.2	3	12	B	22D-B012N104	22D-B012H204	22D-B012F104
3.7	5	17.5	B	22D-B017N104	22D-B017H204	22D-B017F104
5.5	7.5	24	C	22D-B024N104	22D-B024H204	22D-B024F104
7.5	10	33	C	22D-B033N104	22D-B033H204	22D-B033F104

∗ Meets IP40/54/65 (NEMA 1/12/4/4X) when installed in an enclosure of like rating.

380…480V AC, Three-Phase Drives (50/60 Hz, No Filter)

Drive Ratings				IP20/NEMA Type Open	IP20 Plate Drive	IP20 Flange Mount ∗
kW	Hp	Output Current A	Frame Size	Cat. No.	Cat. No.	Cat. No.
0.4	0.5	1.4	B	22D-D1P4N104	22D-D1P4H204	22D-D1P4F104
0.75	1	2.3	B	22D-D2P3N104	22D-D2P3H204	22D-D2P3F104
1.5	2	4	B	22D-D4P0N104	22D-D4P0H204	22D-D4P0F104
2.2	3	6	B	22D-D6P0N104	22D-D6P0H204	22D-D6P0F104
4	5	10.5	B	22D-D010N104	22D-D010H204	22D-D010F104
5.5	7.5	12	C	22D-D012N104	22D-D012H204	22D-D012F104
7.5	10	17	C	22D-D017N104	22D-D017H204	22D-D017F104
11	15	24	C	22D-D024N104	22D-D024H204	22D-D024F104

∗ Meets IP40/54/65 (NEMA 1/12/4/4X) when installed in an enclosure of like rating.

500…600V AC, Three-Phase Drives (50/60 Hz, No Filter)

Drive Ratings				IP20/NEMA Type Open	IP20 Plate Drive	IP20 Flange Mount ✶
kW	Hp	Output Current A	Frame Size	Cat. No.	Cat. No.	Cat. No.
0.75	1	1.7	B	22D-E1P7N104	22D-E1P7H204	22D-E1P7F104
1.5	2	3	B	22D-E3P0N104	22D-E3P0H204	22D-E3P0F104
2.2	3	4.2	B	22D-E4P2N104	22D-E4P2H204	22D-E4P2F104
4	5	6.6	B	22D-E6P6N004	22D-E6P6H204	22D-E6P6F104
5.5	7.5	9.9	C	22D-E9P9N104	22D-E9P9H204	22D-E9P9F104
7.5	10	12	C	22D-E012N104	22D-E012H204	22D-E012F104
11	15	19	C	22D-E019N104	22D-E019H204	22D-E019F104

✶ Meets IP40/54/65 (NEMA 1/12/4/4X) when installed in an enclosure of like rating.

Options

Human Interface Modules and Accessories

Description	Cat. No.
Remote (Panel Mount) LCD Display, Digital Speed Control, CopyCat Capable. Includes 2.0 meter cable. IP66, NEMA Type 4X/12 - Indoor Use Only.	22-HIM-C2S §
Remote Handheld, LCD Display, Full Numeric Keypad, Digital Speed Control, CopyCat Capable. Includes 1.0 meter cable. IP30, NEMA Type 1. Panel mount with optional Bezel Kit.	22-HIM-A3
Remote Handheld, Wireless Interface Module with Bluetooth® Technology. IP30, NEMA Type 1. Panel Mount with optional Bezel Kit.	22-WIM-N1
Remote (Panel Mount), Wireless Interface Module with Bluetooth Technology. IP66, NEMA Type 4X/12 - Indoor Use Only.	22-WIM-N4S
Bezel Kit. Panel Mount for LCD Display, Remote Handheld Unit. IP30, NEMA Type 1. Includes a 22-RJ45CBL-C20 cable.	22-HIM-B1
DSI HIM Cable (DSI HIM to RJ45 cable)	
1.0 Meter (3.3 Feet) DSI HIM Cable (DSI HIM to RJ45 cable)	22-HIM-H10
2.9 Meter (9.51 Feet) DSI HIM Cable (DSI HIM to RJ45 cable)	22-HIM-H30

§ The 22-HIM-C2S is smaller than the 22-HIM-C2 and cannot be used as a direct replacement.

Communication Option Kits

Description	Cat. No.
ControlNet™ Communication Adapter	22-COMM-C ♣
DeviceNet™ Communication Adapter	22-COMM-D ♣
EtherNet/IP™ Communication Adapter	22-COMM-E ♣
LonWorks® Communication Adapter	22-COMM-L ♣
PROFIBUS™ DP Communication Adapter	22-COMM-P ♣
Serial Converter Module (RS485 to RS232). Provides serial communication via DF1 protocol for use with DriveExplorer and DriveExecutive™ software. Includes DSI to RS232 serial converter, 1203-SFC serial cable, 22-RJ45CBL-C20 cable, and DriveExplorer Lite CD.	22-SCM-232
Serial Cable. 2.0 meter with a locking low profile connector. Connects the serial converter to a 9-pin sub-miniature D female computer connector.	1203-SFC
Serial Null Modem Adapter. Use when connecting the serial converter to DriveExplorer on a handheld PC.	1203-SNM
Universal Serial Bus™ (USB) Converter includes 2m USB, 20-HIM-H10 & 22-HIM-H10 Cables	1203-USB
DSI Cable. 2.0 meter RJ45 to RJ45 cable, male to male connectors.	22-RJ45CBL-C20
Splitter Cable. RJ45 one to two port splitter cable.	AK-U0-RJ45-SC1
Terminal Block. RJ45 two position terminal block (6 pieces) with two 120 Ohm terminating resistors (loose).	AK-U0-RJ45-TB2P
Terminating Resistors. 120 Ohm resistor embedded in an RJ45 connector (2 pieces).	AK-U0-RJ45-TR1
DSI External Communications Kit. External mounting kit for 22-COMM Communication Adapters.	22-XCOMM-DC-BASE
External Communications Kit Power Supply Optional 100…240V AC Power Supply for External DSI Communications Kit.	20-XCOMM-AC-PS1
Compact I/O Module (3 Channel)	1769-SM2
Communication Adapter Cover Houses the Communication Adapter for B & C Frame drives. Note: Cover adds 25 mm (0.98 in.) to the overall depth of the drive.	
Frame B Drive	22D-CCB ➢
Frame C Drive	22D-CCC ➢

♣ Requires a Communication Adapter Cover when used with Frame B & C PowerFlex 40/40P drives or Frame C PowerFlex 400 drives.
➢ If IP30, NEMA/UL Type 1 is required, a 22-JBCB (Frame B drives) or 22-JBCC (Frame C drives) must also be ordered.

Safety Options

Description	Cat. No.
DriveGuard Safe Torque-Off	20A-DG01

Terminators

Description ✶	Cat. No.
for use with 3.7 kW (5 Hp) & below drives	1204-TFA1
for use with 1.5 kW (2 Hp) & up drives	1204-TFB2

✶ Refer to Appendix A of publication *DRIVES-IN001* for selection information.

Reflected Wave Reduction Modules w/Common Mode Choke

Description ✶	Cat. No.
17A with Common Mode Choke	1204-RWC-17-A

✶ Refer to Appendix A of publication *DRIVES-IN001* for selection information.

Reflected Wave Reduction Modules

Voltage	ND kW	ND Hp	Cat. No.
380… 480V AC	2.2…4	3…5	1321-RWR8-DP
	4	5	1321-RWR12-DP
	5.5	7.5	1321-RWR18-DP
	7.5	10	1321-RWR25-DP
	11	15	1321-RWR25-DP
500… 600V AC	4	5	1321-RWR8-EP
	5.5	7.5	1321-RWR12-EP
	7.5	10	1321-RWR18-EP
	11	15	1321-RWR25-EP

Dynamic Brake Resistors

Drive Rating			Minimum Resistance ⌘	Resistance ⌘	
Voltage	kW	Hp	Ohms ±10%	Ohms ±5%	Cat. No. ✦
200…240V, 50/60 Hz, Three-Phase	0.4	0.5	48	91	AK-R2-091P500
	0.75	1	48	91	AK-R2-091P500
	1.5	2	48	91	AK-R2-091P500
	2.2	3	32	47	AK-R2-047P500
	3.7	5	19	47	AK-R2-047P500
	5.5	7.5	13	30	AK-R2-030P1K2
	7.5	10	10	30	AK-R2-030P1K2
380…480V, 50/60 Hz, Three-Phase	0.4	0.5	97	360	AK-R2-360P500
	0.75	1	97	360	AK-R2-360P500
	1.5	2	97	360	AK-R2-360P500
	2.2	3	97	120	AK-R2-120P1K2
	4.0	5	77	120	AK-R2-120P1K2
	5.5	7.5	55	120	AK-R2-120P1K2
	7.5	10	39	120	AK-R2-120P1K2
	11	15	24	120	❖AK-R2-120P1K2
500…600V, 50/60 Hz, Three-Phase	0.75	1	120	360	AK-R2-360P500
	1.5	2	120	360	AK-R2-360P500
	2.2	3	82	120	AK-R2-120P1K2
	4.0	5	82	120	AK-R2-120P1K2
	5.5	7.5	51	120	AK-R2-120P1K2
	7.5	10	51	120	AK-R2-120P1K2
	11	15	51	120	❖AK-R2-120P1K2

⌘ Verify resistor Ohms against minimum resistance for drive being used.
✦ Resistors listed are rated 5% duty cycle.
❖ Requires two resistors wired in parallel.

IP30, NEMA/UL Type 1 Conversion Kit

Description	Frame	Cat. No.
Converts IP20 drive to IP30, NEMA/UL Type 1 enclosure. Includes conduit box, mounting screws and plastic top panel.	B	22-JBAB
	C	22-JBAC
Converts IP20 drive to IP30, NEMA/UL Type 1 enclosure. Includes communication option conduit box, mounting screws and plastic top panel.	B	22-JBCB
	C	22-JBCC

Spare Parts

Description		Cat. No.
Fan Replacement Kits	Fan Replacement Kit - Frame B, 1 Fan	SK-U1-FAN1-B1
	Fan Replacement Kit - Frame B, 2 Fans	SK-U1-FAN2-B1
	Fan Replacement Kit - Frame C, 1 Fan	SK-U1-FAN1-C1
	Fan Replacement Kit - Frame C, 1 Fan, 15 Hp	SK-U1-FAN1-C2
Covers	Encoder Terminal Cover (All Frames)	SK-U1-DCVR4-EN
	Frame B Cover with Power Terminal Guard	SK-U1-DCVR3-B1
	Frame C Cover with Power Terminal Guard	SK-U1-DCVR3-C1

EMC Filters (Required to Meet CE Certification)

Drive Ratings			S Type Filter	L Type Filter
Input Voltage	kW	Hp	Cat. No. ✶	Cat. No. ‡
200…240V, 50/60 Hz, Single-Phase	0.4	0.5	❄	–
	0.75	1	❄	–
	1.5	2	❄	–
	2.2	3	❄	–
200…240V, 50/60 Hz, Three-Phase	0.4	0.5	➢22-RF021-BS	22-RF021-BL
	0.75	1	➢22-RF021-BS	22-RF021-BL
	1.5	2	➢22-RF021-BS	22-RF021-BL
	2.2	3	➢22-RF021-BS	22-RF021-BL
	3.7	5	➢22-RF021-BS	22-RF021-BL
	5.5	7.5	22-RF034-CS	22-RF034-CL
	7.5	10	22-RF034-CS	22-RF034-CL
380…480V, 50/60 Hz, Three-Phase	0.4	0.5	22-RF012-BS	22-RF012-BL
	0.75	1	22-RF012-BS	22-RF012-BL
	1.5	2	22-RF012-BS	22-RF012-BL
	2.2	3	22-RF012-BS	22-RF012-BL
	3.7	5	22-RF012-BS	22-RF012-BL
	5.5	7.5	22-RF018-CS	22-RF018-CL
	7.5	10	22-RF018-CS	22-RF018-CL
	11	15	22-RF026-CS	22-RF026-CL
500…600V, 50/60 Hz, Three-Phase	0.75	1	–	22-RF8P0-BL
	1.5	2	–	22-RF8P0-BL
	2.2	3	–	22-RF8P0-BL
	4.0	5	–	22-RF8P0-BL
	5.5	7.5	–	22-RF015-CL
	7.5	10	–	22-RF015-CL
	11	15	–	22-RF024-CL

✶ This filter is suitable for use with a cable length of up to 10 meters for Class A and 1 meter for Class B environments.
❄ Drives are available in these ratings with internal "S Type" filters.
‡ This filter is suitable for use with a cable length of up to 100 meters for Class A and 5 meters for Class B environments.
➢ Filter must be Series B or later.



The PowerFlex 70 offers a compact package of power, control and operator interface, designed to meet the demands for space, simplicity and reliability. This drive provides a broad spectrum of features, allowing you to easily integrate it into your architecture and configure it for most application needs.

Ratings	200…240V:	0.37…18.5 kW / 0.5…25 Hp / 2.2…70 A
	380…480V:	0.37…37 kW / 0.5…50 Hp / 1.1…72 A
	500…600V:	0.37…37 kW / 0.5…50 Hp / 0.9…52 A
Motor Control	• V/Hz control • Sensorless Vector Control • Flux Vector Control	
Communications	Common Industrial Protocol	
User Interface	HIM (option)	
Enclosures	IP20, Flange Mount, IP66 / NEMA 4X	
Safety	DriveGuard Safe Torque-Off / EN 954-1 Cat. 3	
Additional Features	• Speed and torque control with and without encoder feedback • Pjump and Traverse for Fibers application	
Certifications	• UL • cUL • IEC (Designed to Meet) • CE (excluding 600V) • C-Tick (excluding 600V) • NSF Certified (IP66, NEMA/UL Type 4X/12 only) • TÜV FS ISO/EN13849-1 (EN954-1) with Safe Torque-Off option • RINA Certified • ABS • Lloyd's Register • SEMI F47	
Options	See pages 6-65…6-74	

Panel Mount - IP 20, NEMA/UL Type 1, No HIM

200...240V AC, Three-Phase Drives

240V AC Input						208V AC Input ❄							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
2.2	2.4	3.3	0.5	0.33	20AB2P2A0AYNNNC0	2.5	2.7	3.7	0.37	0.25	20AB2P2A0AYNNNC0	N	A
2.2	2.4	3.3	0.5	0.33	20AB2P2A0AYNANC0	2.5	2.7	3.7	0.37	0.25	20AB2P2A0AYNANC0	Y	B
4.2	4.8	6.4	1	0.75	20AB4P2A0AYNNNC0	4.8	5.5	7.4	0.75	0.55	20AB4P2A0AYNNNC0	N	A
4.2	4.8	6.4	1	0.75	20AB4P2A0AYNANC0	4.8	5.5	7.4	0.75	0.55	20AB4P2A0AYNANC0	Y	B
6.8	9	12	2	1.5	20AB6P8A0AYNNNC0	7.8	10.3	13.8	1.5	1.1	20AB6P8A0AYNNNC0	N	B
6.8	9	12	2	1.5	20AB6P8A0AYNANC0	7.8	10.3	13.8	1.5	1.1	20AB6P8A0AYNANC0	Y	B
9.6	10.6	14.4	3	2	20AB9P6A0AYNNNC0	11	12.1	16.5	2.2	1.5	20AB9P6A0AYNNNC0	N	B
9.6	10.6	14.4	3	2	20AB9P6A0AYNANC0	11	12.1	16.5	2.2	1.5	20AB9P6A0AYNANC0	Y	B
15.3	17.4	23.2	5	3	20AB015A0AYNANC0	17.5	19.2	26.2	4	3	20AB015A0AYNANC0	Y	C
22	24.2	33	7.5	5	20AB022A0AYNANC0	25.3	27.8	37.9	5.5	4	20AB022A0AYNANC0	Y	D
28	33	44	10	7.5	20AB028A0AYNANC0	32.2	37.9	50.6	7.5	5.5	20AB028A0AYNANC0	Y	D
42	46.2	63	15	10	20AB042A0AYNANC0	43	55.5	74	11	7.5	20AB042A0AYNANC0	Y	D
54	63	84	20	15	20AB054A0AYNANC0	62.1	72.4	96.6	15	11	20AB054A0AYNANC0	Y	E
70	81	108	25	20	20AB070A0AYNANC0	78.2	93.1	124	18.5	15	20AB070A0AYNANC0	Y	E

❄ Drive must be programmed to lower voltage to obtain the currents shown.

Panel Mount - IP 20, NEMA/UL Type 1, No HIM (continued)

380...480V AC, Three-Phase Drives

480V AC Input						400V AC Input							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
1.1	1.2	1.6	0.5	0.33	20AD1P1A0AYNNNC0	1.3	1.4	1.9	0.37	0.25	20AC1P3A0AYNNNC0	N	A
1.1	1.2	1.6	0.5	0.33	20AD1P1A0AYNANC0	1.3	1.4	1.9	0.37	0.25	20AC1P3A0AYNANC0	Y	B
2.1	2.4	3.2	1	0.75	20AD2P1A0AYNNNC0	2.1	2.4	3.2	0.75	0.55	20AC2P1A0AYNNNC0	N	A
2.1	2.4	3.2	1	0.75	20AD2P1A0AYNANC0	2.1	2.4	3.2	0.75	0.55	20AC2P1A0AYNANC0	Y	B
3.4	4.5	6	2	1.5	20AD3P4A0AYNNNC0	3.5	4.5	6	1.5	1.1	20AC3P5A0AYNNNC0	N	A
3.4	4.5	6	2	1.5	20AD3P4A0AYNANC0	3.5	4.5	6	1.5	1.1	20AC3P5A0AYNANC0	Y	B
5	5.5	7.5	3	2	20AD5P0A0AYNNNC0	5	5.5	7.5	2.2	1.5	20AC5P0A0AYNNNC0	N	B
5	5.5	7.5	3	2	20AD5P0A0AYNANC0	5	5.5	7.5	2.2	1.5	20AC5P0A0AYNANC0	Y	B
8	8.8	12	5	3	20AD8P0A0AYNNNC0	8.7	9.9	13.2	4	3	20AC8P7A0AYNNNC0	N	B
8	8.8	12	5	3	20AD8P0A0AYNANC0	8.7	9.9	13.2	4	3	20AC8P7A0AYNANC0	Y	B
11	12.1	16.5	7.5	5	20AD011A0AYNANC0	11.5	13	17.4	5.5	4	20AC011A0AYNANC0	Y	C
14	16.5	22	10	7.5	20AD014A0AYNANC0	15.4	17.2	23.1	7.5	5.5	20AC015A0AYNANC0	Y	C
22	24.2	33	15	10	20AD022A0AYNANC0	22	24.2	33	11	7.5	20AC022A0AYNANC0	Y	D
27	33	44	20	15	20AD027A0AYNANC0	30	33	45	15	11	20AC030A0AYNANC0	Y	D
34	40.5	54	25	20	20AD034A0AYNANC0	37	45	60	18.5	15	20AC037A0AYNANC0	Y	D
40	51	68	30	25	20AD040A0AYNANC0	43	56	74	22	18.5	20AC043A0AYNANC0	Y	D
52	60	80	40	30	20AD052A0AYNANC0	60	66	90	30	22	20AC060A0AYNANC0	Y	E
65	78	104	50	40	20AD065A0AYNANC0	72	90	120	37	30	20AC072A0AYNANC0	Y	E

500...600V AC, Three-Phase Drives

600V AC Input							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.					
0.9	1	1.4	0.5	0.33	20AE0P9A0AYNNNC0	N	A
1.7	1.9	2.6	1	0.75	20AE1P7A0AYNNNC0	N	A
2.7	3.6	4.8	2	1	20AE2P7A0AYNNNC0	N	A
3.9	4.3	5.8	3	1.5	20AE3P9A0AYNNNC0	N	B
6.1	6.7	9.1	5	3	20AE6P1A0AYNNNC0	N	B
9	9.9	13.5	7.5	5	20AE9P0A0AYNNNC0	N	C
11	13.5	18	10	7.5	20AE011A0AYNNNC0	N	C
17	18.7	25.5	15	10	20AE017A0AYNNNC0	N	D
22	25.5	34	20	15	20AE022A0AYNNNC0	N	D
27	33	44	25	20	20AE027A0AYNNNC0	N	D
32	40.5	54	30	25	20AE032A0AYNNNC0	N	D
41	48	64	40	30	20AE041A0AYNANC0	N	E
52	61.5	82	50	40	20AE052A0AYNANC0	N	E

Wall / Machine Mount - IP66, NEMA/UL Type 4X/12, with HIM, For Indoor Use

200...240V AC, Three-Phase Drives

240V AC Input						208V AC Input ❄							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
2.2	2.4	3.3	0.5	0.33	20AB2P2C3AYNNNC0	2.5	2.7	3.7	0.37	0.25	20AB2P2C3AYNNNC0	N	B
2.2	2.4	3.3	0.5	0.33	20AB2P2C3AYNANC0	2.5	2.7	3.7	0.37	0.25	20AB2P2C3AYNANC0	Y	B
4.2	4.8	6.4	1	0.75	20AB4P2C3AYNNNC0	4.8	5.5	7.4	0.75	0.55	20AB4P2C3AYNNNC0	N	B
4.2	4.8	6.4	1	0.75	20AB4P2C3AYNANC0	4.8	5.5	7.4	0.75	0.55	20AB4P2C3AYNANC0	Y	B
6.8	9	12	2	1.5	20AB6P8C3AYNNNC0	7.8	10.3	13.8	1.5	1.1	20AB6P8C3AYNNNC0	N	B
6.8	9	12	2	1.5	20AB6P8C3AYNANC0	7.8	10.3	13.8	1.5	1.1	20AB6P8C3AYNANC0	Y	B
9.6	10.6	14.4	3	2	20AB9P6C3AYNNNC0	11	12.1	16.5	2.2	1.5	20AB9P6C3AYNNNC0	N	B
9.6	10.6	14.4	3	2	20AB9P6C3AYNANC0	11	12.1	16.5	2.2	1.5	20AB9P6C3AYNANC0	Y	B
15.3	17.4	23.2	5	3	20AB015C3AYNANC0	17.5	19.2	26.2	4	3	20AB015C3AYNANC0	Y	D
22	24.2	33	7.5	5	20AB022C3AYNANC0	25.3	27.8	37.9	5.5	4	20AB022C3AYNANC0	Y	D
28	33	44	10	7.5	20AB028C3AYNANC0	32.2	37.9	50.6	7.5	5.5	20AB028C3AYNANC0	Y	D
42	46.2	63	15	10	20AB042C3AYNANC0	43	55.5	74	11	7.5	20AB042C3AYNANC0	Y	D
54	63	84	20	15	20AB054C3AYNANC0	62.1	72.4	96.6	15	11	20AB054C3AYNANC0	Y	E
70	81	108	25	20	20AB070C3AYNANC0	78.2	93.1	124	18.5	15	20AB070C3AYNANC0	Y	E

❄ Drive must be programmed to lower voltage to obtain the currents shown.

380...480V AC, Three-Phase Drives

480V AC Input						400V AC Input							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
1.1	1.2	1.6	0.5	0.33	20AD1P1C3AYNNNC0	1.3	1.4	1.9	0.37	0.25	20AC1P3C3AYNNNC0	N	B
1.1	1.2	1.6	0.5	0.33	20AD1P1C3AYNANC0	1.3	1.4	1.9	0.37	0.25	20AC1P3C3AYNANC0	Y	B
2.1	2.4	3.2	1	0.75	20AD2P1C3AYNNNC0	2.1	2.4	3.2	0.75	0.55	20AC2P1C3AYNNNC0	N	B
2.1	2.4	3.2	1	0.75	20AD2P1C3AYNANC0	2.1	2.4	3.2	0.75	0.55	20AC2P1C3AYNANC0	Y	B
3.4	4.5	6	2	1.5	20AD3P4C3AYNNNC0	3.5	4.5	6	1.5	1.1	20AC3P5C3AYNNNC0	N	B
3.4	4.5	6	2	1.5	20AD3P4C3AYNANC0	3.5	4.5	6	1.5	1.1	20AC3P5C3AYNANC0	Y	B
5	5.5	7.5	3	2	20AD5P0C3AYNNNC0	5	5.5	7.5	2.2	1.5	20AC5P0C3AYNNNC0	N	B
5	5.5	7.5	3	2	20AD5P0C3AYNANC0	5	5.5	7.5	2.2	1.5	20AC5P0C3AYNANC0	Y	B
8	8.8	12	5	3	20AD8P0C3AYNNNC0	8.7	9.9	13.2	4	3	20AC8P7C3AYNNNC0	N	B
8	8.8	12	5	3	20AD8P0C3AYNANC0	8.7	9.9	13.2	4	3	20AC8P7C3AYNANC0	Y	B
11	12.1	16.5	7.5	5	20AD011C3AYNANC0	11.5	13	17.4	5.5	4	20AC011C3AYNANC0	Y	D
14	16.5	22	10	7.5	20AD014C3AYNANC0	15.4	17.2	23.1	7.5	5.5	20AC015C3AYNANC0	Y	D
22	24.2	33	15	10	20AD022C3AYNANC0	22	24.2	33	11	7.5	20AC022C3AYNANC0	Y	D
27	33	44	20	15	20AD027C3AYNANC0	30	33	45	15	11	20AC030C3AYNANC0	Y	D
34	40.5	54	25	20	20AD034C3AYNANC0	37	45	60	18.5	15	20AC037C3AYNANC0	Y	D
40	51	68	30	25	20AD040C3AYNANC0	43	56	74	22	18.5	20AC043C3AYNANC0	Y	D
52	60	80	40	30	20AD052C3AYNANC0	60	66	90	30	22	20AC060C3AYNANC0	Y	E
65	78	104	50	40	20AD065C3AYNANC0	72	90	120	37	30	20AC072C3AYNANC0	Y	E

Wall / Machine Mount - IP66, NEMA/UL Type 4X/12, with HIM, For Indoor Use (continued)

500...600V AC, Three-Phase Drives

600V AC Input							
Output Amps							
Cont.	1 Min.	3 Sec.	Normal Duty Hp	Heavy Duty Hp	Cat. No.	with Filter	Frame Size
0.9	1	1.4	0.5	0.33	20AE0P9C3AYNNNC0	N	B
1.7	1.9	2.6	1	0.75	20AE1P7C3AYNNNC0	N	B
2.7	3.6	4.8	2	1	20AE2P7C3AYNNNC0	N	B
3.9	4.3	5.8	3	1.5	20AE3P9C3AYNNNC0	N	B
6.1	6.7	9.1	5	3	20AE6P1C3AYNNNC0	N	B
9	9.9	13.5	7.5	5	20AE9P0C3AYNNNC0	N	D
11	13.5	18	10	7.5	20AE011C3AYNNNC0	N	D
17	18.7	25.5	15	10	20AE017C3AYNNNC0	N	D
22	25.5	34	20	15	20AE022C3AYNNNC0	N	D
27	33	44	25	20	20AE027C3AYNNNC0	N	D
32	40.5	54	30	25	20AE032C3AYNNNC0	N	D
41	48	64	40	30	20AE041C3AYNANC0	N	E
52	61.5	82	50	40	20AE052C3AYNANC0	N	E

Wall / Machine Mount - IP54, NEMA/UL Type 12, with HIM

200...240V AC, Three-Phase Drives

240V AC Input					208V AC Input ❄							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.			Cont.	1 Min.	3 Sec.					
54	63	84	20	15	62.1	72.4	96.6	15	11	20AB054G3AYNANC0	Y	E
70	81	108	25	20	78.2	93.1	124	18.5	15	20AB070G3AYNANC0	Y	E

❄ Drive must be programmed to lower voltage to obtain the currents shown.

380...480V AC, Three-Phase Drives

480V AC Input						400V AC Input							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
52	60	80	40	30	20AD052G3AYNANC0	60	66	90	30	22	20AC060G3AYNANC0	Y	E
65	78	104	50	40	20AD065G3AYNANC0	72	90	120	37	30	20AC072G3AYNANC0	Y	E

500...600V AC, Three-Phase Drives

600V AC Input							
Output Amps							
Cont.	1 Min.	3 Sec.	Normal Duty Hp	Heavy Duty Hp	Cat. No.	with Filter	Frame Size
41	48	64	40	30	20AE041G3AYNANC0	Y	E
52	61.5	82	50	40	20AE052G3AYNANC0	Y	E

Flange Mount - Front Chassis = IP20, NEMA/UL Type 1, Heatsink = IP66, NEMA/UL Type 4X/12, No HIM

200...240V AC, Three-Phase Drives

240V AC Input						208V AC Input ❄							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
2.2	2.4	3.3	0.5	0.33	20AB2P2F0AYNNNC0	2.5	2.7	3.7	0.37	0.25	20AB2P2F0AYNNNC0	N	A
2.2	2.4	3.3	0.5	0.33	20AB2P2F0AYNANC0	2.5	2.7	3.7	0.37	0.25	20AB2P2F0AYNANC0	Y	B
4.2	4.8	6.4	1	0.75	20AB4P2F0AYNNNC0	4.8	5.5	7.4	0.75	0.55	20AB4P2F0AYNNNC0	N	A
4.2	4.8	6.4	1	0.75	20AB4P2F0AYNANC0	4.8	5.5	7.4	0.75	0.55	20AB4P2F0AYNANC0	Y	B
6.8	9	12	2	1.5	20AB6P8F0AYNNNC0	7.8	10.3	13.8	1.5	1.1	20AB6P8F0AYNNNC0	N	B
6.8	9	12	2	1.5	20AB6P8F0AYNANC0	7.8	10.3	13.8	1.5	1.1	20AB6P8F0AYNANC0	Y	B
9.6	10.6	14.4	3	2	20AB9P6F0AYNNNC0	11	12.1	16.5	2.2	1.5	20AB9P6F0AYNNNC0	N	B
9.6	10.6	14.4	3	2	20AB9P6F0AYNANC0	11	12.1	16.5	2.2	1.5	20AB9P6F0AYNANC0	Y	B
15.3	17.4	23.2	5	3	20AB015F0AYNANC0	17.5	19.2	26.2	4	3	20AB015F0AYNANC0	Y	C
22	24.2	33	7.5	5	20AB022F0AYNANC0	25.3	27.8	37.9	5.5	4	20AB022F0AYNANC0	Y	D
28	33	44	10	7.5	20AB028F0AYNANC0	32.2	37.9	50.6	7.5	5.5	20AB028F0AYNANC0	Y	D
42	46.2	63	15	10	20AB042F0AYNANC0	43	55.5	74	11	7.5	20AB042F0AYNANC0	Y	D
54	63	84	20	15	20AB054F0AYNANC0	62.1	72.4	96.6	15	11	20AB054F0AYNANC0	Y	E
70	81	108	25	20	20AB070F0AYNANC0	78.2	93.1	124	18.5	15	20AB070F0AYNANC0	Y	E

❄ Drive must be programmed to lower voltage to obtain the currents shown.

380...480V AC, Three-Phase Drives

480V AC Input						400V AC Input							
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	with Filter	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.					
1.1	1.2	1.6	0.5	0.33	20AD1P1F0AYNNNC0	1.3	1.4	1.9	0.37	0.25	20AC1P3F0AYNNNC0	N	A
1.1	1.2	1.6	0.5	0.33	20AD1P1F0AYNANC0	1.3	1.4	1.9	0.37	0.25	20AC1P3F0AYNANC0	Y	B
2.1	2.4	3.2	1	0.75	20AD2P1F0AYNNNC0	2.1	2.4	3.2	0.75	0.55	20AC2P1F0AYNNNC0	N	A
2.1	2.4	3.2	1	0.75	20AD2P1F0AYNANC0	2.1	2.4	3.2	0.75	0.55	20AC2P1F0AYNANC0	Y	B
3.4	4.5	6	2	1.5	20AD3P4F0AYNNNC0	3.5	4.5	6	1.5	1.1	20AC3P5F0AYNNNC0	N	A
3.4	4.5	6	2	1.5	20AD3P4F0AYNANC0	3.5	4.5	6	1.5	1.1	20AC3P5F0AYNANC0	Y	B
5	5.5	7.5	3	2	20AD5P0F0AYNNNC0	5	5.5	7.5	2.2	1.5	20AC5P0F0AYNNNC0	N	B
5	5.5	7.5	3	2	20AD5P0F0AYNANC0	5	5.5	7.5	2.2	1.5	20AC5P0F0AYNANC0	Y	B
8	8.8	12	5	3	20AD8P0F0AYNNNC0	8.7	9.9	13.2	4	3	20AC8P7F0AYNNNC0	N	B
8	8.8	12	5	3	20AD8P0F0AYNANC0	8.7	9.9	13.2	4	3	20AC8P7F0AYNANC0	Y	B
11	12.1	16.5	7.5	5	20AD011F0AYNANC0	11.5	13	17.4	5.5	4	20AC011F0AYNANC0	Y	C
14	16.5	22	10	7.5	20AD014F0AYNANC0	15.4	17.2	23.1	7.5	5.5	20AC015F0AYNANC0	Y	C
22	24.2	33	15	10	20AD022F0AYNANC0	22	24.2	33	11	7.5	20AC022F0AYNANC0	Y	D
27	33	44	20	15	20AD027F0AYNANC0	30	33	45	15	11	20AC030F0AYNANC0	Y	D
34	40.5	54	25	20	20AD034F0AYNANC0	37	45	60	18.5	15	20AC037F0AYNANC0	Y	D
40	51	68	30	25	20AD040F0AYNANC0	43	56	74	22	18.5	20AC043F0AYNANC0	Y	D
52	60	80	40	30	20AD052F0AYNANC0	60	66	90	30	22	20AC060F0AYNANC0	Y	E
65	78	104	50	40	20AD065F0AYNANC0	72	90	120	37	30	20AC072F0AYNANC0	Y	E

❄ Drive must be programmed to lower voltage to obtain the currents shown.

Flange Mount - Front Chassis = IP20, NEMA/UL Type 1, Heatsink = IP66, NEMA/UL Type 4X/12, No HIM (continued)

500...600V AC, Three-Phase Drives

600V AC Input							
Output Amps							
Cont.	1 Min.	3 Sec.	Normal Duty Hp	Heavy Duty Hp	Cat. No.	with Filter	Frame Size
0.9	1	1.4	0.5	0.33	20AE0P9F0AYNNNC0	N	A
1.7	1.9	2.6	1	0.75	20AE1P7F0AYNNNC0	N	A
2.7	3.6	4.8	2	1	20AE2P7F0AYNNNC0	N	A
3.9	4.3	5.8	3	1.5	20AE3P9F0AYNNNC0	N	B
6.1	6.7	9.1	5	3	20AE6P1F0AYNNNC0	N	B
9	9.9	13.5	7.5	5	20AE9P0F0AYNNNC0	N	C
11	13.5	18	10	7.5	20AE011F0AYNNNC0	N	C
17	18.7	25.5	15	10	20AE017F0AYNNNC0	N	D
22	25.5	34	20	15	20AE022F0AYNNNC0	N	D
27	33	44	25	20	20AE027F0AYNNNC0	N	D
32	40.5	54	30	25	20AE032F0AYNNNC0	N	D
41	48	64	40	30	20AE041F0AYNANC0	N	E
52	61.5	82	50	40	20AE052F0AYNANC0	N	E



Ratings	380…480V:	132…1200 kW / 200…1900 Hp / 261…2150 A
	500…600V:	160…2000 kW / 250…900 Hp / 261…820 A
	690V:	160…2300 kW / 150…2400 Hp / 170…2250 A
Motor Control	• V/Hz control • Sensorless Vector Control	
Communications	Common Industrial Protocol	
User Interface	HIM (option)	
Enclosures	IP21	
Safety	DriveGuard Safe Torque-Off / EN954-1 Cat. 3	
Certifications	• UL • cUL • ATEX Certified with Safe Torque-Off • IEC (Designed to Meet) - with Rittal Enclosure • CE - with Rittal Enclosure • C-Tick • TÜV FS ISO/EN13849-1 (EN954-1) with Safe Torque-Off option	
Options	See pages 6-65…6-74	

The PowerFlex 700H drive is ideal for high power applications requiring speed control performance. This drive provides excellent torque at low speeds for demanding speed control applications and has configurable control modes for a wide variety of applications. The PowerFlex 700H also has an ATEX certified option for drives that operate in potentially explosive environments.

IP21, NEMA Type 1

380…480V AC, Three-Phase Drives with 24V DC I/O

480V AC Input						400V AC Input						Frame Size
Output Amps ✶			Normal Duty Hp	Heavy Duty Hp	Cat. No. §➢	Output Amps ✶			Normal Duty kW	Heavy Duty kW	Cat. No. §➢	
Cont.	1 Min.	2 Sec. ❄				Cont.	1 Min.	2 Sec. ❄				
261 (205)	287 (308)	410 (410)	200	150	20CD261A0ANNBNA0	261 (205)	287 (308)	410 (410)	132	110	20CC261A0ANNBNA0	9
300 (245)	330 (368)	450 (490)	250	200	20CD300A0ANNBNA0	300 (245)	330 (368)	450 (490)	160	132	20CC300A0ANNBNA0	9
385 (300)	424 (450)	600 (600)	300	250	20CD385A0ANNBNA0	385 (300)	424 (450)	600 (600)	200	160	20CC385A0ANNBNA0	10
460 (385)	506 (578)	770 (770)	350	300	20CD460A0ANNBNA0	460 (385)	506 (578)	770 (770)	250	200	20CC460A0ANNBNA0	10
500 (420)	550 (630)	750 (840)	450	350	20CD500A0ANNBNA0	500 (420)	550 (630)	750 (840)	250	250	20CC500A0ANNBNA0	10
590 (520)	649 (780)	956 (956)	500	450	20CD590A0ANNBNA0	590 (520)	649 (780)	956 (956)	315	250	20CC590A0ANNBNA0	11
650 (590)	715 (885)	1062 (1062)	500	500	20CD650A0ANNBNA0	650 (590)	715 (885)	1062 (1062)	355	315	20CC650A0ANNBNA0	11
730 (650)	803 (975)	1095 (1170)	600	500	20CD730A0ANNBNA0	730 (650)	803 (975)	1095 (1170)	400	355	20CC730A0ANNBNA0	11
820 (730)	902 (1095)	1230 (1314)	700	600	20CD820A0ANNBNA0	820 (730)	902 (1095)	1230 (1314)	450	400	20CC820A0ANNBNA0	12
920 (820)	1012 (1230)	1380 (1476)	800	700	20CD920A0ANNBNA0	920 (820)	1012 (1230)	1380 (1476)	500	450	20CC920A0ANNBNA0	12
1030 (920)	1133 (1370)	1555 (1600)	900	800	20CD1K0A0ANNBNA0	1030 (920)	1133 (1370)	1555 (1600)	560	500	20CC1K0A0ANNBNA0	12
1150 (1030)	1265 (1545)	1620 (1620)	1000	900	20CD1K1A0ANNBNA0	1150 (1030)	1265 (1545)	1620 (1620)	630	560	20CC1K1A0ANNBNA0	13
1300 (1150)	1430 (1725)	2079 (2079)	1200	1000	20CD1K3A0ANNBNA0	1300 (1150)	1430 (1725)	2079 (2079)	710	630	20CC1K3A0ANNBNA0	13
1450 (1200)	1595 (1800)	2175 (2400)	1250	1000	20CD1K4A0ANNBNA0	1450 (1200)	1595 (1800)	2175 (2400)	800	710	20CC1K4A0ANNBNA0	13
1770 (1600)	1947 (2400)	2655 (2880)	1500	1400	20CD1K7A0ANNENA0	1770 (1600)	1947 (2400)	2655 (2880)	1000	900	20CC1K7A0ANNENA0	14
2150 (1940)	2365 (2910)	3225 (3492)	1900	1700	20CD2K1A0ANNENA0	2150 (1940)	2365 (2910)	3225 (3492)	1200	1100	20CC2K1A0ANNENA0	14

✶ These drives have dual current ratings; normal duty applications and heavy duty applications (in parenthesis). The drive may be operated at either rating.
❄ The 2 sec. output current is only available at initial start or drive operating at light load.
§ Frames 10 & up include a Rittal enclosure.
➢ Drives listed do not include a Control and I/O option.

IP21, NEMA Type 1 (continued)

600…690V AC, Three-Phase Drives with 24V DC I/O

600V AC Input						690V AC Input						Frame Size
Output Amps ✶			Normal Duty Hp	Heavy Duty Hp	Cat. No. §➢	Output Amps ✶			Normal Duty kW	Heavy Duty kW	Cat. No. §➢	
Cont.	1 Min.	2 Sec. ❄				Cont.	1 Min.	2 Sec. ❄				
170 (144)	187 (216)	245 (245)	150	150	20CE170A0ANNBNA0	170 (144)	187 (216)	245 (245)	160	132	20CF170A0ANNBNA0	9
208 (170)	230 (250)	289 (289)	200	150	20CE208A0ANNBNA0	208 (170)	230 (250)	289 (289)	200	160	20CF208A0ANNBNA0	9
261 (208)	287 (312)	375 (375)	250	200	20CE261A0ANNBNA0	261 (208)	287 (312)	375 (375)	250	200	20CF261A0ANNBNA0	10
325 (261)	358 (392)	470 (470)	350	250	20CE325A0ANNBNA0	325 (261)	358 (392)	470 (470)	315	250	20CF325A0ANNBNA0	10
385 (325)	424 (488)	585 (585)	400	350	20CE385A0ANNBNA0	385 (325)	424 (488)	585 (585)	355	315	20CF385A0ANNBNA0	10
416 (325)	458 (488)	585 (585)	450	350	20CE416A0ANNBNA0	416 (325)	458 (488)	585 (585)	400	315	20CF416A0ANNBNA0	10
460 (385)	506 (578)	693 (693)	500	400	20CE460A0ANNBNA0	460 (385)	506 (578)	693 (693)	450	355	20CF460A0ANNBNA0	11
502 (460)	552 (690)	828 (828)	500	500	20CE502A0ANNBNA0	502 (460)	552 (690)	828 (828)	500	450	20CF502A0ANNBNA0	11
590 (502)	649 (753)	885 (904)	600	500	20CE590A0ANNBNA0	590 (502)	649 (753)	885 (904)	560	500	20CF590A0ANNBNA0	11
650 (590)	715 (885)	1062 (1062)	700	650	20CE650A0ANNBNA0	650 (590)	715 (885)	1062 (1062)	630	560	20CF650A0ANNBNA0	12
750 (650)	825 (975)	1170 (1170)	800	700	20CE750A0ANNBNA0	750 (650)	825 (975)	1170 (1170)	710	630	20CF750A0ANNBNA0	12
820 (750)	902 (975)	1170 (1170)	900	700	20CE820A0ANNBNA0	820 (750)	902 (975)	1170 (1170)	800	630	20CF820A0ANNBNA0	12
920 (820)	1012 (1230)	1380 (1410)	1000	900	20CE920A0ANNBNA0	920 (820)	1012 (1230)	1380 (1410)	900	800	20CF920A0ANNBNA0	13
1030 (920)	1133 (1380)	1545 (1755)	1100	1000	20CE1K0A0ANNBNA0	1030 (920)	1133 (1380)	1545 (1755)	1000	900	20CF1K0A0ANNBNA0	13
1180 (1030)	1298 (1463)	1755 (1755)	1300	1100	20CE1K1A0ANNBNA0	1180 (1030)	1298 (1463)	1755 (1755)	1100	1000	20CF1K1A0ANNBNA0	13
1500 (1300)	1650 (1950)	2250 (2340)	1600	1400	20CE1K5A0ANNENA0	1500 (1300)	1650 (1950)	2250 (2340)	1500	1300	20CF1K5A0ANNENA0	14
1900 (1500)	2090 (2250)	2700 (2700)	2000	1600	20CE1K9A0ANNENA0	1900 (1500)	2090 (2250)	2700 (2700)	1900	1500	20CF1K9A0ANNENA0	14
2250 (1900)	2475 (2782)	3335 (3335)	2400	2000	20CE2K2A0ANNENA0	2250 (1900)	2475 (2782)	3335 (3335)	2300	1900	20CF2K2A0ANNENA0	14

✶ These drives have dual current ratings; normal duty applications and heavy duty applications (in parenthesis). The drive may be operated at either rating.
❄ The 2 sec. output current is only available at initial start or drive operating at light load.
§ Frames 10 & up include a Rittal enclosure.
➢ Drives listed do not include a Control and I/O option.

IP20, NEMA Type 1, MCC

380…480V AC, Three-Phase Drives with 24V DC I/O

480V AC Input						400V AC Input						Frame Size
Output Amps ✶			Normal Duty Hp	Heavy Duty Hp	Cat. No. ➢	Output Amps ✶			Normal Duty kW	Heavy Duty kW	Cat. No. ➢	
Cont.	1 Min.	2 Sec. ❄				Cont.	1 Min.	2 Sec. ❄				
385 (300)	424 (450)	600 (600)	300	250	20CD385B0ANNBNA0	385 (300)	424 (450)	600 (600)	200	160	20CD385B0ANNBNA0	10
460 (385)	506 (578)	770 (770)	350	300	20CD460B0ANNBNA0	460 (385)	506 (578)	770 (770)	250	200	20CD460B0ANNBNA0	10
500 (420)	550 (630)	750 (840)	450	350	20CD500B0ANNBNA0	500 (420)	550 (630)	750 (840)	250	250	20CD500B0ANNBNA0	10
590 (520)	649 (780)	956 (956)	500	450	20CD590B0ANNBNA0	590 (520)	649 (780)	956 (956)	315	250	20CD590B0ANNBNA0	11
650 (590)	715 (885)	1062 (1062)	500	500	20CD650B0ANNBNA0	650 (590)	715 (885)	1062 (1062)	355	315	20CD650B0ANNBNA0	11
730 (650)	803 (975)	1095 (1170)	600	500	20CD730B0ANNBNA0	730 (650)	803 (975)	1095 (1170)	400	355	20CD730B0ANNBNA0	11
820 (730)	902 (1095)	1230 (1314)	700	600	20CD820B0ANNBNA0	820 (730)	902 (1095)	1230 (1314)	450	400	20CD820B0ANNBNA0	12
920 (820)	1012 (1230)	1380 (1476)	800	700	20CD920B0ANNBNA0	920 (820)	1012 (1230)	1380 (1476)	500	450	20CD920B0ANNBNA0	12
1030 (920)	1133 (1370)	1555 (1600)	900	800	20CD1K0B0ANNBNA0	1030 (920)	1133 (1370)	1555 (1600)	560	500	20CD1K0B0ANNBNA0	12

✶ These drives have dual current ratings; normal duty applications and heavy duty applications (in parenthesis). The drive may be operated at either rating.
❄ The 2 sec. output current is only available at initial start or drive operating at light load.
➢ Drives listed do not include a Control and I/O option.

600V AC, Three-Phase Drives with 24V DC I/O

600V AC Input						
Output Amps ✶						Frame Size
Cont.	1 Min.	2 Sec. ❄	Normal Duty Hp	Heavy Duty Hp	Cat. No. ➢	
261 (208)	287 (312)	375 (375)	250	200	20CE261B0ANNBNA0	10
325 (261)	358 (392)	470 (470)	350	250	20CE325B0ANNBNA0	10
385 (325)	424 (488)	585 (585)	400	350	20CE385B0ANNBNA0	10
416 (325)	458 (488)	585 (585)	450	350	20CE416B0ANNBNA0	10
460 (385)	506 (578)	693 (693)	500	400	20CE460B0ANNBNA0	11
502 (460)	552 (690)	828 (828)	500	500	20CE502B0ANNBNA0	11
590 (502)	649 (753)	885 (904)	600	500	20CE590B0ANNBNA0	11
650 (590)	715 (885)	1062 (1062)	700	650	20CE650B0ANNBNA0	12
750 (650)	825 (975)	1170 (1170)	800	700	20CE750B0ANNBNA0	12
820 (750)	902 (975)	1170 (1170)	900	700	20CE820B0ANNBNA0	12

✶ These drives have dual current ratings; normal duty applications and heavy duty applications (in parenthesis). The drive may be operated at either rating.
❄ The 2 sec. output current is only available at initial start or drive operating at light load.
➢ Drives listed do not include a Control and I/O option.

IP54, NEMA Type 12, Rittal

380…480V AC, Three-Phase Drives with 24V DC I/O

480V AC Input						400V AC Input						Frame Size
Output Amps ✶			Normal Duty Hp	Heavy Duty Hp	Cat. No. ➢	Output Amps ✶			Normal Duty kW	Heavy Duty kW	Cat. No. ➢	
Cont.	1 Min.	2 Sec. ❄				Cont.	1 Min.	2 Sec. ❄				
385 (300)	424 (450)	600 (600)	300	250	20CD385H0ANNBNA0	385 (300)	424 (450)	600 (600)	200	160	20CC385H0ANNBNA0	10
460 (385)	506 (578)	770 (770)	350	300	20CD460H0ANNBNA0	460 (385)	506 (578)	770 (770)	250	200	20CC460H0ANNBNA0	10
500 (420)	550 (630)	750 (840)	450	350	20CD500H0ANNBNA0	500 (420)	550 (630)	750 (840)	250	250	20CC500H0ANNBNA0	10
590 (520)	649 (780)	956 (956)	500	450	20CD590H0ANNBNA0	590 (520)	649 (780)	956 (956)	315	250	20CC590H0ANNBNA0	11
650 (590)	715 (885)	1062 (1062)	500	500	20CD650H0ANNBNA0	650 (590)	715 (885)	1062 (1062)	355	315	20CC650H0ANNBNA0	11
730 (650)	803 (975)	1095 (1170)	600	500	20CD730H0ANNBNA0	730 (650)	803 (975)	1095 (1170)	400	355	20CC730H0ANNBNA0	11
820 (730)	902 (1095)	1230 (1314)	700	600	20CD820H0ANNBNA0	820 (730)	902 (1095)	1230 (1314)	450	400	20CC820H0ANNBNA0	12
920 (820)	1012 (1230)	1380 (1476)	800	700	20CD920H0ANNBNA0	920 (820)	1012 (1230)	1380 (1476)	500	450	20CC920H0ANNBNA0	12
1030 (920)	1133 (1370)	1555 (1600)	900	800	20CD1K0H0ANNBNA0	1030 (920)	1133 (1370)	1555 (1600)	560	500	20CC1K0H0ANNBNA0	12
1150 (1030)	1265 (1545)	1620 (1620)	1000	900	20CD1K1H0ANNBNA0	1150 (1030)	1265 (1545)	1620 (1620)	630	560	20CC1K1H0ANNBNA0	13
1300 (1150)	1430 (1725)	2079 (2079)	1200	1000	20CD1K3H0ANNBNA0	1300 (1150)	1430 (1725)	2079 (2079)	710	630	20CC1K3H0ANNBNA0	13
1450 (1200)	1595 (1800)	2175 (2400)	1250	1000	20CD1K4H0ANNBNA0	1450 (1200)	1595 (1800)	2175 (2400)	800	710	20CC1K4H0ANNBNA0	13
1770 (1600)	1947 (2400)	2655 (2880)	1500	1400	20CD1K7H0ANNENA0	1770 (1600)	1947 (2400)	2655 (2880)	1000	900	20CC1K7H0ANNENA0	14
2150 (1940)	2365 (2910)	3225 (3492)	1900	1700	20CD2K1H0ANNENA0	2150 (1940)	2365 (2910)	3225 (3492)	1200	1100	20CC2K1H0ANNENA0	14

✶ These drives have dual current ratings; normal duty applications and heavy duty applications (in parenthesis). The drive may be operated at either rating.
❄ The 2 sec. output current is only available at initial start or drive operating at light load.
➢ Drives listed do not include a Control and I/O option.

600…690V AC, Three-Phase Drives with 24V DC I/O

600V AC Input						690V AC Input						Frame Size
Output Amps ✶			Normal Duty Hp	Heavy Duty Hp	Cat. No. ➢	Output Amps ✶			Normal Duty kW	Heavy Duty kW	Cat. No. ➢	
Cont.	1 Min.	2 Sec. ❄				Cont.	1 Min.	2 Sec. ❄				
261 (208)	287 (312)	375 (375)	250	200	20CE261H0ANNBNA0	261 (208)	287 (312)	375 (375)	250	200	20CF261H0ANNBNA0	10
325 (261)	358 (392)	470 (470)	350	250	20CE325H0ANNBNA0	325 (261)	358 (392)	470 (470)	315	250	20CF325H0ANNBNA0	10
385 (325)	424 (488)	585 (585)	400	350	20CE385H0ANNBNA0	385 (325)	424 (488)	585 (585)	355	315	20CF385H0ANNBNA0	10
416 (325)	458 (488)	585 (585)	450	350	20CE416H0ANNBNA0	416 (325)	458 (488)	585 (585)	400	315	20CF416H0ANNBNA0	10
460 (385)	506 (578)	693 (693)	500	400	20CE460H0ANNBNA0	460 (385)	506 (578)	693 (693)	450	355	20CF460H0ANNBNA0	11
502 (460)	552 (690)	828 (828)	500	500	20CE502H0ANNBNA0	502 (460)	552 (690)	828 (828)	500	450	20CF502H0ANNBNA0	11
590 (502)	649 (753)	885 (904)	600	500	20CE590H0ANNBNA0	590 (502)	649 (753)	885 (904)	560	500	20CF590H0ANNBNA0	11
650 (590)	715 (885)	1062 (1062)	700	650	20CE650H0ANNBNA0	650 (590)	715 (885)	1062 (1062)	630	560	20CF650H0ANNBNA0	12
750 (650)	825 (975)	1170 (1170)	800	700	20CE750H0ANNBNA0	750 (650)	825 (975)	1170 (1170)	710	630	20CF750H0ANNBNA0	12
820 (750)	902 (975)	1170 (1170)	900	700	20CE820H0ANNBNA0	820 (750)	902 (975)	1170 (1170)	800	630	20CF820H0ANNBNA0	12
920 (820)	1012 (1230)	1380 (1410)	1000	900	20CE920H0ANNBNA0	920 (820)	1012 (1230)	1380 (1410)	900	800	20CF920H0ANNBNA0	13
1030 (920)	1133 (1380)	1545 (1755)	1100	1000	20CE1K0H0ANNBNA0	1030 (920)	1133 (1380)	1545 (1755)	1000	900	20CF1K0H0ANNBNA0	13
1180 (1030)	1298 (1463)	1755 (1755)	1300	1100	20CE1K1H0ANNBNA0	1180 (1030)	1298 (1463)	1755 (1755)	1100	1000	20CF1K1H0ANNBNA0	13
1500 (1300)	1650 (1950)	2250 (2340)	1600	1400	20CE1K5H0ANNENA0	1500 (1300)	1650 (1950)	2250 (2340)	1500	1300	20CF1K5H0ANNENA0	14
1900 (1500)	2090 (2250)	2700 (2700)	2000	1600	20CE1K9H0ANNENA0	1900 (1500)	2090 (2250)	2700 (2700)	1900	1500	20CF1K9H0ANNENA0	14
2250 (1900)	2475 (2782)	3335 (3335)	2400	2000	20CE2K2H0ANNENA0	2250 (1900)	2475 (2782)	3335 (3335)	2300	1900	20CF2K2H0ANNENA0	14

✶ These drives have dual current ratings; normal duty applications and heavy duty applications (in parenthesis). The drive may be operated at either rating.
❄ The 2 sec. output current is only available at initial start or drive operating at light load.
➢ Drives listed do not include a Control and I/O option.



The PowerFlex 700S offers optimized integration for the most demanding stand-alone and coordinated drive control and drive system applications. The PowerFlex 700S offers a DriveLogix option which combines the powerful performance and flexible control of PowerFlex AC drives with a high-performance Logix engine to produce a highly functional, cost-effective drive and control solution.

Ratings	200…240V:	0.75…66 kW / 1…100 Hp / 4.2…260 A
	380…480V:	0.75…800 kW / 1…1250 Hp / 2.1…1450 A
	500…600V:	0.75…1500 kW / 1…1600 Hp / 1.7…1500 A
	690V:	45…1500 kW / 50…1600 Hp / 77…1500 A
Motor Control	• V/Hz control • Vector Control with FORCE Technology (with and without encoder) • Permanent Magnet Motor Control	
Communications	Common Industrial Protocol	
User Interface	HIM (option)	
Enclosures	IP20, IP21	
Safety	DriveGuard Safe Torque-Off / EN 954-1 Cat. 3	
Additional Features	• Integrated position loop for simple indexing to electronic line shaft applications • SynchLink for high speed data transfer and synchronization • Multiple motor feedback options • DriveLogix	
Certifications	• UL • cUL • CE • C-Tick • IEC (Designed to Meet) • TÜV FS ISO/EN13849-1 (EN954-1) with Safe Torque-Off option • RINA, Frames 1…10	
Options	See pages 6-65…6-74	

IP20, NEMA/UL Type 1

200…240V AC, Three-Phase Drives

240V AC Input						208V AC Input ✶						Frame Size
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
4.2	4.8	6.4	1	0.75	20DB4P2A0EYNANANE	4.8	5.6	7	0.75	0.37	20DB4P2A0EYNANANE	1
6.8	9	12	2	1.5	20DB6P8A0EYNANANE	7.8	10.4	13.8	1.5	0.75	20DB6P8A0EYNANANE	1
9.6	10.6	14.4	3	2	20DB9P6A0EYNANANE	11	12.1	17	2.2	1.5	20DB9P6A0EYNANANE	1
15.3	16.8	23	5	3	20DB015A0EYNANANE	17.5	19.3	26.3	4	2.2	20DB015A0EYNANANE	1
22	24.2	33	7.5	5	20DB022A0EYNANANE	25.3	27.8	38	5.5	4	20DB022A0EYNANANE	1
28	33	44	10	7.5	20DB028A0EYNANANE	32.2	38	50.6	7.5	5.5	20DB028A0EYNANANE	2
42	46.2	63	15	10	20DB042A0EYNANANE	48.3	53.1	72.5	11	7.5	20DB042A0EYNANANE	3
52	63	80	20	15	20DB052A0EYNANANE	56	64	86	15	11	20DB052A0EYNANANE	3
70	78	105	25	20	20DB070A0ENNANANE	78.2	86	117.3	18.5	15	20DB070A0ENNANANE	4 §
80	105	136	30	25	20DB080A0ENNANANE	92	117.3	156.4	22	18.5	20DB080A0ENNANANE	4 §
104 (80) ❄	115 (120)	175 (160)	40	30	20DB104A0ENNANANE	120 (92)	132 (138)	175 (175)	30	22	20DB104A0ENNANANE	5 §
130 (104) ❄	143 (156)	175 (175)	50	40	20DB130A0ENNANANE	130 (104)	143 (156)	175 (175)	30	30	20DB130A0ENNANANE	5 §
154 (130) ❄	169 (195)	231 (260)	60	50	20DB154A0ENNANANE	177 (150)	195 (225)	266 (300)	45	37	20DB154A0ENNANANE	6 §
192 (154) ❄	211 (231)	288 (308)	75	60	20DB192A0ENNANANE	221 (177)	243 (266)	308 (308)	55	45	20DB192A0ENNANANE	6 §
260 (205) ❄	286 (305)	390 (410)	100	75	20DB260A0ENNANANE	260 (205)	286 (305)	390 (410)	66	55	20DB260A0ENNANANE	6 §

✶ Drive must be programmed to lower voltage to obtain higher currents shown.

❄ These drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

§ Also available with internal Brake IGBT (20DxxxxA0E **Y** NANANE).

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	2.4	3.2	1	0.75	20DD2P1A0EYNANANE	2.1	2.4	3.2	0.75	0.55	20DC2P1A0EYNANANE	1
3.4	4.5	6	2	1.5	20DD3P4A0EYNANANE	3.5	4.5	6	1.5	0.75	20DC3P5A0EYNANANE	1
5	5.5	7.5	3	2	20DD5P0A0EYNANANE	5	5.5	7.5	2.2	1.5	20DC5P0A0EYNANANE	1
8	8.8	12	5	3	20DD8P0A0EYNANANE	8.7	9.9	13.2	4	2.2	20DC8P7A0EYNANANE	1
11	12.1	16.5	7.5	5	20DD011A0EYNANANE	11.5	13	17.4	5.5	4	20DC011A0EYNANANE	1
14	16.5	22	10	7.5	20DD014A0EYNANANE	15.4	17.2	23.1	7.5	5.5	20DC015A0EYNANANE	1
22	24.2	33	15	10	20DD022A0EYNANANE	22	24.2	33	11	7.5	20DC022A0EYNANANE	1
27	33	44	20	15	20DD027A0EYNANANE	30	33	45	15	11	20DC030A0EYNANANE	2
34	40.5	54	25	20	20DD034A0EYNANANE	37	45	60	18.5	15	20DC037A0EYNANANE	2
40	51	68	30	25	20DD040A0EYNANANE	43	56	74	22	18.5	20DC043A0EYNANANE	3
52	60	80	40	30	20DD052A0EYNANANE	56	64	86	30	22	20DC056A0EYNANANE	3
65	78	104	50	40	20DD065A0EYNANANE	72	84	112	37	30	20DC072A0EYNANANE	3
77 (65) ❄	85 (98)	116 (130)	60	50	20DD077A0ENNANANE	85 (72)	94 (108)	128 (144)	45	37	20DC085A0ENNANANE	4 §
96 (77) ❄	106 (116)	144 (154)	75	60	20DD096A0ENNANANE	105 (85)	116 (128)	158 (170)	55	45	20DC105A0ENNANANE	5 §
125 (96) ❄	138 (144)	163 (168)	100	75	20DD125A0ENNANANE	125 (96)	138 (144)	163 (168)	55	45	20DC125A0ENNANANE	5 §
–	–	–	–	–	–	140 (105)	154 (158)	210 (210)	75	55	20DC140A0ENNANANE	5 §
156 (125) ❄	172 (188)	233 (250)	125	100	20DD156A0ENNANANE	170 (140)	187 (210)	255 (280)	90	75	20DC170A0ENNANANE	6 §
180 (156) ❄	198 (234)	270 (312)	150	125	20DD180A0ENNANANE	205 (170)	220 (255)	289 (313)	110	90	20DC205A0ENNANANE	6 §
248 (180) ❄	273 (270)	372 (360)	200	150	20DD248A0ENNANANE	260 (205)	286 (308)	390 (410)	132	110	20DC260A0ENNANANE	6 §
261 (205) ❄	287 (308)	410 (410)	200	150	20DD261A0ENNBNANE	261 (205)	287 (308)	410 (410)	132	110	20DC261A0ENNBNANE	9
300 (245) ❄	330 (368)	450 (490)	250	200	20DD300A0ENNBNANE	300 (245)	330 (368)	450 (490)	160	130	20DC300A0ENNBNANE	9
385 (300) ❄	424 (450)	600 (600)	300	250	20DD385A0ENNBNANE	385 (300)	424 (450)	600 (600)	200	160	20DC385A0ENNBNANE	10
460 (385) ❄	506 (578)	770 (770)	350	300	20DD460A0ENNBNANE	460 (385)	506 (578)	770 (770)	250	200	20DC460A0ENNBNANE	10
500 (420) ❄	550 (630)	750 (840)	450	350	20DD500A0ENNBNANE	500 (420)	550 (630)	750 (840)	250	250	20DC500A0ENNBNANE	10
590 (520) ❄	649 (780)	956 (956)	500	450	20DD590A0ENNBNANE	590 (520)	649 (780)	956 (956)	315	250	20DC590A0ENNBNANE	11
650 (590) ❄	715 (885)	1062 (1062)	500	500	20DD650A0ENNBNANE	650 (590)	715 (885)	1062 (1062)	355	315	20DC650A0ENNBNANE	11
730 (650) ❄	803 (975)	1095 (1170)	600	500	20DD730A0ENNBNANE	730 (650)	803 (975)	1095 (1170)	400	355	20DC730A0ENNBNANE	11
820 (730) ❄	902 (1095)	1230 (1314)	700	600	20DD820A0ENNBNANE	820 (730)	902 (1095)	1230 (1314)	450	400	20DC820A0ENNBNANE	12
920 (820) ❄	1012 (1230)	1380 (1476)	800	700	20DD920A0ENNBNANE	920 (820)	1012 (1230)	1380 (1476)	500	450	20DC920A0ENNBNANE	12
1030 (920) ❄	1133 (1370)	1555 (1600)	900	800	20DD1K0A0ENNBNANE	1030 (920)	1133 (1370)	1555 (1600)	560	500	20DC1K0A0ENNBNANE	12
1150 (1030) ❄	1265 (1545)	1620 (1620)	1000	900	20DD1K1A0ENNBNANE	1150 (1030)	1265 (1545)	1620 (1620)	630	560	20DC1K1A0ENNBNANE	13
1300 (1150) ❄	1430 (1725)	2079 (2079)	1200	1000	20DD1K3A0ENNBNANE	1300 (1150)	1430 (1725)	2079 (2079)	710	630	20DC1K3A0ENNBNANE	13
1450 (1200) ❄	1595 (1800)	2175 (2400)	1250	1000	20DD1K4A0ENNBNANE	1450 (1200)	1595 (1800)	2175 (2400)	800	710	20DC1K4A0ENNBNANE	13

❄ These drives have dual current ratings; one for normal duty applications, and one for heavy duty (in parenthesis). The drive may be operated at either rating.
§ Also available with internal Brake IGBT (20DxxxxA0E **Y** NANANE).

500…690V AC, Three-Phase Drives

500…600V AC Input ♣						690V AC Input ♣						
Output Amps			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps			Normal Duty kW	Heavy Duty kW	Cat. No.	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
1.7	2	2.6	1	0.5	20DE1P7A0EYNANANE	–	–	–	–	–	–	1
2.7	3.6	4.8	2	1	20DE2P7A0EYNANANE	–	–	–	–	–	–	1
3.9	4.3	5.9	3	2	20DE3P9A0EYNANANE	–	–	–	–	–	–	1
6.1	6.7	9.2	5	3	20DE6P1A0EYNANANE	–	–	–	–	–	–	1
9	9.9	13.5	7.5	5	20DE9P0A0EYNANANE	–	–	–	–	–	–	1
11	13.5	18	10	7.5	20DE011A0EYNANANE	–	–	–	–	–	–	1
17	18.7	25.5	15	10	20DE017A0EYNANANE	–	–	–	–	–	–	1
22	25.5	34	20	15	20DE022A0EYNANANE	–	–	–	–	–	–	2
27	33	44	25	20	20DE027A0EYNANANE	–	–	–	–	–	–	2
32	40.5	54	30	25	20DE032A0EYNANANE	–	–	–	–	–	–	3
41	48	64	40	30	20DE041A0EYNANANE	–	–	–	–	–	–	3
52	61.5	82	50	40	20DE052A0EYNANANE	52	57	78	50	40	20DF052A0ENNANANE	3 ➢
62	78	104	60	50	20DE062A0EYNANANE	60	66	90	55	45	20DF062A0ENNANANE	4 ➢§
77 (63) ❄	85 (94)	116 (126)	75	60	20DE077A0ENNANANE	82 (60)	90 (90)	120 (123)	75	55	20DF082A0ENNANANE	5 §
99 (77) ❄	109 (116)	126 (138)	100	75	20DE099A0ENNANANE	98 (82)	108 (123)	127 (140)	90	75	20DF098A0ENNANANE	5 §
125 (99) ❄	138 (149)	188 (198)	125	100	20DE125A0ENNANANE	119 (98)	131 (147)	179 (196)	110	90	20DF119A0ENNANANE	6 §
144 (125) ❄	158 (188)	216 (250)	150	125	20DE144A0ENNANANE	142 (119)	156 (179)	213 (238)	132	110	20DF142A0ENNANANE	6 §
170 (144) ❄	187 (216)	245 (245)	150	150	20DE170A0ENNBNANE	170 (144)	187 (216)	245 (245)	160	132	20DF170A0ENNBNANE	9
208 (170) ❄	230 (250)	289 (289)	200	150	20DE208A0ENNBNANE	208 (170)	230 (250)	289 (289)	200	160	20DF208A0ENNBNANE	9
261 (208) ❄	287 (312)	375 (375)	250	200	20DE261A0ENNBNANE	261 (208)	287 (312)	375 (375)	250	200	20DF261A0ENNBNANE	10
325 (261) ❄	358 (392)	470 (470)	350	250	20DE325A0ENNBNANE	325 (261)	358 (392)	470 (470)	315	250	20DF325A0ENNBNANE	10
385 (325) ❄	424 (488)	585 (585)	400	350	20DE385A0ENNBNANE	385 (325)	424 (488)	585 (585)	355	315	20DF385A0ENNBNANE	10
416 (325) ❄	458 (488)	585 (585)	450	350	20DE416A0ENNBNANE	416 (325)	458 (488)	585 (585)	400	315	20DF416A0ENNBNANE	10
460 (385) ❄	506 (578)	693 (693)	450	400	20DE460A0ENNBNANE	460 (385)	506 (578)	693 (693)	450	355	20DF460A0ENNBNANE	11
502 (460) ❄	552 (690)	828 (828)	500	450	20DE502A0ENNBNANE	502 (460)	552 (690)	828 (828)	500	450	20DF502A0ENNBNANE	11
590 (502) ❄	649 (753)	904 (904)	600	500	20DE590A0ENNBNANE	590 (502)	649 (753)	904 (904)	560	500	20DF590A0ENNBNANE	11
650 (590) ❄	715 (885)	1062 (1062)	700	650	20DE650A0ENNBNANE	650 (590)	715 (885)	1062 (1062)	630	560	20DF650A0ENNBNANE	12
750 (650) ❄	825 (975)	1170 (1170)	800	700	20DE750A0ENNBNANE	750 (650)	825 (975)	1170 (1170)	710	630	20DF750A0ENNBNANE	12
820 (750) ❄‡	902 (975)	1170 (1170)	900	700	20DE820A0ENNBNANE	820 (750)	902 (975)	1170 (1170)	800	630	20DF820A0ENNBNANE	12
920 (820) ❄	1012 (1230)	1380 (1410)	1000	900	20DE920A0ENNBNANE	920 (820)	1012 (1230)	1380 (1410)	900	800	20DF920A0ENNBNANE	13
1030 (920) ❄	1133 (1380)	1545 (1755)	1100	1000	20DE1K0A0ENNBNANE	1030 (920)	1133 (1380)	1545 (1755)	1000	900	20DF1K0A0ENNBNANE	13
1180 (1030) ❄	1298 (1463)	1755 (1755)	1300	1100	20DE1K1A0ENNBNANE	1180 (1030)	1298 (1463)	1755 (1755)	1100	1000	20DF1K1A0ENNBNANE	13
1500 (1300) ❄	1650 (1950)	2250 (2340)	1600	1400	20DE1K5A0ENNBNANE	1500 (1300)	1650 (1950)	2250 (2340)	1500	1300	20DF1K5A0ENNBNANE	14

❄ These drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.
‡ 600V class drives at 820 amps (ND) such as 20DF820 & 20DE820 are only capable of producing 95% of starting torque under 10 Hz.
§ Also available with internal Brake IGBT (20DxxxxA0E **Y** NANANE).
♣ CE Certification testing has not been performed on 600V class drives Frames 1…4.
➢ 690V drives are Frame 5.

IP21, NEMA/UL Type 1, MCC

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps ❄			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ❄			Normal Duty kW	Heavy Duty kW	Cat. No.	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
385 (300)	424 (450)	600 (600)	300	250	20DD385B0ENNBNANE	385 (300)	424 (450)	600 (600)	200	160	20DC385B0ENNBNANE	10
460 (385)	506 (578)	770 (770)	350	300	20DD460B0ENNBNANE	460 (385)	506 (578)	770 (770)	250	200	20DC460B0ENNBNANE	10
500 (420)	550 (630)	750 (840)	450	350	20DD500B0ENNBNANE	500 (420)	550 (630)	750 (840)	250	250	20DC500B0ENNBNANE	10
590 (520)	649 (780)	956 (956)	500	450	20DD590B0ENNBNANE	590 (520)	649 (780)	956 (956)	315	250	20DC590B0ENNBNANE	11
650 (590)	715 (885)	1062 (1062)	500	500	20DD650B0ENNBNANE	650 (590)	715 (885)	1062 (1062)	355	315	20DC650B0ENNBNANE	11
730 (650)	803 (975)	1095 (1170)	600	500	20DD730B0ENNBNANE	730 (650)	803 (975)	1095 (1170)	400	355	20DC730B0ENNBNANE	11
820 (730)	902 (1095)	1230 (1314)	700	600	20DD820B0ENNBNANE	820 (730)	902 (1095)	1230 (1314)	450	400	20DC820B0ENNBNANE	12
920 (820)	1012 (1230)	1380 (1476)	800	700	20DD920B0ENNBNANE	920 (820)	1012 (1230)	1380 (1476)	500	450	20DC920B0ENNBNANE	12
1030 (920)	1133 (1370)	1555 (1600)	900	800	20DD1K0B0ENNBNANE	1030 (920)	1133 (1370)	1555 (1600)	560	500	20DC1K0B0ENNBNANE	12

❄ These drives have dual current ratings; one for normal duty applications, and one for heavy duty (in parenthesis). The drive may be operated at either rating.

500…690V AC, Three-Phase Drives

600V AC Input						
Output Amps ❄						
Cont.	1 Min.	3 Sec.	Normal Duty Hp	Heavy Duty Hp	Cat. No.	Frame Size
261 (208)	287 (312)	375 (375)	250	200	20DE261B0ENNBNANE	10
325 (261)	358 (392)	470 (470)	350	250	20DE325B0ENNBNANE	10
385 (325)	424 (488)	585 (585)	400	350	20DE385B0ENNBNANE	10
416 (325)	458 (488)	585 (585)	450	350	20DE416B0ENNBNANE	10
460 (385)	506 (578)	693 (693)	450	400	20DE460B0ENNBNANE	11
502 (460)	552 (690)	828 (828)	500	450	20DE502B0ENNBNANE	11
590 (502)	649 (753)	904 (904)	600	500	20DE590B0ENNBNANE	11
650 (590)	715 (885)	1062 (1062)	700	650	20DE650B0ENNBNANE	12
750 (650)	825 (975)	1170 (1170)	800	700	20DE750B0ENNBNANE	12
820 (750) ‡	902 (975)	1170 (1170)	900	700	20DE820B0ENNBNANE	12

❄ These drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

‡ 600V class drives at 820 amps (ND) such as 20DF820 & 20DE820 are only capable of producing 95% of starting torque under 10 Hz.



Ratings	380…480V:	200…860 kW / 300…1150 Hp / 360...1250 A
	500…600V:	345…650 kW / 465…870 Hp / 425…800 A
	690V:	355…657 kW / 475…881 Hp / 380…705 A
Motor Control	Select PowerFlex 700 or PowerFlex 700S Control	
Communications	Common Industrial Protocol	
User Interface	HIM (option)	
Enclosures	IP00, IP20	
Safety	DriveGuard Safe Torque-Off / EN 954-1 Cat. 3 with PowerFlex 700S control	
Additional Features	SynchLink and DriveLogix functionality with PowerFlex 700S control	
Certifications	• UL • cUL • IEC (Designed to Meet) • CE • TÜV FS ISO/EN13849-1 (EN954-1) with PowerFlex 700S control	
Options	See pages 6-65…6-74	

The PowerFlex 700L is available with the PowerFlex 700 or PowerFlex 700S control in a fully regenerative, liquid-cooled power structure. This powerful combination offers great performance and high power capabilities in a small package along with low harmonics.

Available as a panel mount unit or in a cabinet, this liquid cooled drive features regenerative braking which is ideal for precise, high-response speed and position control, continuous holdback, rapid deceleration and stopping of high inertia loads. Instead of wasting energy with resistor braking technology, regenerative braking actually puts the energy back into the system to be used by other equipment.

400V AC, Three-Phase Drives

Output Amps			Nominal Power Ratings				IP20, NEMA/UL Type 1 ∗	
400V AC Input			Normal Duty		Heavy Duty			
Cont.	1 Min.	3 Sec.	kW	Hp	kW	Hp	Cat. No.	Frame Size
360	396	540	200	268	150	200	20LC360N0ENNAN10WA	2
650	715	975	370	500	270	365	20LC650A0ENNAN10WA	3A
1250	1375	1875	715	960	525	700	20LC1K2A0ENNAN10WA	3B

∗ Frames 3A and 3B Only. Frame 2 drives are IP00, NEMA/UL Type Open.

480V AC, Three-Phase Drives

Output Amps			Nominal Power Ratings				IP20, NEMA/UL Type 1 ∗	
480V AC Input			Normal Duty		Heavy Duty			
Cont.	1 Min.	3 Sec.	kW	Hp	kW	Hp	Cat. No.	Frame Size
360	396	540	224	300	175	235	20LD360N0ENNAN10WA	2
650	715	975	445	600	325	440	20LD650A0ENNAN10WA	3A
1250	1375	1875	860	1150	630	845	20LD1K2A0ENNAN10WA	3B

∗ Frames 3A and 3B Only. Frame 2 drives are IP00, NEMA/UL Type Open.

600V AC, Three-Phase Drives

Output Amps			Nominal Power Ratings				IP20, NEMA/UL Type 1	
600V AC Input			Normal Duty		Heavy Duty			Frame Size
Cont.	1 Min.	3 Sec.	kW	Hp	kW	Hp	Cat. No.	
425	470	640	345	465	255	345	20LE425A0ENNAN10WA	3A
800	885	1200	650	870	480	640	20LE800A0ENNAN10WA	3B

690V AC, Three-Phase Drives

Output Amps			Nominal Power Ratings				IP20, NEMA/UL Type 1	
690V AC Input			Normal Duty		Heavy Duty			Frame Size
Cont.	1 Min.	3 Sec.	kW	Hp	kW	Hp	Cat. No.	
380	420	570	355	475	260	350	20LF380A0ENNAN10WA	3A
705	780	1060	657	881	485	650	20LF705A0ENNAN10WA	3B

Cooling Loops

Drive Requirements		Supply Loop Requirements			Liquid to Liquid Heat Exchanger ❄
Frame Size	Heat Dissipation into Liquid	Minimum Flow @ Pressure ✶	Maximum Pressure	Temperature Range	Cat. No.
2	7,900 W	15.1 LPM @ 0.83 bar (4 GPM @ 12 PSI)	8.62 bar (125 PSI)	0…40 °C (32…104 °F)	20L-LL13K-P75A
3A	12,000 W	22.7 LPM @ 0.83 bar (6 GPM @ 12 PSI)	8.62 bar (125 PSI)	0…35 °C (32…95 °F)	20L-LL13K-P75A
3B	24,000 W	56.8 LPM @ 0.83 bar (15 GPM @ 12 PSI)	8.62 bar (125 PSI)	0…35 °C (32…95 °F)	20L-LL24K-1P0A

✶ The minimum pressure applies to the pressure drop across the drive and does not take into account additional pressure drop in the system such as piping or hosing.

❄ Recommended cooling loops shown are based on a single drive per cooling loop. Consult your local Rockwell Automation sales office or Allen-Bradley distributor for use of multiple drives on one cooling loop.

Hose Kits

Hose Length [m (ft.)]	Hoses per Kit	Drive Side Coupling Size	Heat Exchanger Side Coupling Size	Used with …	Hose Kit Cat. No. ‡
3 (10)	2	0.75 in.	0.75 in.	Frame 2 and 13 kW HEX	20L-GH10-B1
9.1 (30)	2	0.75 in.	0.75 in.	Frame 2 and 13 kW HEX	20L-GH30-B1
3 (10)	2	1 in.	1 in. with 90° Elbow	Frame 3A and 13 kW HEX	20L-GH10-A2
9.1 (30)	2	1 in.	1 in. with 90° Elbow	Frame 3A and 13 kW HEX	20L-GH30-A2
3 (10)	2	1 in.	1 in.	Frame 3B and 24 kW HEX	20L-GH10-A1
9.1 (30)	2	1 in.	1 in.	Frame 3B and 24 kW HEX	20L-GH30-A1

‡ Each hose kit contains (2) hoses and the appropriate connectors.



Designed for general purpose applications, the PowerFlex 753 AC drive offers multiple options and features along with the added benefit of simple integration. The PowerFlex 753 comes standard with built-in I/O making it a cost effective solution ideal for OEMs and system integrators looking to reduce engineering costs, deliver machines to market faster and meet end-user demand for more productive and safer machines.

Ratings	380…480V: 0.75…250 kW / 1…350 Hp / 2.1…456 A
Motor Control	• V/Hz Control • Adjustable Voltage Control • Vector Control with FORCE Technology • Sensorless Vector Control
Communications	Common Industrial Protocol
User Interface	HIM (option)
Enclosures	IP00/IP20, Flange Mount, IP54/NEMA/UL Type 12
Safety	• Safe Torque-Off / EN 954-1 Cat. 3 • Safe Speed Monitor PLe/SIL3 Cat. 4
Additional Features	• DeviceLogix • Preventative Diagnostics • Standard I/O with 3 Digital In, 1 Analog In, 1 Analog Out, 1 Relay & 1 Transistor Out • Three option slots for I/O, feedback, safety, auxiliary control power, communications • Indexing • Pump Jack and Pump Off for oil well applications • Pjump and Traverse for Fibers application • Conformal Coating
Certifications	• UL • cUL • CE • C-Tick • SEMI F47 • GOST-R • TÜV FS ISO/EN13849-1 (EN954-1) with Safe Torque-Off option • Meets material restrictions specified in the RoHS directive
Options	See pages 6-65…6-74

IP00/IP20, NEMA/UL Type Open ❄

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps ‡			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ‡			Normal Duty kW	Heavy Duty kW	Cat. No. ✶	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	3.1	3.7	1	1	20F11ND2P1AA0NNNNN	2.1	3.1	3.7	0.75	0.75	20F11NC2P1JA0NNNNN	2
3.4	5.1	6.1	2	2	20F11ND3P4AA0NNNNN	3.5	5.2	6.3	1.5	1.5	20F11NC3P5JA0NNNNN	2
5	7.5	9	3	3	20F11ND5P0AA0NNNNN	5	7.5	9.0	2.2	2.2	20F11NC5P0JA0NNNNN	2
8	12	14.4	5	5	20F11ND8P0AA0NNNNN	8.7	13	15.6	4	4	20F11NC8P7JA0NNNNN	2
11	16.5	19.8	7.5	7.5	20F11ND011AA0NNNNN	11.5	17.2	20.7	5.5	5.5	20F11NC011JA0NNNNN	2
14 (11)	15.4 (16.5)	21 (21)	10	7.5	20F11ND014AA0NNNNN	15.4 (11.5)	16.9 (17.3)	23.1 (23.1)	7.5	5.5	20F11NC015JA0NNNNN	2
22 (14)	24.2 (21)	33 (33)	15	10	20F11ND022AA0NNNNN	22 (15.4)	24.2 (23.1)	33 (33)	11	7.5	20F11NC022JA0NNNNN	2
27 (22)	29.7 (33)	40.5 (40.5)	20	15	20F11ND027AA0NNNNN	30 (22)	33 (33)	45 (45)	15	11	20F11NC030JA0NNNNN	3
34 (27)	37.4 (40.5)	51 (51)	25	20	20F11ND034AA0NNNNN	37 (30)	40.7 (45)	55.5 (55.5)	18.5	15	20F11NC037JA0NNNNN	3
40 (34)	44 (51)	60 (61.2)	30	25	20F11ND040AA0NNNNN	43 (37)	47.3 (55.5)	64.5 (66.6)	22	18.5	20F11NC043JA0NNNNN	3
52 (40)	57.2 (60)	78 (78)	40	30	20F11ND052AA0NNNNN	60 (43)	66 (66)	90 (90)	30	22	20F11NC060JA0NNNNN	4
65 (52)	71.5 (78)	97.5 (97.5)	50	40	20F11ND065AA0NNNNN	72 (60)	79.2 (90)	108 (108)	37	30	20F11NC072JA0NNNNN	4
77 (65)	84.7 (97.5)	115.5 (117)	60	50	20F11ND077AA0NNNNN	85 (72)	93.5 (108)	127.5 (129.6)	45	37	20F11NC085JA0NNNNN	5
96 (77)	105.6 (115.5)	144 (144)	75	60	20F11ND096AA0NNNNN	104 (85)	114.4 (127.5)	156 (156)	55	45	20F11NC104JA0NNNNN	5
125 (96)	137.5 (144)	187.5 (187.5)	100	75	20F1AND125AN0NNNNN	140 (104)	154 (156)	210 (210)	75	55	20F1ANC140JN0NNNNN	6
156 (125)	171.6 (187.5)	234 (234)	125	100	20F1AND156AN0NNNNN	170 (140)	187 (210)	255 (255)	90	75	20F1ANC170JN0NNNNN	6
186 (156)	204.6 (234)	279 (280.8)	150	125	20F1AND186AN0NNNNN	205 (170)	225.5 (255)	307.5 (307.5)	110	90	20F1ANC205JN0NNNNN	6
248 (186)	272.8 (279)	372 (372)	200	150	20F1AND248AN0NNNNN	260 (205)	286 (307.5)	390 (390)	132	110	20F1ANC260JN0NNNNN	6
302 (248)	332.2 (372)	453 (453)	250	200	20F1AND302AN0NNNNN	302 (260)	332.2 (390)	453 (468)	160	132	20F1ANC302JN0NNNNN	7
361 (302)	397.1 (453)	541.5 (543.6)	300	250	20F1AND361AN0NNNNN	367 (302)	403.7 (453)	550.5 (550.5)	200	160	20F1ANC367JN0NNNNN	7
415 (361)	456.5 (541.5)	622.5 (649.8)	350	300	20F1AND415AN0NNNNN	456 (367)	501.6 (550.5)	684 (684)	250	200	20F1ANC456JN0NNNNN	7

✶ The 11th character determines default Filtering and Common Mode Cap jumper configuration. "J" = Installed, "A" = Removed.

❄ Frames 2…5 are IP20, Frames 6…7 are IP00.

‡ Some drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

IP54, NEMA/UL Type 12

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps ‡			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ‡			Normal Duty kW	Heavy Duty kW	Cat. No.	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	3.1	3.7	1	1	20F11GD2P1AA0NNNNN	2.1	3.1	3.7	0.75	0.75	20F11GC2P1∗A0NNNNN	2
3.4	5.1	6.1	2	2	20F11GD3P4AA0NNNNN	3.5	5.2	6.3	1.5	1.5	20F11GC3P5∗A0NNNNN	2
5	7.5	9	3	3	20F11GD5P0AA0NNNNN	5	7.5	9.0	2.2	2.2	20F11GC5P0∗A0NNNNN	2
8	12	14.4	5	5	20F11GD8P0AA0NNNNN	8.7	13	15.6	4	4	20F11GC8P7∗A0NNNNN	2
11	16.5	19.8	7.5	7.5	20F11GD011AA0NNNNN	11.5	17.2	20.7	5.5	5.5	20F11GC011∗A0NNNNN	2
14 (11)	15.4 (16.5)	21 (21)	10	7.5	20F11GD014AA0NNNNN	15.4 (11.5)	16.9 (17.3)	23.1 (23.1)	7.5	5.5	20F11GC015∗A0NNNNN	2
22 (14)	24.2 (21)	33 (33)	15	10	20F11GD022AA0NNNNN	22 (15.4)	24.2 (23.1)	33 (33)	11	7.5	20F11GC022∗A0NNNNN	2
27 (22)	29.7 (33)	40.5 (40.5)	20	15	20F11GD027AA0NNNNN	30 (22)	33 (33)	45 (45)	15	11	20F11GC030∗A0NNNNN	3
34 (27)	37.4 (40.5)	51 (51)	25	20	20F11GD034AA0NNNNN	37 (30)	40.7 (45)	55.5 (55.5)	18.5	15	20F11GC037∗A0NNNNN	3
40 (34)	44 (51)	60 (61.2)	30	25	20F11GD040AA0NNNNN	43 (37)	47.3 (55.5)	64.5 (66.6)	22	18.5	20F11GC043∗A0NNNNN	3
52 (40)	57.2 (60)	78 (78)	40	30	20F11GD052AA0NNNNN	60 (43)	66 (66)	90 (90)	30	22	20F11GC060∗A0NNNNN	4
65 (52)	71.5 (78)	97.5 (97.5)	50	40	20F11GD065AA0NNNNN	72 (60)	79.2 (90)	108 (108)	37	30	20F11GC072∗A0NNNNN	5
77 (65)	84.7 (97.5)	115.5 (117)	60	50	20F11GD077AA0NNNNN	85 (72)	93.5 (108)	127.5 (129.6)	45	37	20F11GC085∗A0NNNNN	5
96 (77)	105.6 (115.5)	144 (144)	75	60	20F1AGD096AN0NNNNN	104 (85)	114.4 (127.5)	156 (156)	55	45	20F1AGC104∗N0NNNNN	6
125 (96)	137.5 (144)	187.5 (187.5)	100	75	20F1AGD125AN0NNNNN	140 (104)	154 (156)	210 (210)	75	55	20F1AGC140∗N0NNNNN	6
156 (125)	171.6 (187.5)	234 (234)	125	100	20F1AGD156AN0NNNNN	170 (140)	187 (210)	255 (255)	90	75	20F1AGC170∗N0NNNNN	6
186 (156)	204.6 (234)	279 (280.8)	150	125	20F1AGD186AN0NNNNN	205 (170)	225.5 (255)	307.5 (307.5)	110	90	20F1AGC205∗N0NNNNN	6
248 (186)	272.8 (279)	372 (372)	200	150	20F1AGD248AN0NNNNN	260 (205)	286 (307.5)	390 (390)	132	110	20F1AGC260∗N0NNNNN	7
302 (248)	332.2 (372)	453 (453)	250	200	20F1AGD302AN0NNNNN	302 (260)	332.2 (390)	453 (468)	160	132	20F1AGC302∗N0NNNNN	7
361 (302)	397.1 (453)	541.5 (543.6)	300	250	20F1AGD361AN0NNNNN	367 (302)	403.7 (453)	550.5 (550.5)	200	160	20F1AGC367∗N0NNNNN	7
415 (361)	456.5 (541.5)	622.5 (649.8)	350	300	20F1AGD415AN0NNNNN	456 (367)	501.6 (550.5)	684 (684)	250	200	20F1AGC456∗N0NNNNN	7

∗ The 11th character determines default Filtering and Common Mode Cap jumper configuration. "J" = Installed, "A" = Removed.

‡ Some drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

Flange Mount
Front = IP20, NEMA/UL Type Open, Back/Heatsink = IP66, NEMA/UL Type 4X

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						
Output Amps ‡			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ‡			Normal Duty kW	Heavy Duty kW	Cat. No.	Frame Size
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	3.1	3.7	1	1	20F11FD2P1AA0NNNNN	2.1	3.1	3.7	0.75	0.75	20F11FC2P1∗A0NNNNN	2
3.4	5.1	6.1	2	2	20F11FD3P4AA0NNNNN	3.5	5.2	6.3	1.5	1.5	20F11FC3P5∗A0NNNNN	2
5	7.5	9	3	3	20F11FD5P0AA0NNNNN	5	7.5	9.0	2.2	2.2	20F11FC5P0∗A0NNNNN	2
8	12	14.4	5	5	20F11FD8P0AA0NNNNN	8.7	13	15.6	4	4	20F11FC8P7∗A0NNNNN	2
11	16.5	19.8	7.5	7.5	20F11FD011AA0NNNNN	11.5	17.2	20.7	5.5	5.5	20F11FC011∗A0NNNNN	2
14 (11)	15.4 (16.5)	21 (21)	10	7.5	20F11FD014AA0NNNNN	15.4 (11.5)	16.9 (17.3)	23.1 (23.1)	7.5	5.5	20F11FC015∗A0NNNNN	2
22 (14)	24.2 (21)	33 (33)	15	10	20F11FD022AA0NNNNN	22 (15.4)	24.2 (23.1)	33 (33)	11	7.5	20F11FC022∗A0NNNNN	2
27 (22)	29.7 (33)	40.5 (40.5)	20	15	20F11FD027AA0NNNNN	30 (22)	33 (33)	45 (45)	15	11	20F11FC030∗A0NNNNN	3
34 (27)	37.4 (40.5)	51 (51)	25	20	20F11FD034AA0NNNNN	37 (30)	40.7 (45)	55.5 (55.5)	18.5	15	20F11FC037∗A0NNNNN	3
40 (34)	44 (51)	60 (61.2)	30	25	20F11FD040AA0NNNNN	43 (37)	47.3 (55.5)	64.5 (66.6)	22	18.5	20F11FC043∗A0NNNNN	3
52 (40)	57.2 (60)	78 (78)	40	30	20F11FD052AA0NNNNN	60 (43)	66 (66)	90 (90)	30	22	20F11FC060∗A0NNNNN	4
65 (52)	71.5 (78)	97.5 (97.5)	50	40	20F11FD065AA0NNNNN	72 (60)	79.2 (90)	108 (108)	37	30	20F11FC072∗A0NNNNN	4
77 (65)	84.7 (97.5)	115.5 (117)	60	50	20F11FD077AA0NNNNN	85 (72)	93.5 (108)	127.5 (129.6)	45	37	20F11FC085∗A0NNNNN	5
96 (77)	105.6 (115.5)	144 (144)	75	60	20F11FD096AA0NNNNN	104 (85)	114.4 (127.5)	156 (156)	55	45	20F11FC104∗A0NNNNN	5

∗ The 11th character determines default Filtering and Common Mode Cap jumper configuration. "J" = Installed, "A" = Removed.

‡ Some drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

Note: Frames 6…7 require a user installed flange kit with an IP00, NEMA/UL Type Open drive.



Designed for ease of integration, application flexibility and performance the PowerFlex 755 AC drive provides improved functionality across many manufacturing systems. The PowerFlex 755 AC drive is designed to maximize user's investment and help improve productivity. Ideal for applications that require safety, high motor control performance, and application flexibility, the PowerFlex 755 is highly functional and cost effective solution.

Ratings	380…480V: 0.75…250 kW / 1…350 Hp / 2.1…456 A
Motor Control	• V/Hz Control • Vector Control with FORCE Technology • Sensorless Vector Control • Permanent Magnet Motor Control
Communications	Embedded EtherNet/IP port standard, Common Industrial Protocol
User Interface	HIM (option)
Enclosures	IP00/IP20, Flange Mount, IP54/NEMA/UL Type 12
Safety	• Safe Torque-Off PLe/SIL3 Cat. 3 • Safe Speed Monitor PLe/SIL3 Cat. 4
Additional Features	• DeviceLogix • Preventative Diagnostics • Five option slots for I/O, feedback, safety, auxiliary control power, communications • Accurate positioning with PCAM, Indexer, Electronic Gearing, and speed/position profiling • Incremental and Absolute feedback supported • TorqProve for lifting applications • Conformal Coating
Certifications	• UL • cUL • CE • C-Tick • SEMI F47 • GOST-R • TÜV FS ISO/EN13849-1 (EN954-1) with Safe Torque-Off option • Meets material restrictions specified in the RoHS directive
Options	See pages 6-65…6-74

IP00/IP20, NEMA/UL Type Open ❄

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps ‡			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ‡			Normal Duty kW	Heavy Duty kW	Cat. No. ✶	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	3.1	3.7	1	1	20G11ND2P1AA0NNNNN	2.1	3.1	3.7	0.75	0.75	20G11NC2P1✶A0NNNNN	2 §
3.4	5.1	6.1	2	2	20G11ND3P4AA0NNNNN	3.5	5.2	6.3	1.5	1.5	20G11NC3P5✶A0NNNNN	2 §
5	7.5	9	3	3	20G11ND5P0AA0NNNNN	5	7.5	9.0	2.2	2.2	20G11NC5P0✶A0NNNNN	2 §
8	12	14.4	5	5	20G11ND8P0AA0NNNNN	8.7	13	15.6	4	4	20G11NC8P7✶A0NNNNN	2 §
11	16.5	19.8	7.5	7.5	20G11ND011AA0NNNNN	11.5	17.2	20.7	5.5	5.5	20G11NC011✶A0NNNNN	2 §
14 (11)	15.4 (16.5)	21 (21)	10	7.5	20G11ND014AA0NNNNN	15.4 (11.5)	16.9 (17.3)	23.1 (23.1)	7.5	5.5	20G11NC015✶A0NNNNN	2
22 (14)	24.2 (21)	33 (33)	15	10	20G11ND022AA0NNNNN	22 (15.4)	24.2 (23.1)	33 (33)	11	7.5	20G11NC022✶A0NNNNN	2
27 (22)	29.7 (33)	40.5 (40.5)	20	15	20G11ND027AA0NNNNN	30 (22)	33 (33)	45 (45)	15	11	20G11NC030✶A0NNNNN	3
34 (27)	37.4 (40.5)	51 (51)	25	20	20G11ND034AA0NNNNN	37 (30)	40.7 (45)	55.5 (55.5)	18.5	15	20G11NC037✶A0NNNNN	3
40 (34)	44 (51)	60 (61.2)	30	25	20G11ND040AA0NNNNN	43 (37)	47.3 (55.5)	64.5 (66.6)	22	18.5	20G11NC043✶A0NNNNN	3
52 (40)	57.2 (60)	78 (78)	40	30	20G11ND052AA0NNNNN	60 (43)	66 (66)	90 (90)	30	22	20G11NC060✶A0NNNNN	4
65 (52)	71.5 (78)	97.5 (97.5)	50	40	20G11ND065AA0NNNNN	72 (60)	79.2 (90)	108 (108)	37	30	20G11NC072✶A0NNNNN	4
77 (65)	84.7 (97.5)	115.5 (117)	60	50	20G11ND077AA0NNNNN	85 (72)	93.5 (108)	127.5 (129.6)	45	37	20G11NC085✶A0NNNNN	5
96 (77)	105.6 (115.5)	144 (144)	75	60	20G11ND096AA0NNNNN	104 (85)	114.4 (127.5)	156 (156)	55	45	20G11NC104✶A0NNNNN	5
125 (96)	137.5 (144)	187.5 (187.5)	100	75	20G1AND125AN0NNNNN	140 (104)	154 (156)	210 (210)	75	55	20G1ANC140✶N0NNNNN	6
156 (125)	171.6 (187.5)	234 (234)	125	100	20G1AND156AN0NNNNN	170 (140)	187 (210)	255 (255)	90	75	20G1ANC170✶N0NNNNN	6
186 (156)	204.6 (234)	279 (280.8)	150	125	20G1AND186AN0NNNNN	205 (170)	225.5 (255)	307.5 (307.5)	110	90	20G1ANC205✶N0NNNNN	6
248 (186)	272.8 (279)	372 (372)	200	150	20G1AND248AN0NNNNN	260 (205)	286 (307.5)	390 (390)	132	110	20G1ANC260✶N0NNNNN	6
302 (248)	332.2 (372)	453 (453)	250	200	20G1AND302AN0NNNNN	302 (260)	332.2 (390)	453 (468)	160	132	20G1ANC302✶N0NNNNN	7
361 (302)	397.1 (453)	541.5 (543.6)	300	250	20G1AND361AN0NNNNN	367 (302)	403.7 (453)	550.5 (550.5)	200	160	20G1ANC367✶N0NNNNN	7
415 (361)	456.5 (541.5)	622.5 (649.8)	350	300	20G1AND415AN0NNNNN	456 (367)	501.6 (550.5)	684 (684)	250	200	20G1ANC456✶N0NNNNN	7

✶ The 11th character determines default Filtering and Common Mode Cap jumper configuration. "J" = Installed, "A" = Removed.

❄ Frames 2…5 are IP20, Frames 6…7 are IP00.

‡ These drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

§ Contact your local Rockwell Automation sales office or Allen-Bradley distributor for availability.

IP54, NEMA/UL Type 12

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps ‡			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ‡			Normal Duty kW	Heavy Duty kW	Cat. No. ∗	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	3.1	3.7	1	1	20G11GD2P1AA0NNNNN	2.1	3.1	3.7	0.75	0.75	20G11GC2P1∗A0NNNNN	2 §
3.4	5.1	6.1	2	2	20G11GD3P4AA0NNNNN	3.5	5.2	6.3	1.5	1.5	20G11GC3P5∗A0NNNNN	2 §
5	7.5	9	3	3	20G11GD5P0AA0NNNNN	5	7.5	9.0	2.2	2.2	20G11GC5P0∗A0NNNNN	2 §
8	12	14.4	5	5	20G11GD8P0AA0NNNNN	8.7	13	15.6	4	4	20G11GC8P7∗A0NNNNN	2 §
11	16.5	19.8	7.5	7.5	20G11GD011AA0NNNNN	11.5	17.2	20.7	5.5	5.5	20G11GC011∗A0NNNNN	2 §
14 (11)	15.4 (16.5)	21 (21)	10	7.5	20G11GD014AA0NNNNN	15.4 (11.5)	16.9 (17.3)	23.1 (23.1)	7.5	5.5	20G11GC015∗A0NNNNN	2
22 (14)	24.2 (21)	33 (33)	15	10	20G11GD022AA0NNNNN	22 (15.4)	24.2 (23.1)	33 (33)	11	7.5	20G11GC022∗A0NNNNN	2
27 (22)	29.7 (33)	40.5 (40.5)	20	15	20G11GD027AA0NNNNN	30 (22)	33 (33)	45 (45)	15	11	20G11GC030∗A0NNNNN	3
34 (27)	37.4 (40.5)	51 (51)	25	20	20G11GD034AA0NNNNN	37 (30)	40.7 (45)	55.5 (55.5)	18.5	15	20G11GC037∗A0NNNNN	3
40 (34)	44 (51)	60 (61.2)	30	25	20G11GD040AA0NNNNN	43 (37)	47.3 (55.5)	64.5 (66.6)	22	18.5	20G11GC043∗A0NNNNN	3
52 (40)	57.2 (60)	78 (78)	40	30	20G11GD052AA0NNNNN	60 (43)	66 (66)	90 (90)	30	22	20G11GC060∗A0NNNNN	4
65 (52)	71.5 (78)	97.5 (97.5)	50	40	20G11GD065AA0NNNNN	72 (60)	79.2 (90)	108 (108)	37	30	20G11GC072∗A0NNNNN	5
77 (65)	84.7 (97.5)	115.5 (117)	60	50	20G11GD077AA0NNNNN	85 (72)	93.5 (108)	127.5 (129.6)	45	37	20G11GC085∗A0NNNNN	5
96 (77)	105.6 (115.5)	144 (144)	75	60	20G1AGD096AN0NNNNN	104 (85)	114.4 (127.5)	156 (156)	55	45	20G1AGC104∗N0NNNNN	6
125 (96)	137.5 (144)	187.5 (187.5)	100	75	20G1AGD125AN0NNNNN	140 (104)	154 (156)	210 (210)	75	55	20G1AGC140∗N0NNNNN	6
156 (125)	171.6 (187.5)	234 (234)	125	100	20G1AGD156AN0NNNNN	170 (140)	187 (210)	255 (255)	90	75	20G1AGC170∗N0NNNNN	6
186 (156)	204.6 (234)	279 (280.8)	150	125	20G1AGD186AN0NNNNN	205 (170)	225.5 (255)	307.5 (307.5)	110	90	20G1AGC205∗N0NNNNN	6
248 (186)	272.8 (279)	372 (372)	200	150	20G1AGD248AN0NNNNN	260 (205)	286 (307.5)	390 (390)	132	110	20G1AGC260∗N0NNNNN	7
302 (248)	332.2 (372)	453 (453)	250	200	20G1AGD302AN0NNNNN	302 (260)	332.2 (390)	453 (468)	160	132	20G1AGC302∗N0NNNNN	7
361 (302)	397.1 (453)	541.5 (543.6)	300	250	20G1AGD361AN0NNNNN	367 (302)	403.7 (453)	550.5 (550.5)	200	160	20G1AGC367∗N0NNNNN	7
415 (361)	456.5 (541.5)	622.5 (649.8)	350	300	20G1AGD415AN0NNNNN	456 (367)	501.6 (550.5)	684 (684)	250	200	20G1AGC456∗N0NNNNN	7

∗ The 11th character determines default Filtering and Common Mode Cap jumper configuration. "J" = Installed, "A" = Removed.

‡ Some drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

§ Contact your local Rockwell Automation sales office or Allen-Bradley distributor for availability.

Flange Mount
Front = IP20, NEMA/UL Type Open, Back/Heatsink = IP66, NEMA/UL Type 4X

380…480V AC, Three-Phase Drives

480V AC Input						400V AC Input						Frame Size
Output Amps ‡			Normal Duty Hp	Heavy Duty Hp	Cat. No.	Output Amps ‡			Normal Duty kW	Heavy Duty kW	Cat. No. ∗	
Cont.	1 Min.	3 Sec.				Cont.	1 Min.	3 Sec.				
2.1	3.1	3.7	1	1	20G11FD2P1AA0NNNNN	2.1	3.1	3.7	0.75	0.75	20G11FC2P1∗A0NNNNN	2 §
3.4	5.1	6.1	2	2	20G11FD3P4AA0NNNNN	3.5	5.2	6.3	1.5	1.5	20G11FC3P5∗A0NNNNN	2 §
5	7.5	9	3	3	20G11FD5P0AA0NNNNN	5	7.5	9.0	2.2	2.2	20G11FC5P0∗A0NNNNN	2 §
8	12	14.4	5	5	20G11FD8P0AA0NNNNN	8.7	13	15.6	4	4	20G11FC8P0∗A0NNNNN	2 §
11	16.5	19.8	7.5	7.5	20G11FD011AA0NNNNN	11.5	17.2	20.7	5.5	5.5	20G11FC011∗A0NNNNN	2 §
14 (11)	15.4 (16.5)	21 (21)	10	7.5	20G11FD014AA0NNNNN	15.4 (11.5)	16.9 (17.3)	23.1 (23.1)	7.5	5.5	20G11FC015∗A0NNNNN	2
22 (14)	24.2 (21)	33 (33)	15	10	20G11FD022AA0NNNNN	22 (15.4)	24.2 (23.1)	33 (33)	11	7.5	20G11FC022∗A0NNNNN	2
27 (22)	29.7 (33)	40.5 (40.5)	20	15	20G11FD027AA0NNNNN	30 (22)	33 (33)	45 (45)	15	11	20G11FC030∗A0NNNNN	3
34 (27)	37.4 (40.5)	51 (51)	25	20	20G11FD034AA0NNNNN	37 (30)	40.7 (45)	55.5 (55.5)	18.5	15	20G11FC037∗A0NNNNN	3
40 (34)	44 (51)	60 (61.2)	30	25	20G11FD040AA0NNNNN	43 (37)	47.3 (55.5)	64.5 (66.6)	22	18.5	20G11FC043∗A0NNNNN	3
52 (40)	57.2 (60)	78 (78)	40	30	20G11FD052AA0NNNNN	60 (43)	66 (66)	90 (90)	30	22	20G11FC060∗A0NNNNN	4
65 (52)	71.5 (78)	97.5 (97.5)	50	40	20G11FD065AA0NNNNN	72 (60)	79.2 (90)	108 (108)	37	30	20G11FC072∗A0NNNNN	4
77 (65)	84.7 (97.5)	115.5 (117)	60	50	20G11FD077AA0NNNNN	85 (72)	93.5 (108)	127.5 (129.6)	45	37	20G11FC085∗A0NNNNN	5
96 (77)	105.6 (115.5)	144 (144)	75	60	20G11FD096AA0NNNNN	104 (85)	114.4 (127.5)	156 (156)	55	45	20G11FC104∗A0NNNNN	5

∗ The 11th character determines default Filtering and Common Mode Cap jumper configuration. "J" = Installed, "A" = Removed.

‡ Some drives have dual current ratings; one for normal duty applications, and one for heavy duty applications (in parenthesis). The drive may be operated at either rating.

Note: Frames 6…7 require a user installed flange kit with an IP00, NEMA/UL Type Open drive.

§ Contact your local Rockwell Automation sales office or Allen-Bradley distributor for availability.

Human Interface and Wireless Interface Modules


Blank Plate


20-HIM-A3


20-HIM-A5


20-HIM-A6


20-HIM-C3S


20-HIM-C5S


20-HIM-C6S


20-WIM-N1


20-WIM-N4S

Human Interface and Wireless Interface Modules

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
No HIM (Blank Plate), Handheld/Local (Drive Mount)	20-HIM-A0	✓	✓	✓	✓	✓
LCD Display, Full Numeric Keypad, Handheld/Local (Drive Mount)	20-HIM-A3	✓	✓	✓	✓	
LCD Display, Programmer Only, Handheld/Local (Drive Mount)	20-HIM-A5	✓	✓	✓	✓	
Enhanced, LCD, Full Numeric, Handheld/Local (Drive Mount)	20-HIM-A6	✓	✓	✓	✓	✓
Remote (Panel Mount) LCD Display, Full Numeric Keypad ✶❄	20-HIM-C3S	✓	✓	✓	✓	
Remote (Panel Mount) LCD Display, Programmer Only ✶❄	20-HIM-C5S	✓	✓	✓	✓	
Enhanced, LCD, Full Numeric ✶❄	20-HIM-C6S	✓	✓	✓	✓	✓
Wireless Interface Module, Handheld/Local (Drive Mount)	20-WIM-N1	✓	✓	✓	✓	✓
Wireless Interface Module, Remote (Panel Mount) ✶❄	20-WIM-N4S	✓	✓	✓	✓	✓

✶ IP66, NEMA Type 4X/12 - For indoor use only.
❄ Includes a 1202-C30 interface cable (3 meters) for connection to drive.

Human Interface Module Accessories

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
Bezel Kit for LCD HIMs, NEMA Type 1 ❄	20-HIM-B1	✓	✓	✓	✓	✓
PowerFlex HIM Interface Cable, 1 m (39 in) §	20-HIM-H10	✓	✓	✓	✓	✓
Comm Option Cable Kit (Male-Male)						
0.33 m (1.1 ft)	1202-C03	✓	✓	✓	✓	✓
1 m (3.3 ft)	1202-C10	✓	✓	✓	✓	✓
3 m (9.8 ft)	1202-C30	✓	✓	✓	✓	✓
9 m (29.5 ft)	1202-C90	✓	✓	✓	✓	✓
Cable Kit (Male-Female) ♣						
0.33 m (1.1 ft)	1202-H03	✓	✓	✓	✓	✓
1 m (3.3 ft)	1202-H10	✓	✓	✓	✓	✓
3 m (9.8 ft)	1202-H30	✓	✓	✓	✓	✓
9 m (29.5 ft)	1202-H90	✓	✓	✓	✓	✓
DPI™ Cable Kit with Connectors, Tools and 100 m (328 ft) Cable	1202-CBL-KIT-100M	✓	✓	✓	✓	✓
DPI Cable Connector Kit	1202-TB-KIT-SET	✓	✓	✓	✓	✓
DPI/SCANport™ One to Two Port Splitter Cable	1203-S03	✓	✓	✓	✓	✓

❄ Includes a 1202-C30 interface cable (3 meters) for connection to drive.
§ Required only when HIM is used as handheld or remote.
♣ Required in addition to 20-HIM-H10 for distances up to a total maximum of 10 m (32.8 ft).

Communication Accessories

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
Serial Null Modem Adapter	1203-SNM	✓	✓	✓	✓	✓
Smart Self-powered Serial Converter (RS232) includes 1203-SFC and 1202-C10 Cables	1203-SSS	✓	✓	✓	✓	✓
Universal Serial Bus™ (USB) Converter includes 2 m USB, 20-HIM-H10 & 22-HIM-H10 Cables	1203-USB	✓	✓	✓	✓	✓
ControlNet Ex Right-Angle T-Tap	1786-TPR			✓	✓	✓
Communication Carrier Card	20-750-20COMM					✓

Communication Option Kits

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
BACnet® MS/TP RS485 Communication Adapter	20-COMM-B	✓	✓			
ControlNet™ Communication Adapter (Coax)	20-COMM-C	✓	✓	✓	✓	✓ ‡
ControlNet™ Communication Adapter (Coax) Conformal Coat	20-COMM-C-MX3	✓	✓	✓	✓	✓ ‡
DeviceNet Option Module	20-750-DNET					✓
DeviceNet™ Communication Adapter	20-COMM-D	✓	✓	✓	✓	✓ ‡
DeviceNet™ Communication Adapter Conformal Coat	20-COMM-D-MX3	✓	✓	✓	✓	✓ ‡
EtherNet/IP™ Communication Adapter	20-COMM-E	✓	✓	✓	✓	✓ ‡
EtherNet/IP™ Communication Adapter Conformal Coat	20-COMM-E-MX3	✓	✓	✓	✓	✓ ‡
HVAC Communication Adapter	20-COMM-H	✓	✓	✓ ⌘		✓ ⌘‡
Interbus™ Communication Adapter	20-COMM-I	✓	✓	✓	✓	✓ ‡
CANopen® Communication Adapter	20-COMM-K	✓	✓	✓	✓	✓ ‡
LonWorks® Communication Adapter	20-COMM-L	✓	✓			
Modbus/TCP Communication Adapter	20-COMM-M	✓	✓	✓	✓	✓ ‡
PROFIBUS™ DP Communication Adapter	20-COMM-P	✓	✓	✓	✓	✓ ‡
ControlNet™ Communication Adapter (Fiber)	20-COMM-Q	✓	✓	✓	✓	✓ ‡
Remote I/O Communication Adapter	20-COMM-R	✓	✓	✓	✓	✓ ‡
Remote I/O Communication Adapter Conformal Coat	20-COMM-R-MX3	✓	✓	✓	✓	✓ ‡
RS485 DF1 Communication Adapter	20-COMM-S	✓	✓	✓	✓	✓ ‡
RS485 DF1 Communication Adapter Conformal Coat	20-COMM-S-MX3	✓	✓	✓	✓	✓ ‡
External Communications Kit Power Supply	20-XCOMM-AC-PS1	✓	✓	✓	✓	✓
DPI External Communications Kit	20-XCOMM-DC-BASE	✓	✓	✓	✓	✓
External DPI I/O Option Board ➢	20-XCOMM-IO-OPT1	✓	✓	✓	✓	✓
Compact I/O Module (3 Channel)	1769-SM1	✓	✓	✓	✓	✓
DriveLogix ControlNet Communication Adapter (Coax) ❄	1788-CNC			✓	✓ ✦	
DriveLogix Comm Option, ControlNet Redundant (Coax) ❄	1788-CNCR			✓	✓ ✦	
DriveLogix Comm Option, ControlNet (Fiber) ❄	1788-CNF			✓	✓ ✦	
DriveLogix Comm Option, ControlNet Redundant (Fiber) ❄	1788-CNFR			✓	✓ ✦	
DriveLogix Comm Option, DeviceNet (Open Conn.) ❄	1788-DNBO			✓	✓ ✦	
DriveLogix Comm Option, EtherNet/IP (Twisted Pair) ❄	1788-ENBT			✓	✓ ✦	
DriveLogix5730 Comm Option, Embedded EtherNet/IP	20D-DL2-ENET0			✓	✓ ✦	

➢ For use only with DPI External Communications Kits 20-XCOMM-DC-BASE.
⌘ Only Modbus RTU can be used (PowerFlex 700 - Vector Control only).
❄ For use with DriveLogix option only. Requires Logix Expansion Board (20D-DL2-LEB0).
‡ Requires a Communication Carrier Card (20-750-20COMM). Refer to page 6-67 for compatibility details.
✦ When using a PowerFlex 700S control.

Feedback Options

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
5V/12V Encoder ❖	20A-ENC-1	✓				
12V/5V Encoder	20B-ENC-1				✓ ♠	
12V/5V Encoder with Conformal Coat	20B-ENC-1-MX3					
Multi-Device Interface ➢	20D-MDI-C2			✓	✓ ✦	
2nd Encoder, 5V/12V ➢	20D-P2-ENC0			✓	✓ ✦	
Resolver ➢	20D-RES-A1			✓	✓ ✦	
Stegmann High Resolution Hyperface Encoder ➢	20D-STEG-B1			✓	✓ ✦	
Heidenhain High Resolution EnDat Encoder	20D-HEID-D0			✓	✓ ✦	
Incremental Encoder	20-750-ENC-1					✓
Dual Incremental Encoder	20-750-DENC-1					✓
Universal Feedback (includes Stegmann, Heidenhain, SSI, Biss, Incremental)	20-750-UFB-1					✓ ✶

❖ Works only with PowerFlex 70 Enhanced Control.
➢ Requires Expanded Cassette
♠ When using a PowerFlex 700 with Vector Control.
✶ PowerFlex 755 only.
✦ When using a PowerFlex 700S control.

PowerFlex 750-Series Legacy Communication Options

Most legacy communication adapters (20-COMM) can be used with the PowerFlex 755. However, the restrictions stated below do apply.

Adapter	Accesses Ports 1…6 for I/O	Accesses Port 7…14 Devices	Supports Drive Add On Profiles	Supports Asian-Languages ➢
20-COMM-B	Not Compatible			
20-COMM-C	✓❄	✓ v3.001 §	✓ ♣	✓ v3.001 §
20-COMM-D		✓ v2.005 §	Not Compatible	
20-COMM-E		✓ v4.001 §	✓ ♣	✓ v4.001 §
20-COMM-H	✓‡	Not Compatible		
20-COMM-I	✓❄			
20-COMM-K				
20-COMM-L	Not Compatible			
20-COMM-M	✓❄	✓ v2.001 §	Not Compatible	✓ v2.001 §
20-COMM-P		Not Compatible		
20-COMM-Q		✓ v3.001 §	✓ ♣	✓ v3.001 §
20-COMM-R		Not Compatible		
20-COMM-S				

❄ Controller must be capable of reading/writing 32-bit floating point (REAL) values.
‡ Only works in the Modbus RTU mode.
§ Requires this adapter firmware version or higher.
♣ Requires firmware version v1.05 or higher of the drive Add On Profiles for RSLogix 5000 version v16 or higher.
➢ Chinese, Japanese, and Korean languages are supported at the time of publication.

I/O Option Kits

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
24V DC Digital Inputs (6) w/Analog I/O (4), Slot A ⌘	20C-DA1-A		✓			
115V AC Digital Inputs (6) w/Analog I/O (4), Slot A ⌘	20C-DA1-B		✓			
115V AC Digital Outputs (3), Slot B ⌘	20C-DO1		✓			
24V DC I/O with 2 Analog In, 2 Analog Out, 6 Digital In and 2 Relay Outputs	20-750-2262C-2R					✓
115V AC I/O with 2 Analog In, 2 Analog Out, 6 Digital In and 2 Relay Outputs	20-750-2262D-2R					✓
24V DC I/O with 2 Analog In, 2 Analog Out, 6 Digital In, 3 Digital Out, 1 Relay & 2 Transistor Outputs	20-750-2263C-1R2T					✓

⌘ Only one card allowed per slot.

Safety Options

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
DriveGuard Safe Torque-Off	20A-DG01	✓				
DriveGuard Safe Torque-Off w/2nd Encoder	20D-P2-DG01			✓	✓ ✦	
DriveGuard Safe Torque-Off (ATEX capable) ⌘	20C-DG1		✓			
Safe Torque-Off	20-750-S					✓
Safe Speed Monitor	20-750-S1					✓

⌘ Only one card allowed per slot.
✦ When using PowerFlex 700S control.

PowerFlex 750-Series Option Kits

Description		Frame	Cat. No.	Used with PowerFlex Drive				
				70	700H	700S	700L	753/755
Flange Adapter Kits	Converts Open Type drive to external heatsink (flange) with NEMA/UL Type 1 integrity backside ✶	2	20-750-FLNG1-F2					✓
		3	20-750-FLNG1-F3					✓
		4	20-750-FLNG1-F4					✓
		5	20-750-FLNG1-F5					✓
	Converts Open Type drive to external heatsink (flange) with NEMA/UL Type 4X/12 integrity backside	6	20-750-FLNG4-F6					✓
		7	20-750-FLNG4-F7					✓
EMC Option Kits	EMC Plate with Core	2	20-750-EMC1-F2					✓
	EMC Plate with Core	3	20-750-EMC1-F3					✓
	EMC Plate with Cores	4	20-750-EMC1-F4					✓
	EMC Plate with Cores	5	20-750-EMC1-F5					✓
	EMC Core	2	20-750-EMC2-F2					✓
	EMC Core	3	20-750-EMC2-F3					✓
	EMC Cores	4…5	20-750-EMC2-F45					✓
NEMA/UL Type 1 Option Kits	NEMA/UL Type 1 Kit	2	20-750-NEMA1-F2					✓
	NEMA/UL Type 1 Kit	3	20-750-NEMA1-F3					✓
	NEMA/UL Type 1 Kit	4	20-750-NEMA1-F4					✓
	NEMA/UL Type 1 Kit	5	20-750-NEMA1-F5					✓
	NEMA/UL Type 1 Kit	6	20-750-NEMA1-F6					✓
	NEMA/UL Type 1 Kit	7	20-750-NEMA1-F7					✓
DC Bus Bar Option Kits	DC Bus Bars	6	20-750-DCBB1-F6					✓
		7	20-750-DCBB1-F7					✓

✶ This kit is for use with IP20, NEMA/UL Type 0 drives and **will not provide** an air-tight or water-tight seal. Where sealing is required (e.g. contaminated, dirty or wet environments), a drive with an "F" enclosure option must be used.

Other Options

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
115V AC Interface	AK-M9-115VAC-1	✓				
Frame E Flange Gasket	AK-M9-GASKET1-E4	✓				
Service Connection Board ❄	SK-M9-SCB1	✓				
Removable I/O Terminal Block	SK-G9-TB1-S1					
Removable Encoder Terminal Block	SK-G9-TB1-ENC1					
Touch Cover - Converts IP00/Open Type drive to IP20/NEMA/UL Type 1. No wiring space provided.	20-OPT-TC		✓			
Top Hat- Converts IP00/Open Type drive to IP20/NEMA/UL Type 1. Allows for wiring space.	20-OPT-TH		✓			
Auxiliary Control Power Supply	20-24V-AUX1			✓		
24V Aux Power Supply	20-750-APS					✓
PowerFlex 700S Phase II Control with Expanded Cassette	20D-P2-CKE1			✓	✓ ✦	
PowerFlex 700S Phase II Control with Slim Cassette	20D-P2-CKS1			✓		
PowerFlex 700S DriveLogix5730 Phase II Control with Expanded Cassette	20D-DL2-CKE1			✓	✓ ✦	
PowerFlex 700S DriveLogix5730 Phase II Control with Slim Cassette	20D-DL2-CKS1			✓		

❄ Provides temporary DPI/HIM connection for NEMA/UL Type 1 and Flange drives with cover removed.
✦ When using PowerFlex 700S control and Expanded Cassette.

SynchLink™ Accessories

Description ✶	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
SynchLink Board	20D-P2-SLB0			✓	✓ ✦	
SynchLink Fiber Base Block	1751-SLBA			✓	✓ ✦	
SynchLink 4-port Fiber Splitter Block	1751-SL4SP			✓	✓ ✦	
SynchLink Fiber Bypass Switch Block	1751-SLBP			✓	✓ ✦	
2x1 Meter Fiber Link for Power Monitor/SynchLink	1403-CF001			✓	✓ ✦	
2x3 Meter Fiber Link for Power Monitor/SynchLink	1403-CF003			✓	✓ ✦	
2x5 Meter Fiber Link for Power Monitor/SynchLink	1403-CF005			✓	✓ ✦	
10 Meter Fiber Link for Power Monitor/SynchLink	1403-CF010			✓	✓ ✦	
20 Meter Fiber Link for Power Monitor/SynchLink	1403-CF020			✓	✓ ✦	
50 Meter Fiber Link for Power Monitor/SynchLink	1403-CF050			✓	✓ ✦	
100 Meter Fiber Link for Power Monitor/SynchLink	1403-CF100			✓	✓ ✦	
250 Meter Fiber Link for Power Monitor/SynchLink	1403-CF250			✓	✓ ✦	

✶ Refer to publication number 1769-SG001 for details on SynchLink.
✦ When using PowerFlex 700S control.

DriveLogix Option Kits

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
Logix Expansion board for DriveLogix5730 ➢	20D-DL2-LEB0			✓	✓ ✦	
Industrial Compact Flash 64 MB Memory Card for DriveLogix5730	1784-CF64			✓	✓ ✦	

➢ Requires Expanded Cassette.
✦ When using PowerFlex 700S control.

DriveLogix I/O Cables

Description	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
DriveLogix5730 - Compact I/O cable, 3.28 ft. (1 meter), Left Bus Cap ➢§	20D-DL2-CL3			✓	✓ ✦	
DriveLogix5730 - Compact I/O cable, 3.28 ft. (1 meter), Right Bus Cap ➢§	20D-DL2-CR3			✓	✓ ✦	
Logix5000 RS-232 Programming Cable	1756-CP3			✓	✓ ✦	

➢ Requires Expanded Cassette.
§ Refer to Publication 1769-SG001 for details and selection of Compact I/O.
✦ When using PowerFlex 700S control.

PowerFlex 70 Small Duty Internal Dynamic Brake Resistors

Limited duty resistors mount directly to the back surface of the drive and require no extra panel space. Internal resistors are non-destructive and do not require a resistor overheat external safety circuit.

PowerFlex 70 AC Drive			Small Duty Internal DB Resistor								
								Application Type 1		Application Type 2	
Normal Duty∗ [kW (Hp)]	Heavy Duty∗ [kW (Hp)]	Min DB Res [Ohms ±10%]	Cat. No.	Resistance ❄ [Ohms ±5%]	Continuous Power [kW]	Max Energy [kJ]	Max Braking Torque [% of ND Motor]	Braking Torque [% of ND Motor]	Duty Cycle	Braking Torque [% of ND Motor]	Duty Cycle
200…240 Volt AC Input Drives											
0.37 (0.5)	0.25 (0.33)	33	20AB-DB1-A	62	0.048	8.3	307%	100%	25.9%	150%	17.3%
0.75 (1.0)	0.55 (0.75)	33	20AB-DB1-A	62	0.048	7.3	300%	100%	12.8%	150%	8.5%
1.5 (2.0)	1.1 (1.5)	33	20AB-DB1-B	62	0.028	0.8	160%	100%	3.7%	150%	2.5%
2.2 (3.0)	1.5 (2.0)	33	20AB-DB1-B	62	0.028	0.8	109%	100%	2.5%	109%	2.3%
4.0 (5.0)	3.0 (3.0)	30	20AB-DB1-C	62	0.040	0.8	60%	60%	3.3%	N/A	N/A
5.5 (7.5)	4.0 (5.0)	21	20AB-DB1-D	22	0.036	0.9	117%	100%	1.3%	117%	1.1%
7.5 (10)	5.5 (7.5)	21	20AB-DB1-D	22	0.036	0.9	86%	86%	1.1%	N/A	N/A
400…480 Volt AC Input Drives											
0.37 (0.5)	0.25 (0.33)	68	20AD-DB1-A	115	0.048	8.3	320%	100%	25.9%	150%	17.3%
0.75 (1.0)	0.55 (0.75)	68	20AD-DB1-A	115	0.048	9.0	259%	100%	12.8%	150%	8.5%
1.5 (2.0)	1.1 (1.5)	68	20AD-DB1-A	115	0.048	2.4	243%	100%	6.4%	150%	4.3%
2.2 (3.0)	1.5 (2.0)	68	20AD-DB1-B	115	0.028	0.9	206%	100%	2.5%	150%	1.7%
4.0 (5.0)	3.0 (3.0)	68	20AD-DB1-B	115	0.028	0.9	129%	100%	1.4%	129%	1.1%
5.5 (7.5)	4.0 (5.0)	74	20AD-DB1-C	115	0.04	0.9	94%	94%	1.5%	N/A	N/A
7.5 (10)	5.5 (7.5)	74	20AD-DB1-C	115	0.04	0.9	69%	69%	1.5%	N/A	N/A
11 (15)	7.5 (10)	44	20AD-DB1-D	62	0.036	0.8	87%	87%	0.8%	N/A	N/A
15 (20)	11 (15)	31	20AD-DB1-D	62	0.036	0.8	64%	64%	0.8%	N/A	N/A
500…600 Volt AC Input Drives											
0.37 (0.5)	0.25 (0.33)	117	20AD-DB1-A	115	0.048	8.3	287%	100%	25.9%	150%	17.3%
0.75 (1.0)	0.55 (0.75)	117	20AD-DB1-A	115	0.048	9.0	263%	100%	12.8%	150%	8.5%
1.5 (2.0)	1.1 (1.5)	117	20AD-DB1-A	115	0.048	2.4	243%	100%	6.4%	150%	4.3%
2.2 (3.0)	1.5 (2.0)	117	20AD-DB1-B	115	0.028	0.9	202%	100%	2.5%	150%	1.7%
4.0 (5.0)	3.0 (3.0)	80	20AD-DB1-B	115	0.028	0.9	193%	100%	1.4%	150%	0.9%
5.5 (7.5)	4.0 (5.0)	80	20AD-DB1-C	115	0.04	0.9	147%	100%	1.5%	147%	1.0%
7.5 (10)	5.5 (7.5)	80	20AD-DB1-C	115	0.04	0.9	108%	100%	1.1%	108%	1.0%
11 (15)	7.5 (10)	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15 (20)	11 (15)	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

∗ Duty cycle listed is based on full speed to zero speed deceleration. For constant regen at full speed, duty cycle capability is half of what is listed. Application Type 1 represents maximum capability up to 100% braking torque where possible. Application Type 2 represents more than 100% braking torque where possible, up to a maximum of 150%.

❄ Always check resistor Ohms against minimum resistance for drive being used.

PowerFlex 70 Medium Duty External Dynamic Brake Resistors

These resistors provide a larger duty cycle capability than the internal type. Includes an internal thermal switch for use in external safety circuit.

PowerFlex 70 AC Drive			Medium Duty External DB Resistor								
								Application Type 1		Application Type 2	
Normal Duty✶ [kW (Hp)]	Heavy Duty✶ [kW (Hp)]	Min DB Res [Ohms ±10%]	Cat. No.	Resistance ❄ [Ohms ±5%]	Continuous Power [kW]	Max Energy [kJ]	Max Braking Torque [% of ND Motor]	Braking Torque [% of ND Motor]	Duty Cycle	Braking Torque [% of ND Motor]	Duty Cycle
200…240 Volt AC Input Drives											
0.37 (0.5)	0.25 (0.33)	33	AK-R2-091P500	91	0.086	17	293%	100%	46%	150%	31%
0.75 (1.0)	0.55 (0.75)	33	AK-R2-091P500	91	0.086	17	218%	100%	23%	150%	15%
1.5 (2.0)	1.1 (1.5)	33	AK-R2-091P500	91	0.086	17	109%	100%	11%	109%	11%
2.2 (3.0)	1.5 (2.0)	33	AK-R2-047P500	47	0.166	33	144%	100%	15%	144%	11%
4.0 (5.0)	3.0 (3.0)	30	AK-R2-047P500	47	0.166	33	79%	79%	11%	N/A	N/A
5.5 (7.5)	4.0 (5.0)	23	AK-R2-030P1K2	30	0.26	52	90%	90%	10%	N/A	N/A
7.5 (10)	5.5 (7.5)	23	AK-R2-030P1K2	30	0.26	52	66%	66%	10%	N/A	N/A
400…480 Volt AC Input Drives											
0.37 (0.5)	0.25 (0.33)	68	AK-R2-360P500	360	0.086	17	305%	100%	47%	150%	31%
0.75 (1.0)	0.55 (0.75)	68	AK-R2-360P500	360	0.086	17	220%	100%	23%	150%	15%
1.5 (2.0)	1.1 (1.5)	68	AK-R2-360P500	360	0.086	17	110%	100%	12%	110%	11%
2.2 (3.0)	1.5 (2.0)	68	AK-R2-120P1K2	120	0.26	52	197%	100%	24%	150%	16%
4.0 (5.0)	3.0 (3.0)	68	AK-R2-120P1K2	120	0.26	52	124%	100%	13%	124%	10%
5.5 (7.5)	4.0 (5.0)	74	AK-R2-120P1K2	120	0.26	52	90%	90%	10%	N/A	N/A
7.5 (10)	5.5 (7.5)	74	AK-R2-120P1K2	120	0.26	52	66%	66%	10%	N/A	N/A
11 (15) ‡	7.5 (10) ‡	44	‡	60	0.52	104	90%	90%	10%	N/A	N/A
15 (20) ‡	11 (15) ‡	31	‡	60	0.52	104	66%	66%	10%	N/A	N/A
500…600 Volt AC Input Drives											
0.37 (0.5)	0.25 (0.33)	117	AK-R2-360P500	360	0.086	17	274%	100%	46%	150%	31%
0.75 (1.0)	0.55 (0.75)	117	AK-R2-360P500	360	0.086	17	251%	100%	23%	150%	15%
1.5 (2.0)	1.1 (1.5)	117	AK-R2-360P500	360	0.086	17	172%	100%	11%	150%	8%
2.2 (3.0)	1.5 (2.0)	117	AK-R2-120P1K2	120	0.26	52	193%	100%	24%	150%	16%
4.0 (5.0)	3.0 (3.0)	80	AK-R2-120P1K2	120	0.26	52	185%	100%	13%	150%	9%
5.5 (7.5)	4.0 (5.0)	80	AK-R2-120P1K2	120	0.26	52	141%	100%	9%	141%	7%
7.5 (10)	5.5 (7.5)	80	AK-R2-120P1K2	120	0.26	52	103%	100%	7%	103%	7%
11 (15) ‡	7.5 (10) ‡	48	‡	60	0.52	104	141%	100%	9%	141%	7%
15 (20) ‡	11 (15) ‡	48	‡	60	0.52	104	103%	100%	7%	103%	7%

✶ Duty cycle listed is based on full speed to zero speed deceleration. For constant regen at full speed, duty cycle capability is half of what is listed. Application Type 1 represents maximum capability up to 100% braking torque where possible. Application Type 2 represents more than 100% braking torque where possible, up to a maximum of 150%.

❄ Always check resistor Ohms against minimum resistance for drive being used.

‡ For 11 and 15 kW (15 and 20 Hp) applications, use two 7.5 kW (10 Hp) size resistors wired in parallel.

Internal Dynamic Brake Resistor Kits

These resistors have a limited duty cycle. Refer to the PowerFlex Dynamic Braking Selection Guide to determine if an internal resistor will be sufficient for your application. An external resistor may be required.

Drive Input Voltage	Brake Resistance [Ω]	Frame	Cat. No.	Used with PowerFlex Drive				
				70	700H	700S	700L	753/755
208…240V AC	62	0	20BB-DB1-0			✓		
	62	1 (except 7.5 Hp)	20BB-DB1-1			✓		
	22	1 (7.5 Hp)	20BB-DB2-1			✓		
	22	2	20BB-DB1-2			✓		
380…600V AC	115	0	20BD-DB1-0			✓		
	115	1	20BD-DB1-1			✓		
	68	2	20BD-DB1-2			✓		
	68	2	20-750-DB1-D2					✓

Dynamic Brake, Chopper Only Kits

Voltage	Rating	Peak Transistor Current Rating [A]	Minimum DB Resistance [Ohms]	Cat. No.	Used with PowerFlex Drive				
					70	700H	700S	700L	753/755
200…240V AC	18A	50	9	1336-WA018			✓		
	70A	200	2.3	1336-WA070			✓		
	115A	400	1.25	1336-WA115			✓		
380…480V AC	9A	25	37	1336-WB009		✓	✓		✓
	35A	100	9	1336-WB035		✓	✓		✓
	110A	400	2.5	1336-WB110		✓	✓		✓
500…600V AC	9A	25	46	1336-WC009		✓	✓		
	35A	75	15.5	1336-WC035		✓	✓		
	85A	400	3	1336-WC085		✓	✓		

Terminators

Description ❄	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
for use with 3.7 kW (5 Hp) & below drives	1204-TFA1	✓		✓	✓	✓
for use with 1.5 kW (2 Hp) & up drives	1204-TFB2	✓	✓	✓	✓	✓

❄ Refer to Appendix A of publication Drives-IN001 for selection information.

Reflected Wave Reduction Modules w/Common Mode Choke

Description ❄	Cat. No.	Used with PowerFlex Drive				
		70	700H	700S	700L	753/755
17A with Common Mode Choke	1204-RWC-17-A	✓	✓	✓		✓

❄ Refer to Appendix A of publication Drives-IN001 for selection information.

Reflected Wave Reduction Modules

Voltage	ND kW	ND Hp	Cat. No.	Used with PowerFlex Drive				
				70	700H	700S	700L	753/755
380…480V AC	4	5	1321-RWR8-DP	✓		✓		✓
	5.5	7.5	1321-RWR12-DP	✓		✓		✓
	7.5	10	1321-RWR18-DP	✓		✓		✓
	11	15	1321-RWR25-DP	✓		✓		✓
	15	20	1321-RWR35-DP	✓		✓		✓
	18.5	25	1321-RWR35-DP	✓		✓		✓
	22	30	1321-RWR45-DP	✓		✓		✓
	30	40	1321-RWR55-DP	✓		✓		✓
	37	50	1321-RWR80-DP	✓		✓		✓
	45	60	1321-RWR80-DP			✓		✓
	55	75	1321-RWR100-DP			✓		✓
	75	100	1321-RWR130-DP			✓		✓
	75	100	1321-RWR160-DP			✓		
	90	125	1321-RWR160-DP			✓		✓
	110	150	1321-RWR200-DP			✓		✓
	149	200	1321-RWR250-DP		✓	✓		✓
	149	200	1321-RWR320-DP			✓		
	187	250	1321-RWR320-DP		✓	✓		✓
500…600V AC	4	5	1321-RWR8-EP	✓		✓		
	5.5	7.5	1321-RWR8-EP			✓		
	5.5	7.5	1321-RWR12-EP	✓				
	7.5	10	1321-RWR12-EP	✓		✓		
	11	15	1321-RWR18-EP	✓		✓		
	15	20	1321-RWR25-EP	✓		✓		
	18.5	25	1321-RWR25-EP			✓		
	18.5	25	1321-RWR35-EP	✓				
	22	30	1321-RWR35-EP	✓		✓		
	30	40	1321-RWR45-EP	✓		✓		
	37	50	1321-RWR55-EP	✓		✓		
	45	60	1321-RWR80-EP			✓		
	55	75	1321-RWR80-EP			✓		
	75	100	1321-RWR100-EP			✓		
	90	125	1321-RWR130-EP			✓		
	110	150	1321-RWR160-EP			✓		
	110	150	1321-RWR200-EP			✓		
	149	200	1321-RWR200-EP			✓		

1492 Wiring System Modules and Cables

Wiring System Modules and Cables provide an easy means to extend drive control wiring. A pre-wired cable (available in various lengths) plugs into the appropriate drive I/O terminal block. The remaining cable end plugs into the Wiring Module which provides a terminal block for direct I/O connection. See publication 1492-TD008 for detailed information.

1492 Wiring Module and Cable Selection

Drive I/O	Wiring Module Description	Wiring Module Cat. No.		PowerFlex 700H Cable (see below)	PowerFlex 700S Cable (see below)	Used with PowerFlex Drive				
		Fixed Terminal Block	Removable Terminal Block			70	700H	700S	700L	753/755
Analog I/O (TB1)	6 Channel Isolated - 3 Terminals/Ch.	1492-AIFM6S-3	1492-RAIFM6S-3	1492-ACABxxxZ7H	1492-ACABxxxZ7S		✓	✓		
DC Discrete Digital I/O (TB2)	Standard, 264V AC/DC	1492-IFM20F	1492-RIFM20F	1492-CABxxxA7H	1492-CABxxxA7S		✓	✓		
	Narrow Standard, 132V AC/DC	1492-IFM20FN	1492-RIFM20FN	1492-CABxxxA7H	1492-CABxxxA7S		✓	✓		
	Extra Terminals (2 per I/O), 264V AC/DC	1492-IFM20F-2	1492-RIFM20F-2	1492-CABxxxA7H	1492-CABxxxA7S		✓	✓		
AC Discrete Digital I/O (20C-DA1-B & 20C-DO1)	Standard, 264V AC/DC	1492-IFM20F	1492-RIFM20F	1492-CABxxxB7H	1492-CABxxxB7H		✓			
	Narrow Standard, 132V AC/DC	1492-IFM20FN	1492-RIFM20FN	1492-CABxxxB7H	1492-CABxxxB7H		✓			
	Extra Terminals (2 per I/O), 264V AC/DC	1492-IFM20F-2	1492-RIFM20F-2	1492-CABxxxB7H	1492-CABxxxB7H		✓			
Encoder	2 Channel Encoder Input - 4 Outputs	1492-AIFMCE4	–	1492-ACABxxxX7S	1492-ACABxxxX7S			✓		
	2 Channel Fused Encoder Input - 4 Fused Outputs	1492-AIFMCE4-F	–	1492-ACABxxxX7S	1492-ACABxxxX7S			✓		

1492 Pre-Wired Cable Assemblies

Description	PowerFlex 700H Cat. No.	PowerFlex 700S Cat. No.	Used with PowerFlex Drive				
			70	700H	700S	700L	753/755
Pre-Wired Cable for Analog I/O							
0.5 m (1.6 ft)	1492-ACAB005Z7H	1492-ACAB005Z7S		✓	✓		
1.0 m (3.3 ft)	1492-ACAB010Z7H	1492-ACAB010Z7S		✓	✓		
2.5 m (8.2 ft)	1492-ACAB025Z7H	1492-ACAB025Z7S		✓	✓		
5.0 m (16.4 ft)	1492-ACAB050Z7H	1492-ACAB050Z7S		✓	✓		
Pre-Wired Cable for Discrete DC I/O							
0.5 m (1.6 ft)	1492-CAB005A7H	1492-CAB005A7S		✓	✓		
1.0 m (3.3 ft)	1492-CAB010A7H	1492-CAB005A7S		✓	✓		
2.5 m (8.2 ft)	1492-CAB025A7H	1492-CAB025A7S		✓	✓		
5.0 m (16.4 ft)	1492-CAB050A7H	1492-CAB050A7S		✓	✓		
Pre-Wired Cable for Discrete AC I/O							
0.5 m (1.6 ft)	1492-CAB005B7H	–		✓			
1.0 m (3.3 ft)	1492-CAB010B7H	–		✓			
2.5 m (8.2 ft)	1492-CAB025B7H	–		✓			
5.0 m (16.4 ft)	1492-CAB050B7H	–		✓			
Pre-Wired Cable for Encoder							
0.5 m (1.6 ft)	–	1492-ACAB005X7S			✓		
1.0 m (3.3 ft)	–	1492-ACAB010X7S			✓		
2.5 m (8.2 ft)	–	1492-ACAB025X7S			✓		
5.0 m (16.4 ft)	–	1492-ACAB050X7S			✓		

Servo Drive Comparison

Kinetix® Integrated Motion systems help increase machine productivity with GuardMotion™ technology. GuardMotion is the basis for safety innovations integrated into Kinetix motion products. Safe-off, also known as Safe Torque-off, helps machine builders and manufacturers implement machine solutions that provide safety and maximum availability. Tasks such as machine setup, cleaning, removal of jams and other typical maintenance work that previously required power-down conditions can now be accomplished without removing power from the entire machine. With the Safe-off capability, the drive output is safely disabled to eliminate motor torque. As a result, users enjoy faster machine restart and shorter machine downtime. In addition, components such as output contactors can be eliminated, simplifying machine design and reducing both panel space requirements and overall system cost.

Kinetix 6200 and Kinetix 6500 drives offer Safe Speed Monitoring, as well as Safe-off capability.

GuardMotion drives can be identified by the GuardMotion logo on the front label of the drive.

Drive Features	Kinetix 300	Kinetix 6500	Kinetix 6200	Kinetix 6000	Kinetix 7000
Main Characteristics	• Single-axis • EtherNet/IP • Safe Torque-off Control	• Multi-axis • Common Bus • Modular Design • Safe Speed Monitoring		• Multi-axis • Common Bus • Safe-Off Control	• Multi-axis • Common Bus • Safe-Off Control
Drive Configuration	Single-axis	1…8 axes on Bulletin 2094 power rail		1…8 axes on Bulletin 2094 power rail	Single-axis
Input Voltage	120V/240V/480V	324…528V AC, Three-phase (460V systems)		195…265V AC, Three-phase (230V systems) 324…528V AC, Three-phase (460V systems)	324…528V AC, Three-phase
Common Bus Follower Input Voltage	Not Applicable	458…747V DC (460V systems)		275…375V DC (230V systems) 458…747V DC (460V systems)	450…750V DC
Continuous Output Power (inverter)	0.4…3 kW	1.8…6.6 kW (460V systems)		1.2…11 kW (230V systems) 1.8…22 kW (460V systems)	22…149 kW
Continuous Output Current (inverter)	2…12 A rms	2.8…10.3 A rms (460V systems)		3.7…34.6 A rms (230V systems) 2.8…34.6 A rms (460V systems)	40…248 A rms
Drive Digital Inputs	• Enable, Overtravel ± • High Speed Registration (1) • Configurable (8)	• Enable, Home, Overtravel ± • High Speed Registration (2/axis)			• Enable, Home, Overtravel ± • High Speed Registration (2)
Drive Digital Outputs	• Ready • Configurable (4)	Motor Brake Relay Output (with suppression)			
DPI Connector	Not applicable	Not applicable		• DriveExplorer • HIM	
Programming	• Built-in Web Server • RSLogix 5000 Software (Ladder Diagram, Structured Text, and Sequential Function Charts)	RSLogix 5000 Software (Ladder Diagram, Structured Text, and Sequential Function Charts)			
Logix Module Compatibility	• ControlLogix® and CompactLogix™ EtherNet/IP Adapter Modules	• 1756-EN2F, 1756-EN2T, 1756-EN2TR, 1756-EN3TR	• 1756-M03SE, 1756-M08SE, 1756-M16SE • 1768-M04SE		
I/O Control	EtherNet/IP	EtherNet/IP	Fiber-optic SERCOS	Fiber-optic SERCOS	
Feedback	• High-resolution absolute multi-turn and single-turn encoder • Incremental Encoder • Auxiliary axis for master gearing mode	• High-resolution absolute multi-turn and single-turn encoder • Incremental Encoder • Heidenhain EnDat Encoder • Feedback-only auxiliary axis		• High-resolution absolute multi-turn and single-turn encoder • Incremental encoder • Resolver • Feedback-only auxiliary axis	• High-resolution absolute multi-turn and single-turn encoder • Incremental encoder • Feedback-only auxiliary axis
Rotary Motor Compatibility	• MP-Series (Bulletin MPL/MPF/MPS/MPM) • TL-Series (Bulletin TLY)	• MP-Series (Bulletin MPL/MPF/MPS/MPM) • RDD-Series Direct Drive Motors		• MP-Series (Bulletin MPL/MPF/MPS/MPM) • RDD-Series Direct Drive Motors • TL-Series	• HPK-Series • MP-Series (Bulletin MPL and MPM) • RDD-Series Direct Drive Motors
Linear Motor Compatibility	Not applicable	• LDC-Series		• LDC-Series	Not applicable
Linear Actuator Compatibility	• MP-Series Linear Stages • MP-Series Electric Cylinders • TL-Series Electric Cylinders	• MP-Series Linear Stages • MP-Series Multi-axis Linear Stages • MP-Series Electric Cylinders		• MP-Series Linear Stages • MP-Series Multi-axis Linear Stages • MP-Series Electric Cylinders	Not applicable
Accessory Compatibility	• 2097 Shunt Resistors • 2097 AC Line Filter Modules • 2097 I/O Terminal Block • 2097 Memory Module Programmer	• 2094 Line Interface Modules • 2090 Resistive Brake Modules • 1394 External Shunt Modules • 1336 External Active Shunt Modules (dynamic brake)		• 2094 Line Interface Modules • 2090 Resistive Brake Modules • 1394 External Shunt Modules • 1336 External Active Shunt Modules (dynamic brake)	• 8720MC Regenerative PS • 8720MC Line Reactor • 1336 External Active Shunt • 1336 Brake Chopper Module • 2094 Line Interface Modules

Safety Solutions for Kinetix® Servo Drives

Kinetix 300 Drives



Features

- PLd, Category 3 per ISO 13849-1
- Stop Category 0 per EN 60204-1
- Removable terminals
- Common solution for any power range

Kinetix 300 Specifications

Standards	IEC/EN 60204-1, ISO 13849-1
Category	PLd, Category 3 per ISO 13849-1
Certifications	CE, cUL, and TÜV functional safety
Safety Inputs	Insulated, compatible with single-ended output (+24V DC)
Enable Voltage Range	20…24V DC
Disable Voltage Range	0…1.0V DC
Input Impedance	6.8 k Ω
Safety Status	Isolated Open Collector (Emitter is grounded.)
Output Load Capability	100 mA
Response Time	Less than 1 ms
Recommended Conductor Size Terminal Screw	Stranded Wire with Ferrule: 0.75 mm² (18 AWG) Solid Wire: 1.5 mm² (16 AWG)
Recommended Torque Terminal Screw	0.2 N•m (1.8 lb•in)
Safety Status	Isolated Open Collector (Emitter is grounded.)
User Manual	Kinetix® 300 User Manual, publication 2097-UM001

Description

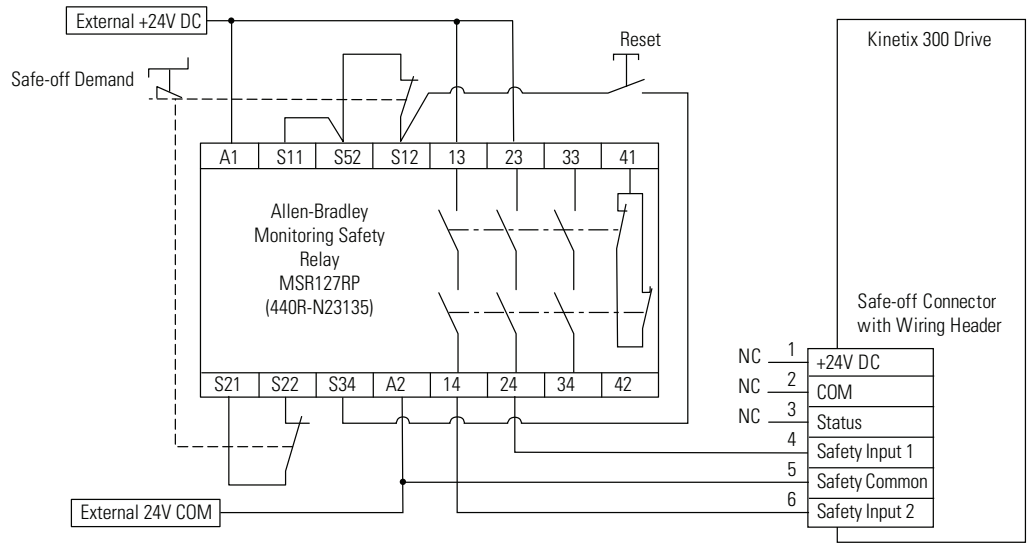
Kinetix® 300 EtherNet/IP Indexing servo drives help protect personnel and increase machine productivity with Safe Torque-off functionality. The Kinetix 300 drive implements solid-state safety circuits for excellent reliability.

Cat. No. 2097-	V31-PR0	V31-PR2	V32-PR0	V32-PR2	V32-PR4	V33-PR1	V33-PR3	V33-PR5	V33-PR6	V34-PR3	V34-PR5	V34-PR6
AC Input Voltage	120/240V rms (1-Phase)		240V rms (1-Phase)			240V rms (1-Phase or 3-Phase)				480V rms (3-Phase)		
AC Input Frequency	48…62 Hz											
Main AC Input Current Nominal (rms)	9.7 A (120V input) 5.0 A (240V input)	16.8 A (120V input) 8.6 A (240V input)	5.0 A	8.6 A	15 A	3.0 A	5.0 A	8.7 A	13.9 A	2.7 A	5.5 A	7.9 A
Back-up Control Power Input	20…26V DC											
Continuous Power Output	400 W	800 W	400 W	800 W	1.7 kW	500 W	1.0 kW	2.0 kW	3.0 kW	1.0 kW	2.0 kW	3.0 kW
Continuous Output Current (rms)	2.0 A	4.0 A	2.0 A	4.0 A	8.0 A	2.0 A	4.0 A	8.0 A	12.0 A	2.0 A	4.0 A	6.0 A
Peak Current (rms) 3 s	6.0 A	12.0 A	6.0 A	12.0 A	24.0 A	6.0 A	12.0 A	24.0 A	36.0 A	6.0 A	12.0 A	18.0 A
Module Size Specifications												
Height (mm)	190.5	190.5	190.5	190.5	190.5	190.5	190.5	190.5	190.5	190.5	190.5	190.5
Width (mm)	68	68.5	68	68.5	86.8	68	68.5	94.4	68	68.5	94.4	68
Depth (mm)	185.1	185.1	229.6	229.6	229.6	185.1	185.1	185.1	229.6	185.1	185.1	229.6

Kinetix 300 Stop Category 0 Configuration

The Kinetix 300 drive is shown with a single-axis relay in a Stop Category 0 configuration.

Kinetix 300 Relay Configuration Stop Category 0



Accessories

Safe-off Headers for Kinetix 300 Drives

Description	Cat. No.
Spare Connector Header Set	2097-CONN1

Safety Solutions for Kinetix® Servo Drives

Kinetix 6200 and Kinetix 6500 Drives



Kinetix 6200



Kinetix 6500

Safe Speed Servo Drives

Description

Kinetix® 6200 and Kinetix® 6500 servo drives have safety features that help improve machine operating efficiencies by providing safer access to guarded areas while a machine or process continues operation under limited conditions. Leveraging the proven performance of the Kinetix 6000 family, these drives include features such as safe stop, zero speed monitoring, safe direction monitoring, and safe maximum acceleration monitoring. Control modules couple with IAM and AM power modules to provide drive status indicators and an interface to I/O, communication, safety functionality, and feedback.

The Kinetix 6200 features a SERCOS interface, while the Kinetix 6500 provides EtherNet/IP network connectivity. Both drives offer Safe Torque-off or Safe Speed Monitoring options.

Features

- TÜV-certified up to and including SIL3 per IEC 61508 and PLe per ISO 13849-1
- Reduce panel space and eliminate wiring between external safety monitor and the drive because of the drive's embedded safety
- Interchangeable control modules let you easily transform from Safe-off to Safe Speed functionality or from SERCOS interface™ to EtherNet/IP networking
- Embedded, dual-channel monitoring capability
- Includes automatic, manual, or manual monitored reset
- Supports cascaded system via solid state safety outputs
- Uses the same Allen-Bradley motors and actuators as the Kinetix 6000, including the MP-series low inertia, medium inertia, stainless steel and food grade motors, RDD-series direct drive motors, LDC-series linear motors, MP-series linear stages, MP-series electric cylinders

Kinetix 6200 and Kinetix 6500 Specifications

Standards	IEC/EN 60204-1, ISO12100, IEC 61508, IEC 61800-5-2
Category	PLe and Cat. 4 per EN ISO 13849-1
Safety Integrity Level	SIL3 per IEC 61508 and EN62061
Certifications	C-Tick, CE, cUL, and TÜV functional safety
Safety Inputs	5
PFd(t) for 20-year interval	Single-encoder configuration: 10.3E-04 Dual-encoder configuration: 4.15E-04
PFh(t) for 20-year interval	Single-encoder configuration: 5.88E-09 Dual-encoder configuration: 2.37E-09
Overspeed Response Time	user-configurable
Recommended Conductor Size Terminal Screw	0.25…0.75 mm² (24…18 AWG)
Recommended Torque Terminal Screw	0.22…0.25 N•m (1.9…2.0 lb•in)
Safety Reference Manual	• Kinetix 6200 and Kinetix 6500 Safe Speed Monitoring Safety Reference Manual, Publication 2094-RM001 • Kinetix 6200 and Kinetix 6500 Safe Torque-off Safety Reference Manual, Publication 2094-RM002

Kinetix 6200 and Kinetix 6500 IAM Power Module (460V) Specifications

IAM Power Module	2094-BC01-MP5-M	2094-BC01-M01-M	2094-BC02-M02-M
AC Input Voltage	324…528V rms 3-Phase (360…480 nom)		
AC Input Frequency	47…63 Hz		
Main AC Input Current Nominal (rms)	10 A	10 A	24 A
DC Input Voltage (Common Bus follower)	458…747V DC		
DC Input Current (Common Bus follower)	9 A	9 A	22.6 A
Control Power AC Input Voltage	95…264V rms single-phase (230V nominal)		
Continuous Output Current to Bus (Adc)	9 A	9 A	22.6 A
Intermittent Output Current to Bus (Adc)	20 A	20 A	38 A
Continuous Power Output to Bus (nominal)	6 kW	6 kW	15 kW
Module Size Specifications			
Height (mm)	290	290	290
Width (mm)	125	125	125
Depth (mm)	290	290	290

Kinetix 6200 and Kinetix 6500 AM Power Module (460V) Specifications

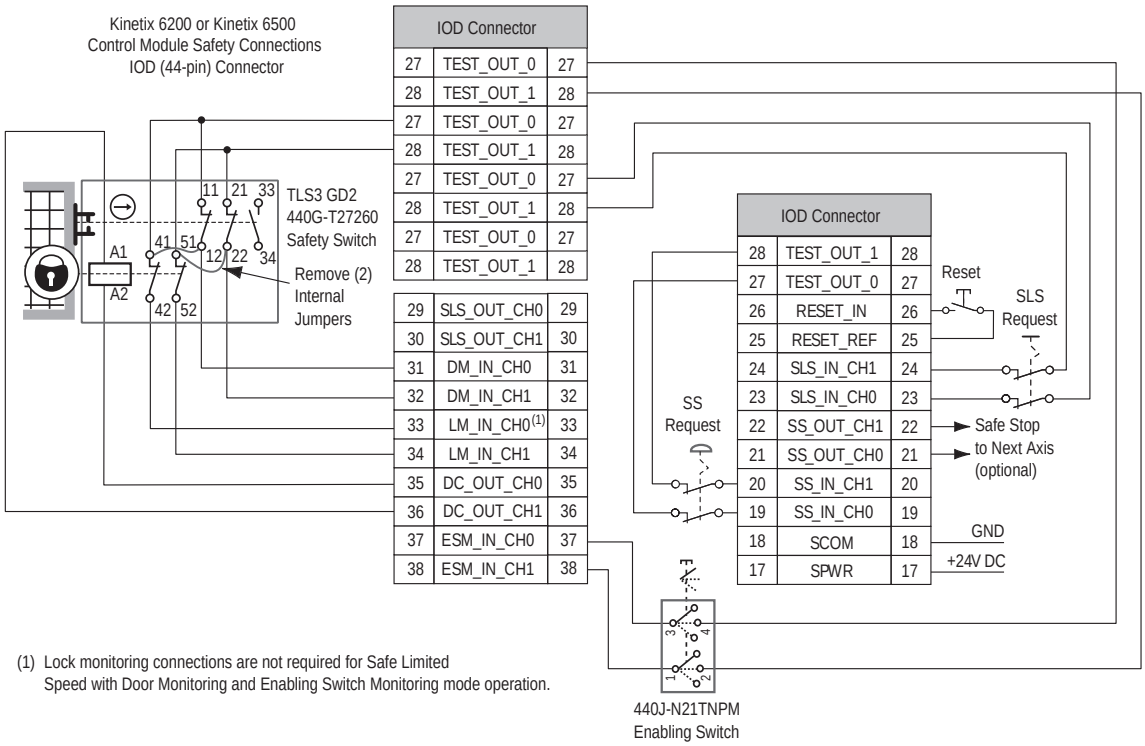
AM Power Modules	2094-BMP5-M (2094-BC01-MP5-M)	2094-BM01-M (2094-BC01-M01-M)	2094-BM02-M (2094-BC02-M02-M)
Continuous Output Current (rms)	2.8 A	6.1 A	10.3 A
Continuous Output Current (0-peak)	4.0 A	8.6 A	14.6 A
Peak Output Current (rms)	7.0 A	15.3 A	25.8 A
Peak Output Current (0-peak)	9.9 A	21.6 A	36.4 A
Maximum Seconds at Peak			
Continuous Power Output (nominal)	1.8 kW	3.9 kW	6.6 kW
Module Size Specifications			
Height (mm)	290	290	290
Width AM (mm)	70	70	70
Depth (mm)	290	290	290

Kinetix 6200 and Kinetix 6500 Control Module Specifications

Cat. No.	2094-SE02F-M00-S1	2094-SE02F-M00-S0	2094-EN02D-M01-S1	2094-EN02D-M01-S0
Drive Family	Kinetix 6200		Kinetix 6500	
Control/Communication	SERCOS interface		EtherNet/IP networking	
Safety Features	Safe Speed Monitoring	Safe Torque-off	Safe Speed Monitoring	Safe Torque-off
Connectors	• IOD connector for I/O, safety, and auxiliary feedback • MF connector for motor feedback			

Kinetix 6200 Safe Limited Speed with Door Monitoring and Enabling Switch Monitoring Configuration

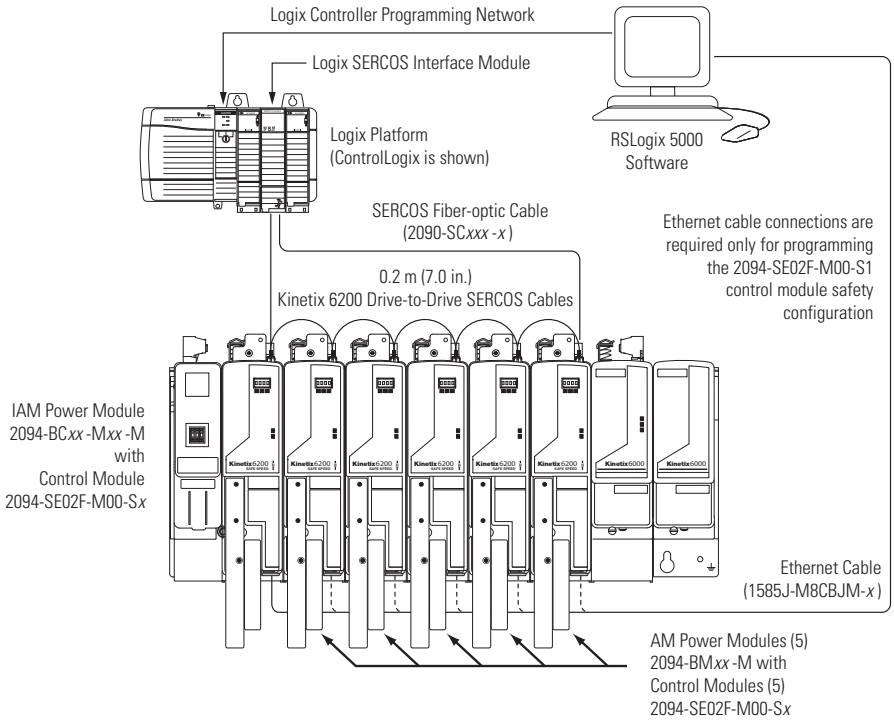
The Kinetix 6200 drive is shown wired for Safe Limited Speed with Door Monitoring and Enabling Switch Monitoring, one of 11 user-selectable operating modes, based on combinations of available safety functions. The proper configuration of this speed monitoring mode in RSLogix™ 5000 software is required.



(1) Lock monitoring connections are not required for Safe Limited Speed with Door Monitoring and Enabling Switch Monitoring mode operation.

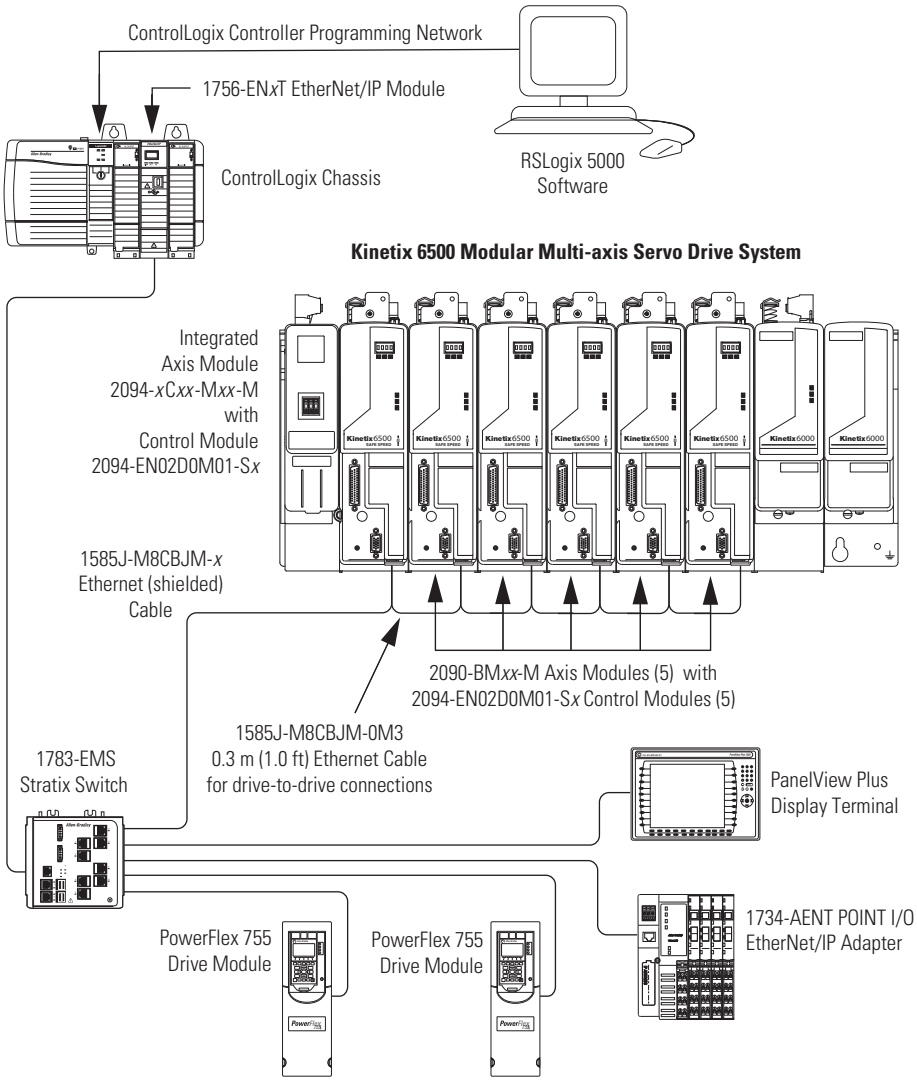
Kinetix 6200 Communication Configuration (SERCOS)

This Kinetix 6200 drive configuration uses the SERCOS interface for configuring the Logix module and Ethernet for diagnostics and configuring safety functions.



Kinetix 6500 Star Communication Configuration (EtherNet/IP)

In this Kinetix 6500 drive configuration, the devices are connected using star topology. Each device is connected directly to the switch, making this topology fault tolerant. The 2094 power rail modules and other devices operate independently. The loss of one device does not impact the operation of the other devices.



Accessories

Drive-to-drive SERCOS Cables for Kinetix 6200 Drives

From this drive	To this drive	Cat. No.
2094-BCxx-Mxx-M or 2094-BMxx-M	2094-BMxx-M	2090-SCEPO-2
2094-BCxx-Mxx-M or 2094-BMxx-M	2094-BMxx-S	2090-SCEPO-1
2094-BCxx-Mxx-S or 2094-BMxx-S	2094-BMxx-S	2090-SCEPO-1
2094-BCxx-Mxx-S or 2094-BMxx-S	2094-BMxx-M	2090-SCEPO-2

For I/O, Safety, Motor Feedback, and Auxiliary Feedback connections on Kinetix 6200 and Kinetix 6500 Safe Speed drives, use the 44-pin Low-profile Connector Kit, catalog number 2090-K6CK-D44M.

A 1585J-M8CBJM-x (shielded) Ethernet cable is required for programming and safety configuration of the Kinetix 6200 and Kinetix 6500 drive via RSLogix 5000 software.

Safety Solutions for Kinetix® Servo Drives

Kinetix 6000 and Kinetix 7000 Drives



Kinetix 6000



Kinetix 7000

Description

The Kinetix® 6000 multi-axis servo drive provides power simplicity to handle even the most demanding applications quickly, easily, and cost-effectively. The compact size, simplified wiring, easy-to-use components, and integrated Safe-off capability make Kinetix 6000 drives an ideal choice for both OEMs and end-users.

The Kinetix® 7000 high power servo drive is designed to accommodate the most demanding requirements and extends the benefits of Kinetix Integrated Motion, and Safe-off capability to applications up to 149 kW. The Kinetix 7000 high power drive supports three-phase AC input power (380…480V AC) and DC input for common bus applications.

Features

- Category 3 per EN 954-1
- SIL3 per IEC 61508
- Stop Category 0 per EN 60204-1
- Stop Category 1 per EN 60204-1 (requires safety relay with time delay outputs)
- Two positive-guided, mechanically linked safety auxiliary contacts for monitoring
- Removable terminals
- Common solution for any power range

Kinetix 6000 and Kinetix 7000 Specifications

Standards	EN 954-1, EN ISO 13849-2, EN 60204-1, EN 50178, EN 61800-3, IEC 61508
Category	PLe and Cat. 3 per EN ISO 13849-1
Safety Integrity Level	SIL3 per IEC 61508
Certifications	C-Tick, CE, cUL, and TÜV functional safety
Safety Inputs	Two N.C.
PFd(t) for 20-year interval	4.75E-07
PFh(t) for 20-year interval	5.43E-12
Coil Pull-in Voltage	24V DC (Nom.), 18V DC (Min.), 26.4V DC (Max.)
Coil Drop-out Voltage	0V DC (Min.), 2.4V DC (Max.)
Coil Resistance	720 Ω (Nom.), 648 Ω (Min.), 792 Ω (Max.)
Coil Current	33.3 mA (Nom.), 55.0 mA (Max.)
Coil Pull-in Time:	25 ms
Coil Drop-out Time:	20 ms
Response Time	25 ms
Recommended Conductor Size Terminal Screw	Stranded Wire with Ferrule: 0.75 mm² (18 AWG) Solid Wire 1.5 mm² (16 AWG)
Recommended Torque Terminal Screw	0.235 N•m (2.0 lb•in)
Mechanical Life	10,000,000 operations
Safety Reference Manual	Publication GMC-RM002

Kinetix 6000 (230V Models) with GuardMotion Specifications

IAM Converters (2094-)	AC05-MP5-S	AC05-M01-S	AC09-M02-S	AC16-M03-S	AC32-M05-S
AC Input Voltage	195…264V rms 3-Phase				
AC Input Frequency	47…63 Hz				
Main AC Input Current Nominal (rms)	10 A	10 A	19 A	36 A	71 A
DC Input Voltage (Common Bus follower)	275…375V DC				
DC Input Current (Common Bus follower)	10 A	10 A	19 A	36 A	71 A
Control Power AC Input Voltage	95…264V rms Single-Phase (115/230V nominal)				
Continuous Output Current to Bus (Adc)	10 A	10 A	19 A	36 A	71 A
Intermittent Output Current to Bus (Adc)	20 A	20 A	38 A	72 A	142 A
Continuous Power Output to Bus (nominal)	3 kW	3 kW	6 kW	11.3 kW	22.5 kW
IAM and AM Inverters (2094-)	**AC05-MP5-S and AMP5-S**	**AC05-M01-S and AM01-S**	**AC09-M02-S and AM02-S**	**AC16-M03-S and AM03-S**	**AC32-M05-S and AM05-S**
Continuous Output Current (rms)	3.7 A	6.0 A	10.6 A	17.3 A	34.6 A
Continuous Output Current (0-peak)	5.2 A	8.5 A	15 A	24.5 A	48.9 A
Peak Output Current (rms)	7.4 A	12.0 A	21.2 A	34.6 A	51.9 A
Peak Output Current (0-peak)	10.5 A	17.0 A	30.0 A	48.9 A	73.4 A
Maximum Seconds at Peak	2.5	2.5	2.5	2.5	2.5
Continuous Power Output (nominal)	1.2 kW	1.9 kW	3.4 kW	5.5 kW	11 kW
Module Size Specifications					
Height (mm)	200	200	200	300	300
Width AM (mm)	70	70	70	70	70
Width IAM (mm)	125	125	125	125	195
Depth (mm)	195	195	195	195	195

Kinetix 6000 (460V Models) with GuardMotion Specifications

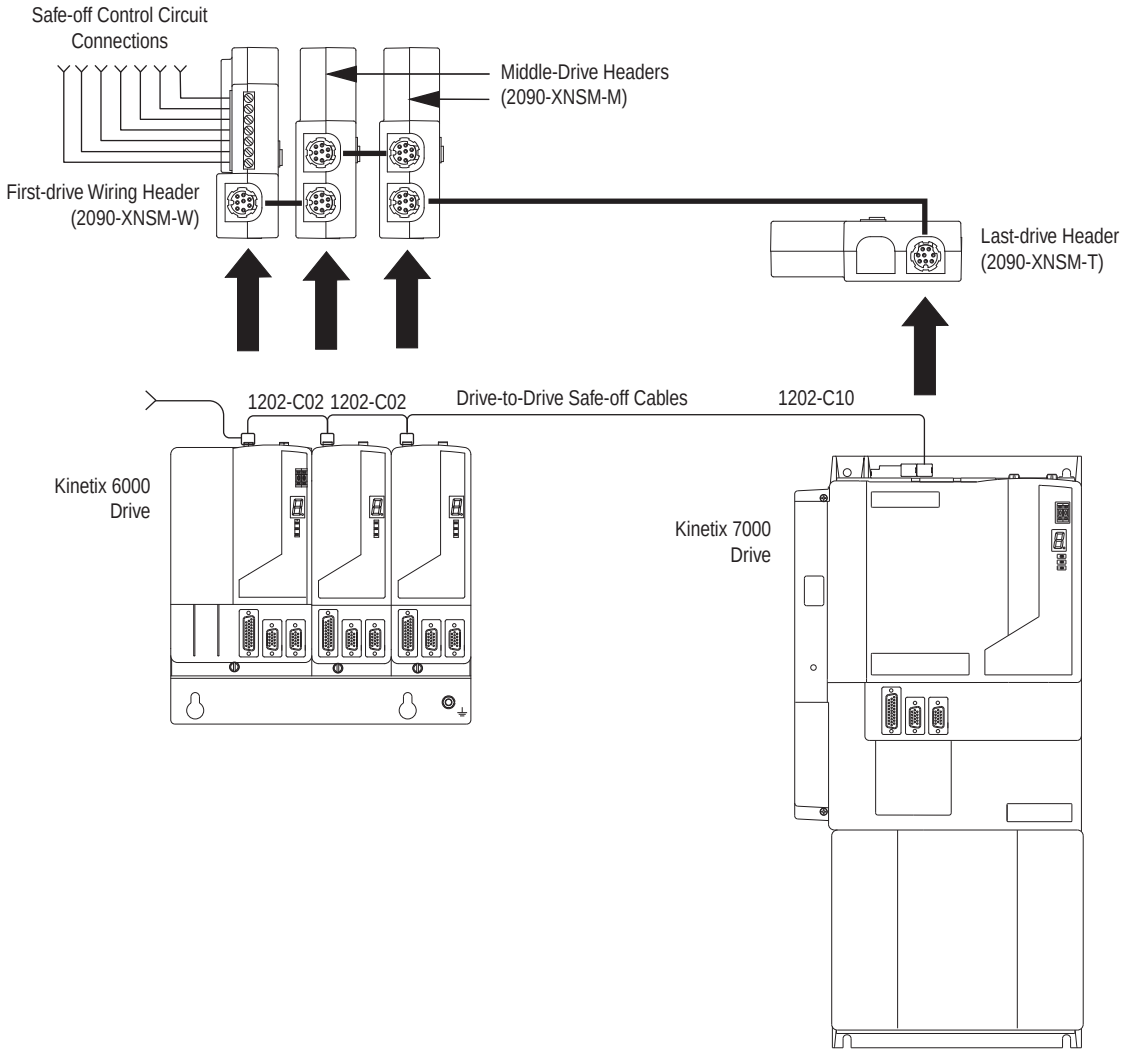
IAM Converters (2094-)	BC01-MP5-S	BC01-M01-S	BC02-M02-S	BC04-M03-S	BC07-M05-S
AC Input Voltage	324-528V rms 3-Phase				
AC Input Frequency	47…63 Hz				
Main AC Input Current Nominal (rms)	10 A	10 A	24 A	44 A	71 A
DC Input Voltage (Common Bus follower)	458…747V DC				
DC Input Current (Common Bus follower)	10 A	10 A	24 A	43 A	71 A
Control Power AC Input Voltage	95…264V rms Single-Phase (115/230V nominal)				
Continuous Output Current to Bus (Adc)	10 A	10 A	24 A	43 A	71 A
Intermittent Output Current to Bus (Adc)	20 A	20 A	48 A	86 A	142 A
Continuous Power Output to Bus (nominal)	6 kW	6 kW	15 kW	27.6 kW	45 kW
IAM and AM Inverters (2094-)	**BC01-MP5-S and BMP5-S**	**BC01-M01-S and BM01-S**	**BC02-M02-S and BM02-S**	**BC04-M03-S and BM03-S**	**BC07-M05-S and BM05-S**
Continuous Output Current (rms)	2.8 A	6.1 A	10.3 A	21.2 A	34.6 A
Continuous Output Current (0-peak)	4.0 A	8.6 A	14.6 A	30.0 A	48.9 A
Peak Output Current (rms)					
Series A	4.2 A	9.2 A	15.5 A	31.8 A	51.9 A
Series B	7.0 A	15.3 A	25.8 A	31.8 A	51.9 A
Peak Output Current (0-peak)					
Series A	5.9 A	12.9 A	21.8 A	45.0 A	73.4 A
Series B	9.9 A	21.6 A	36.4 A	45.0 A	73.4 A
Maximum Seconds at Peak	2.5	2.5	2.5	2.5	2.5
Continuous Power Output (nominal)	1.8 kW	3.9 kW	6.6 kW	13.5 kW	22 kW
Module Size Specifications					
Height (mm)	250	250	250	250	310
Width AM (mm)	70	70	70	140	140
Width IAM (mm)	125	125	125	195	195
Depth (mm)	260	260	260	260	260

Kinetix 7000 Specifications

2099-	BM06-S	BM07-S	BM08-S	BM09-S	BM10-S	BM11-S	BM12-S
AC Input Voltage @ 47…63 Hz	380…480V AC +/- 10%						
AC Input Frequency	47…63 Hz						
DC Input Voltage	450…750V DC						
Main AC Input Current (rms)	36.7 A	47.7 A	59.6 A	90.1 A	117 A	169 A	233 A
DC Input Current	42.9 A	55.7 A	69.7 A	105 A	137 A	204 A	281 A
Control Power Input	18…30V DC						
Continuous Power Output	22 kW	30 kW	37 kW	56 kW	75 kW	112 kW	149 kW
Continuous Power Output	30 Hp	40 Hp	50 Hp	75 Hp	100 Hp	150 Hp	200 Hp
Continuous Output Current (rms)	40 A	52 A	65 A	96 A	125 A	180 A	248 A
Continuous Output Current (0-peak)	56 A	73 A	92 A	135 A	176 A	254 A	351 A
Peak Current (rms) 60 s	51 A	60 A	78 A	115 A	138 A	234 A	273 A
Peak Current (0-peak) 60 s	72 A	84.8 A	110 A	162.6 A	195 A	331 A	386 A
Peak Current (rms) 3 s	68 A	80 A	104 A	154 A	163 A	312 A	372 A
Peak Current (0-peak) 3 s	96 A	113 A	147 A	217.7 A	230.5 A	441 A	526 A
Drive Height (mm)	517.5	517.5	517.5	644.5	690.3	977.1	977.1
Drive Depth (mm)	224	224	224	287	287	283	283
Drive Width (mm)	254	254	254	332	332	429	429

Safe-off Multi-Axis Configuration

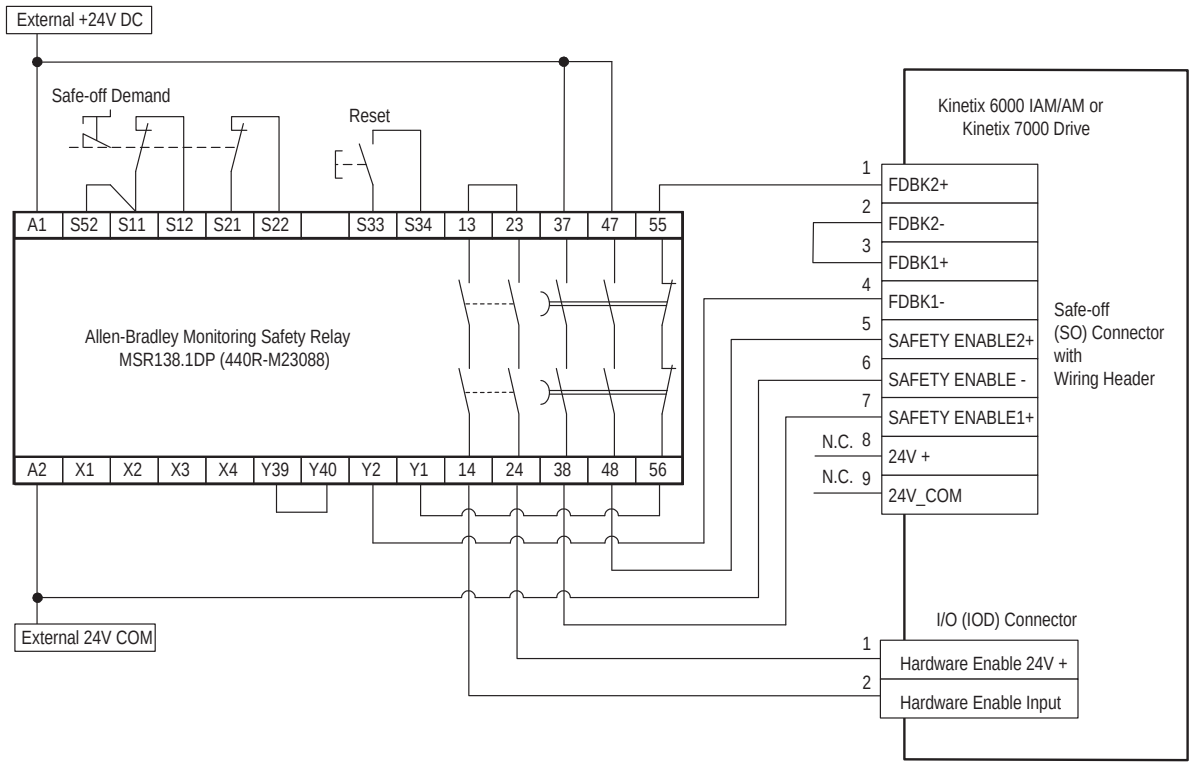
Kinetix 6000 to Kinetix 7000 Safe-off Multi-Axis Configuration



Stop Category 1 Configuration (Kinetix 6000 or Kinetix 7000)

Single-Axis Relay Configuration

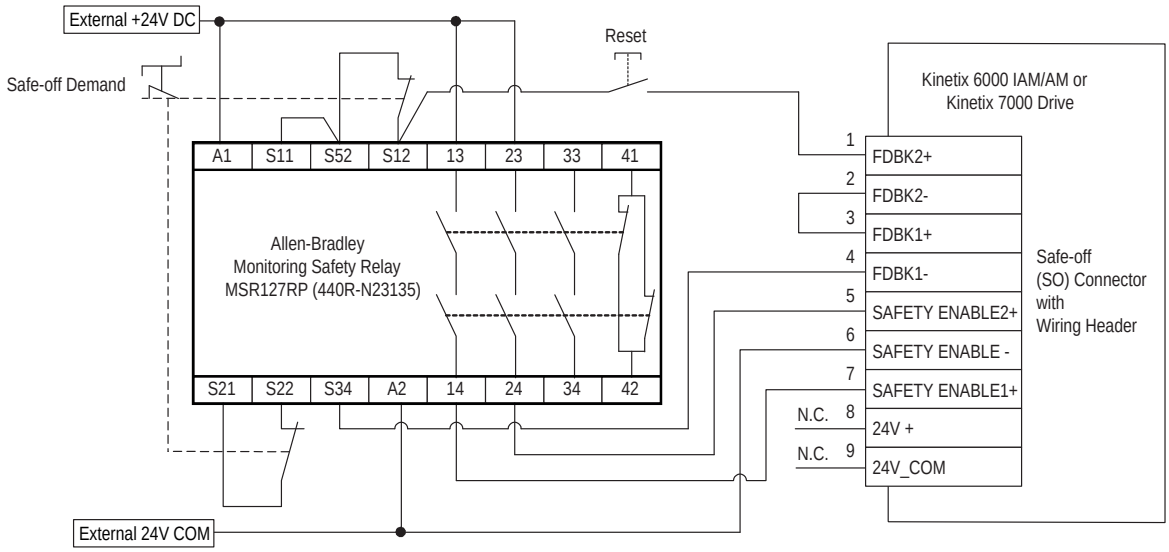
The Kinetix 6000 or Kinetix 7000 drive Safe-off connector is wired to an Allen-Bradley safety relay. The proper configuration in RSLogix™ 5000 software is required.



Stop Category 0 Configuration (Kinetix 6000 or Kinetix 7000)

Single-Axis Relay Configuration

The Kinetix 6000 or Kinetix 7000 drive Safe-off connector is wired to an Allen-Bradley safety relay.



You can use an Allen-Bradley GuardPLC™ or GuardLogix® controller instead of the safety relay to provide the safety logic for more complex safety systems.

Accessories

Safe-off Headers for Kinetix 6000 or Kinetix 7000 Drives

Description	Cat. No.
Safe-off wiring header for the first drive in multiple safety drive configurations (optional)	2090-XNSM-W
Safe-off middle header for the first drive-to-drive connections in multiple safety drive configurations with three or more drives (optional)	2090-XNSM-M
Safe-off terminating header for the last in multiple safety drive configurations (optional)	2090-XNSM-T

Safe-off Interface Cables for Kinetix 6000 or Kinetix 7000 Drives

Safe-off interface cables are required for making connections with 2090-XNSM-W, -M, and -T headers.

Description	Cat. No.
Drive-to-drive safety cable, 200 mm (7.9 in.), for connecting single-wide Kinetix 6000 modules.	1202-C02
Drive-to-drive safety cable, 350 mm (13.8 in.), for connecting double-wide Kinetix 6000 modules.	1202-C03
Drive-to-drive safety cable, 1050 mm (41.3 in.), for connections. • between Kinetix 6000 power rail and Kinetix 7000 drive. • between two Kinetix 6000 power rails. • between two Kinetix 7000 drives.	1202-C10

Because of the current capacity limitation of the Safe-off cable connectors, multiple Safe-off drive configurations must not exceed eight Kinetix 6000 or Kinetix 7000 drive modules.



The Allen-Bradley CENTERLINE ArcShield arc-resistant controller provides rugged process control for applications requiring a higher level of personnel protection. ArcShield products are compliant to the IEEE C37.20.7 standard, and provide Type 2 protection during an arc flash.

The ArcShield controller safely redirects the arc flash energy out the top of the unit and away from personnel. This level of protection is also maintained when the low voltage door is open for maintenance purposes.

The ArcShield products have a robust enclosure design which contain the arc flash energy and exhaust materials until vents on top of the enclosure open. Once opened, the vents provide a path for materials to exit the enclosure. An overhead plenum is used to direct the materials to a safe location, away from personnel near the equipment. The low voltage panel is reinforced and sealed, to prevent arc flash exhaust materials from entering this compartment.

As standard, a plenum exhaust section is provided with each new ArcShield order. The plenum exhaust section can be mounted on either the left or right end of the line-up, and it extends 1016 mm (40 in.) past the end of the line-up.

As the ArcShield may have an impact on horsepower ratings, please contact your local Rockwell Automation sales office or Allen-Bradley distributor to confirm.

Features

- Reinforced cabinet and power cell door closure mechanism
- Multi-point latching mechanism, reinforced cross bracing and gasket sealing
- Reinforced back plates — added support plates secured with multiple bolts increase rigidity and security
- Reinforced low voltage panel to withstand arc flash energy and shield maintenance personnel while working in the isolated low voltage compartment
- Arc “Pressure Relief” vent to direct gases and material away from personnel during an arc flash
- Available with removable arc exhaust plenum

ArcShield Controller Specifications

Bulletin Number	Controller Size	Approximate Mounting Dimensions [mm (in.)]			Approx. Weight [kg (lb)]
		Width	Depth ♣	Height	
1512A	200/400/450 ✶	660 (26)/ 914 (36)	914 (36)	3264 (128.5)	627 (1380)/ 860 (1900)
	200/400/450 ❄	1118 (44)	914 (36)	3264 (128.5)	1107 (2435)
	600 ✶	914 (36)	914 (36)	3264 (128.5)	773 (1700)
	600 ❄	1372 (54)	914 (36)	3264 (128.5)	1250 (2750)
	800	1575 (62)	914 (36)	3264 (128.5)	907 (2000)
1512AT	200/400/450 ✶	660 (26)/	914 (36)	3264 (128.5)	627 (1380)/ 773 (1700)
	600 ✶	914 (36)	914 (36)	3264 (128.5)	773 (1700)
	800 ✶	1575 (62)	914 (36)	3264 (128.5)	907 (2000)
1512B	200/400 ✶	914 (36)	914 (36)	3264 (128.5)	1050 (2310)
	200/400 ❄	1372 (54)	914 (36)	3264 (128.5)	1530 (3365)
1512BT	200/400 ✶	914 (36)	914 (36)	3264 (128.5)	1050 (2310)
1562E	200/400 ✶	914 (36)	914 (36)	3264 (128.5)	886 (1950)
	200/400 ❄	1372 (54)	914 (36)	3264 (128.5)	1364 (3000)
1591A	457 (18) ‡	457 (18)	914 (36)	2311 (91)	432 (950)
	457 (18) §	457 (18)	914 (36)	3264 (128.5)	464 (1020)
	914 (36) ✶	914 (36)	914 (36)	3264 (128.5)	732 (1610)
	914 (36) §	914 (36)	914 (36)	3264 (128.5)	732 (1610)

✶ Arc resistant with plenum.
❄ Arc resistant with plenum, plus PFCC option.
‡ Arc resistant without plenum.
§ Arc resistant with plenum c/w low voltage panel.
♣ Overhead arc plenums are 1168 mm (460 in.), mounted on top and flush to the rear of the structures.

Medium Voltage Arc Resistant Motor Control Center Specifications

		CENTERLINE 1500 Motor Control Center with ArcShield 	CENTERLINE 1500 Motor Control Center with IntelliCENTER Technology and ArcShield 
General	Enclosure Types Available	Arc Resistant NEMA/UL Type 12	Arc Resistant NEMA/UL Type 12
	Section Height	2300 mm (91 in.) plus Plenum	2300 mm (91 in.) plus Plenum
	Section Width	660, 914, 1372, 1575, 2032, 2540 mm (26, 36, 54, 62, 80, 100 in.)	660, 914, 1372, 1575, 2032, 2540 mm (26, 36, 54, 62, 80, 100 in.)
	Section Depth	914 mm (36 in.)	914 mm (36 in.)
	Horizontal Bus Current Rating	1200, 2000, or 3000 A	1200, 2000, or 3000 A
	Vertical Bus Current Rating	400, 600, or 800 A	400, 600, or 800 A
	Bus Short Circuit Rating	60 kA RMS SYM	60 kA RMS SYM
MCC Units Available	ArcShield Controllers	Yes	Yes
	Full Voltage Non-reversing Starters	Yes	Yes
	Full Voltage Reversing Starters	Yes	Yes
	Starters for 2-Speed Motors	Yes	Yes
	Electronic Soft Starters	Yes	Yes
	Variable Speed Drives	N/A	N/A
	Power Monitoring Equipment	Yes	Yes
	PLC and Controller Units	Yes	Yes
	Transformer Units	Yes	Yes
Intelligent Motor Control Features	Built-in Network Media	No	Yes
	IntelliCENTER Software	No	Yes, preconfigured software with: • Elevation View • Monitor View • Event Logger • Electronic System Documentation • ActiveX Objects for HMI use
Preconfigured Network	Pre-Tested Network Connections	No	Yes
	Rich Data	No	Yes
	Advanced Diagnostics	No	Yes
	Network Interfaces	No	• DeviceNet™ • Ethernet • ControlNet™ • PROFIBUS • Modbus Plus™
	Remote Access Motor Control Data	No	Yes

CENTERLINE 2100 Motor Control Centers with ArcShield



Reduce your risk of arc flash injury through the use of the industry leading arc containment design, which has been tested to meet the arc resistant standards for medium voltage equipment, IEEE C37.20.7: IEEE Guide for Testing Medium-Voltage Metal- Enclosed Switchgear for Internal Arcing Faults.

ArcShield enhances the CENTERLINE 2100 Motor Control Center (MCC) and is the first low voltage MCC to offer arc-containing features. ArcShield helps provide you with Type 2 accessibility and improves protection for your personnel against internal arcing faults. With Type 2 accessibility, personnel are shielded at the front, rear and sides of the enclosure in the unlikely event of an arcing fault.

Arc resistant baffles for the CENTERLINE 2100 MCCs with ArcShield allow you to have an arc resistant MCC with a wider range of MCC units, even units that require venting, such as variable frequency drives (VFDs). Arc resistant baffles allow air flow to help dissipate the heat and still provide Type 2 accessibility.

CENTERLINE 2100 MCCs with ArcShield are available on the quick delivery program; allowing your order to go directly to the factory and ship in as little as four weeks.

Contain Arc Flashes

Arc-containment door latches help deliver an extra level of protection by allowing pressure relief and keeping the doors from detaching from the structure. Manual or automatic shutters and insulated bus covers help reduce fault propagation within your MCC. The lower horizontal bus ratings and incoming protection sized for your MCC, help reduce the amount of arc flash energy in your application. By containing an arc flash, your potential exposure to hazardous conditions can be reduced.

Reduce Electrical Shock Hazards

CENTERLINE 2100 MCCs are designed to enhance safe operation by helping isolate you from potentially hazardous voltages by providing a solid grounding system and helping minimize potential electrical shock hazards. Additional options such as IntelliCENTER® software, DeviceNet™ ports, blown fuse indicators, exterior windows on unit doors, infrared inspection ports and finger-safe component barriers can help you create a safer working environment by reducing your potential to make contact with energized components.

CENTERLINE 2500 Motor Control Centers with ArcShield



The CENTERLINE 2500 MCC is designed to meet the needs of your global facilities operating in Latin America, Asia, Europe and other areas of the world where motor control centers must meet IEC standards. With more intelligent components and more options than other MCC manufacturers, you get a total power, control and information solution packaged for your local specifications, built on a common platform.

CENTERLINE 2500 MCCs with ArcShield offers you better protection against harmful arc flash hazards. Using a CENTERLINE 2500 MCC with ArcShield helps protect your personnel if an arc flash were to occur within an MCC.

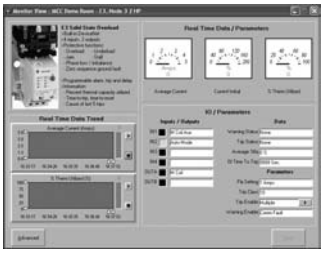
CENTERLINE 2500 MCC with ArcShield provides personnel and assembly protection per IEC/TR 61641:2008 for arcing durations up to 300 ms (available for systems at 415V (max), with 65 kA (max) available current).

In combination with the standard safety features built into every CENTERLINE 2500 MCC, choosing ArcShield provides additional benefits, including:

- Enclosures with no front ventilation
- Pressure relief system designed to exhaust gases through the top of the enclosure, away from personnel
- Arc containment latches on all doors capable of withstanding the high internal pressure generated by an arc blast
- Insulated power bus closing plates included at the ends of each MCC lineup
- For even more protection, optical and current sensing technology for use with crowbar or shunt trip devices is available as an option.

IntelliCENTER Technology

Minimize Entry into Arc Flash Boundary



IntelliCENTER technology helps enhance personnel safety

- Advanced diagnostics of IntelliCENTER software provide remote access to your MCC data for troubleshooting, minimizing your need for entry in the arc flash boundary zone
- With the ability to remotely monitor MCC, you can perform many routine maintenance tasks without "suiting up," reducing personnel exposure to hazardous energy levels
- IntelliCENTER Software can warn of failures before they occur – increasing your ability to respond proactively before a hazardous situation occurs

Low Voltage Arc Resistant Motor Control Center Specifications

		CENTERLINE 2100 Motor Control Center with ArcShield 		CENTERLINE 2500 Motor Control Center with ArcShield 
General	Enclosure Types	NEMA 1, 1G, 3R, 4, 12		IP 20, 40, 42, 54
	Section Height	2286 mm (90 in.)		2300 mm (91 in.)
	Section Width (for plug-in units)	508 mm (20 in.) - 635 mm (25 in.) available with 229 mm (9 in.) wireway		700, 800, 900 or 1000 mm (28, 32, 36, or 40 in.)
	Section Load Capacity	600 or 1200 A		600 or 1200 A
	Arc Resistant Rating	**Device Limited**	**Arc Duration 100 ms or less**	N/A
	Rated Voltage	600V	480V	up to 690V
	Horizontal Bus Current Rating	600…1200 A	600…3000 A	800…3200 A
	Section Depth (for plug-in units)	381 or 508 mm (15 or 20 in.)	508 mm (20 in.)	600 or 800 mm (24 or 32 in.)
	Short Circuit Withstand Rating	42000 or 65000 A rms symmetrical		Up to 65000 A rms symmetrical
Available Equipment for MCC Units	Full Voltage Non-reversing Starters	Yes		Yes
	Full Voltage Reversing Starters	Yes		Yes
	Starters for 2-speed motors	Yes		Yes
	Soft Starters	Yes		Yes
	Variable Frequency Drives	Yes		Yes
	Mains and Feeders	Yes		Yes
	PLC & Controller Units	Yes		Yes
	Lighting Panels	Yes		Yes
	Transformer Units	Yes		Yes
IntelliCENTER Technology	Built-in Network	Yes, DeviceNet™ Class 1, 600V, 8 A		Yes, DeviceNet Class 1, 600V, 8 A
	Network Interfaces	• EtherNet/IP • ControlNet™ • PROFIBUS • Modbus Plus™		• EtherNet/IP • ControlNet • PROFIBUS • Modbus Plus
	Preconfigured Network	Yes		Yes
	Pre-tested Network Connections	Yes		Yes
	Advanced Diagnostics	Yes		Yes
	IntelliCENTER Software	Preconfigured Software with • Elevation View • Monitor View • Event Log • Electronic System Documentation • ActiveX Objects for HMI Use		Preconfigured Software with • Elevation View • Monitor View • Event Log • Electronic System Documentation • ActiveX Objects for HMI Use
	Remote Access to Motor Control Data	Yes		Yes
	Detailed Device Information	Yes		Yes

Bulletin 100S/104S Safety Contactors



Bulletin 100S-C/104S-C safety contactors provide mechanically linked positively guided contacts, required in feedback circuits of modern safety applications. The mechanically linked N.C. auxiliary contacts will not change state when a power pole welds. In addition, the gold-plated bifurcated auxiliary contacts are ideally suited for low-energy applications or feedback control circuits with multiple series-connected N.C. auxiliary contacts.

- Mechanically linked N.C. auxiliary contacts
- Front-mounted auxiliary contacts:
  Gold bifurcated
  Permanently fixed
  Protective cover to prevent manual operation
  Red contact housing foreasy identification
  Incorporates IEC 60947-5-1 “Mechanically Linked” or IEC 60947-4-1 "Mirror Contact" symbol
- AC and DC operating coils
- SUVA Third-Party certification

Standards Compliance

EN50205
CSA C22.2 No. 14
UL 508
EN/IEC 60947-4
IEC 60947-4-1 Annex H — Mirror Contacts
IEC 60947-5-1 Annex L — Mechanically Linked Contacts

Certifications

SUVA Third-Party Certified
CE Marked
cULus Listed (File No. E3125;
Guide NLDX, NLDX7)

Your order must include: cat. no. of the contactor specified with coil voltage code and, if required, cat. no. of any accessories and/or replacement coils.

3-Pole AC- and DC-Operated Contactors

I_e [A]		Ratings for Switching AC Motors — AC-2, AC-3, AC-4										Aux. Contacts		Cat. No.✶❄
		3-Phase kW (50 Hz)				Hp (60 Hz)								
						1-Phase		3-Phase						
AC-3	AC-1	230V	400V/ 415V	500V	690V	115V	230V	200V	230V	460V	575V	N.O.	N.C.	
9	32	3	4	4	4	1/2	1-1/2	2	2	5	7-1/2	0	5	100S-C09⊗05BC
												1	4	100S-C09⊗14BC
12	32	4	5.5	5.5	5.5	1/2	2	3	3	7-1/2	10	0	5	100S-C12⊗05BC
												1	4	100S-C12⊗14BC
16	32	5.5	7.5	7.5	7.5	1	3	5	5	10	15	0	5	100S-C16⊗05BC
												1	4	100S-C16⊗14BC
23	32	7.5	11	13	10	2	3	5	7-1/2	15	15	0	5	100S-C23⊗05BC
												1	4	100S-C23⊗14BC
30	65	10	15	15	15	2	5	7-1/2	10	20	25	0	4	100S-C30⊗04BC
												1	4	**100S-C30⊗14BC**
37	65	11	18.5/20	20	18.5	3	5	10	10	25	30	0	4	100S-C37⊗04BC
												1	4	**100S-C37⊗14BC**
43	85	13	22	25	22	3	7-1/2	10	15	30	30	0	4	100S-C43⊗04BC
												1	4	**100S-C43⊗14BC**
60	100	18.5	32	37	32	5	10	15	20	40	50	0	4	‡ 100S-C60⊗04BC
												1	4	‡ **100S-C60⊗14BC**
72	100	22	40	45	40	5	15	20	25	50	60	0	4	‡ 100S-C72⊗04BC
												1	4	‡ **100S-C72⊗14BC**
85	100	25	45	55	45	7-1/2	15	25	30	60	60	0	4	‡ 100S-C85⊗04BC
												1	4	‡ **100S-C85⊗14BC**
97	130	30	55	55	55	10	15	30	30	75	75	0	4	‡ **100S-C97⊗04BC**
												1	4	‡ **100S-C97⊗14BC**

✶ For other contact configurations and full product details, please contact your local Rockwell Automation sales office or Allen-Bradley distributor.
❄ If standard cross-stamped front-mount auxiliary contacts are required, remove the letter "B" before the letter "C" in the cat. no. Example: Cat. No. **100S-C09⊗05BC** becomes Cat. No. **100S-C09⊗05C**.
‡ Bifurcated front-mount auxiliary contacts on Cat. Nos. **100S-C60…C97** conform to mirror contact performance only.
⊗ Coil Voltage Code, see page 6-94

4-Pole AC- and DC-Operated Contactors

Ratings for Switching AC Motors												Contact Configuration				
		AC-2, AC-3, AC-4				Hp (60 Hz)						Main Pole		Auxillary Contacts		
I_e [A]		3-Phase kW (50 Hz)❄														
						1-Phase		3-Phase ❄								
AC-3	AC-1	230V	400V/ 415V	500V	690V	115V	230V	200V	230V	460V	575V	N.O.	N.C.	N.O.	N.C.	Cat. No.✶‡
9	32	3	4	4	4	1/2	1-1/2	2	2	5	7-1/2	4	0	0	4	100S-C09⊗404BC
												3	1	0	4	100S-C09⊗304BC
12	32	4	5.5	5.5	5.5	1/2	2	3	3	7-1/2	10	4	0	0	4	100S-C12⊗404BC
												3	1	0	4	100S-C12⊗304BC
16	32	5.5	7.5	7.5	7.5	1	3	5	5	10	15	4	0	0	4	100S-C16⊗404BC
												3	1	0	4	100S-C16⊗304BC
23	32	7.5	11	13	10	2	3	5	7-1/2	15	15	4	0	0	4	100S-C23⊗404BC
												3	1	0	4	100S-C23⊗304BC

✶ For other contact configurations, please contact your local Rockwell Automation sales office or Allen-Bradley distributor.

❄ Three-phase ratings only apply to contactors with at least three N.O. power poles.

⊗ Coil Voltage Code, see page 6-94

‡ If standard cross-stamped front-mount auxiliary contacts are required, remove the letter "B" before the letter "C" in the cat. no. Example: Cat. No. **100S-C09⊗404BC** becomes Cat. No. **100S-C09⊗404C**.

Reversing AC- and DC-Operated Contactors

- 3 Main Contacts
- Includes Mechanical/Electrical Interlock
- Includes Reversing Power Wiring



I_e [A]		Ratings for Switching AC Motors AC-2, AC-3, AC-4										Aux. Contacts Installed per Contactor		Cat. No.∗❄
		3-Phase kW (50 Hz)				Hp (60 Hz)								
						1-Phase		3-Phase						
AC-3	AC-1	230V	400V/ 415V	500V	690V	115V	230V	200V	230V	460V	575V	N.O.	N.C. ‡	
9	32	3	4	4	4	1/2	1-1/2	2	2	5	7-1/2	0	6	104S-C09⊗012BC
												1	5	104S-C09⊗210BC
12	32	4	5.5	5.5	5.5	1/2	2	3	3	7-1/2	10	0	6	104S-C12⊗012BC
												1	5	104S-C12⊗210BC
16	32	5.5	7.5	7.5	7.5	1	3	5	5	10	15	0	6	104S-C16⊗012BC
												1	5	104S-C16⊗210BC
23	32	7.5	11	13	10	2	3	5	7-1/2	15	15	0	6	104S-C23⊗012BC
												1	5	104S-C23⊗210BC
30	65	10	15	15	15	2	5	7-1/2	10	20	25	0	5	104S-C30⊗010BC
												1	5	104S-C30⊗210BC
37	65	11	18.5/20	20	18.5	3	5	10	10	25	30	0	5	104S-C37⊗010BC
												1	5	104S-C37⊗210BC
43	85	13	22	25	22	3	7-1/2	10	15	30	30	0	5	104S-C43⊗010BC
												1	5	104S-C43⊗210BC
60	100	18.5	32	37	32	5	10	15	20	40	50	0	5	§ 104S-C60⊗010BC
												1	5	§ 104S-C60⊗210BC
72	100	22	40	45	40	5	15	20	25	50	60	0	5	§ 104S-C72⊗010BC
												1	5	§ 104S-C72⊗210BC
85	100	25	45	55	45	7-1/2	15	25	30	60	60	0	5	§ 104S-C85⊗010BC
												1	5	§ 104S-C85⊗210BC
97	130	30	55	55	55	10	15	30	30	75	75	0	5	§ 104S-C97⊗010BC
												1	5	§ 104S-C97⊗210BC

∗ For other contact configurations, please contact your local Rockwell Automation sales office or Allen-Bradley distributor.

❄ If standard cross-stamped front-mount auxiliary contacts are required, remove the letter "B" before the letter "C" in the cat. no. Example: Cat. No. **104S-C09⊗05BC** becomes Cat. No. **104S-C09⊗05C**.

‡ One of the N.C. auxiliary contacts is supplied as part of the mechanical/electrical interlock.

§ Bifurcated front-mount auxiliary contacts on Cat. Nos. **104S-C60…C97** conform to mirror contact performance only.

⊗ Coil Voltage Code, see page 6-94

⊗ Coil Voltage Code and Terminal Position

The Cat. No. as listed is incomplete. Select a coil voltage code from the table below to complete the Cat. No. Example: 120V, 60Hz: **Cat. No. 100S-C09⊗05BC** becomes **Cat. No.100S-C09D05BC.**

[V]	12	24	32	36	42	48	100	100-110	110	120	127	200	200-220	208	208-240	220-230
AC, 50 Hz	R	K	V	W	X	Y	KP	—	D	P	S	KG	L	—	—	F
AC, 60 Hz	Q	J	—	V	—	X	—	KP	—	D	—	—	KG	H	L	—
AC, 50/60 Hz	–	KJ	—	—	—	KY	KP	—	KD	—	—	KG	KL‡	—	—	KL‡

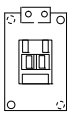
[V]	230	230-240	240	277	347	380	380-400	400	400-415	440	480	500	550	600
AC, 50 Hz	—	VA	T	—	—	—	N	—	G	B	—	M	C	—
AC, 60 Hz	—	—	A	T	I	E	—	—	—	N	B	—	—	C
AC, 50/60 Hz	KF	—	KA	—	—	—	—	KN	—	KB	—	—	—	—

‡ Not available in 100S/104S-C97 contactors

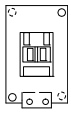
[V]			9	12	24	36	48	60	64	72	80	110	115	125	220	230	250
100S/104S-C09…C43	Standard	DC	ZR	ZQ	ZJ	ZW	ZY	ZZ	ZB	ZG	ZE	ZD	ZP	ZS	ZA	ZF	ZT
	with Integrated Diode		—	—	DJ	—	—	—	—	—	—	—	—	—	—	—	—
	Electronic with Integrated Diode		—	—	EJ	—	—	—	—	—	—	—	—	—	—	—	—
100S/104S-C60…C97	with Integrated Diode		DR	DQ	DJ	DW	DY	DZ	DB	DG	DE	DD	DP	DS	DA	DF	DT

Coil Terminal Position

- All contactors are delivered with the coil terminals located on the **line side.**
- For **load side** coil terminations, insert a **U** prior to the coil voltage code.
  Example: **Cat. No. 100S-C09UD05BC.**

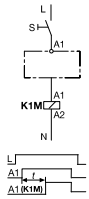
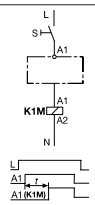
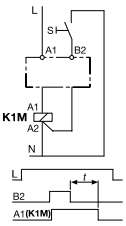
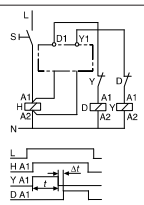
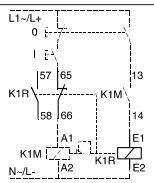


Cat. No. 100S-C09⊗05C Line Side



Cat. No. 100S-C09U⊗05C Load Side

Control Modules (For 100S-C09…C97 contactors)

	Description		Connection Diagrams	For Use With	Cat. No.
	**Pneumatic Timing Modules** Pneumatic timing element contacts switch after the delay time. The contacts on the main control relay continue to operate without delay.	**On-Delay** 0.3…30 s Range 1.8…180 s Range		100-C or 700-CF with AC or 24V DC electronic coils	100-FPTA30 100-FPTA180
		Off-Delay 0.3…30 s Range 1.8…180 s Range		100-C all, 700-CF all	100-FPTB30 100-FPTB180
	**Electronic Timing Modules — On-Delay** Delay of the contactor or control relay solenoid. The contactor or control relay is energized at the end of the delay time.	**On-Delay** 1…30 s Range 1…30 s Range 10…180 s Range 110…240V, 50/60 Hz 110…250V DC		100-C with 24…48V DC coils, 700-CF with DC coils	100-ETA3 100-ETA30 100-ETA180
		On-Delay 0.1…3 s Range 1…30 s Range 10…180 s Range 24…48V DC		100-C with 24…48V DC coils, 700-CF with DC coils	100-ETAZJ3 100-ETAZJ30 100-ETAZJ180
	**Electronic Timing Modules — Off-Delay** Delay of the contactor or control relay solenoid. After interruption of the control signal, the contactor or control relay is deenergized at the end of the delay time.	**Off-Delay** 0.3…3 s Range 1…30 s Range 10…180 s Range 24V, 50/60 Hz		100-C09…C37, 700-CF with 24V 50/60 Hz coils	100-ETBKJ3 100-ETBKJ30 100-ETBKJ180
		Off-Delay 0.3…3 s Range 1…30 s Range 10…180 s Range 110…240V, 50/60 Hz		100-C, 700-CF with 110…240V 50/60 Hz coils	100-ETB3 100-ETB30 100-ETB180
	**Electronic Timing Modules** Delay of the contactor solenoid. Contactor K 3 (Y) is de-energized (off) and K 2 (D) is energized (on) after the end of the set Y end time. (Switching delay at 50 ms.) Continuous adjustment range High repeat accuracy	**Transition Time Y Contactor** 1…30 s Range 110…240V, 50/60 Hz		100-C with 110…240V AC, 50/60 Hz coils	100-ETY30
	**Mechanical Interlocks** For interlocking of two contactors. Common interlock for all Bul. 100-C contactor sizes Interlocking of different sizes possible Mechanical and electrical interlocking possible in one module by means of integrated auxiliary contacts 9 mm dovetail connector included	Mechanical only without auxiliary contacts		100-C (except 100-C40, -C90)	100-MCA00
		Mechanical/ electrical with 2 N.C. auxiliary contacts		100-C (except 100-C40, -C90)	100-MCA02
	**Mechanical Latch** Following contactor latching, the contactor coil is immediately de-energized (off) by the N.C. auxiliary contact (65-66). Electrical or manual release 1 N.O. + 1 N.C. auxiliary contacts Suitable for all Bul. 100-C contactor sizes, 9…97 A	Maximum command duration 0.03…10 s		100-C with AC coils (except 100-C90)	100-FL11⊗

Package Quantity = 1

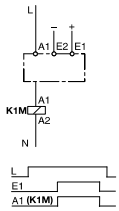
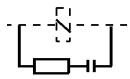
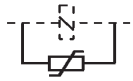
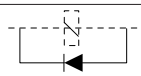
⊗ Coil Voltage Code

The cat. no. as listed is incomplete. Select a voltage suffix code from the table below to complete the Cat. No. Example: 120V, 60 Hz: **Cat. No. 100-FL11**⊗ becomes **Cat. No. 100-FL11D**.

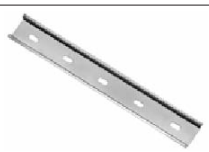
[V]∗	24V	48V	100V	110V	120V	230-240V	240V	277V	380-400V	400-415V	440V	480V
AC, 50 Hz	K	Y	KP	D	—	VA	T	—	N	G	B	—
AC, 60 Hz	J	—	—	—	D	—	A	T	—	—	N	B

∗ For special voltages, please contact your local Rockwell Automation sales office or Allen-Bradley distributor.

Control Modules (For 100S-C09…C97 contactors), Continued

	Description		Voltage Range	Connection Diagrams	For Use With	Cat. No.
	**DC Interface (Electronic)** Interface between the DC control signal (PLC) and the AC operating mechanism of the contactor. Requires no additional surge suppression on the relay coils		Input: 12V DC Output: 110…240V AC		100-C with AC coils 110…240V AC	100-JE12
			Input: 18…30V DC Output: 110…240V AC			100-JE
			Input: 48V DC Output: 110…240V AC			100-JE48
	**Surge Suppressors** For limitation of coil switching transients. Plug-in, coil mounted. Suitable for all 100-C contactor sizes, 9…85 A. RC, varistor, and diode versions.	**RC Module** AC operating mechanism	24…48V AC, 50/60 Hz		100-C with AC coils	100-FSC48
			110…280V AC, 50/60 Hz			100-FSC280
			380…480V AC, 50/60 Hz			100-FSC480
		Varistor Module AC/DC operating mechanism	12…55V AC/ 12…77V DC		100-C with AC or DC coils	100-FSV55
			56…136V AC/ 78…180V DC		100-C with AC or DC coils	100-FSV136
			137…277V AC/ 181…350V DC		100-C with AC or DC coils	100-FSV277
			278…575V AC		100-C with AC or DC coils	100-FSV575
		Diode Module DC operating mechanism	12…250V DC		100-C with DC coils	100-FSD250

Assembly Components (For 100S-C09…C97 contactors)

	Description	For Use With	Pkg. Quantity*	Cat. No.
 *Cat. No. 100-S0*	**Dovetail Connectors** For use in contactor and starter assemblies. Single Connector — 0 mm Spacing	100-C	10	100-S0
	Dovetail Connectors For use in contactor and starter assemblies. Dual Connector — 9 mm Spacing			100-S9
 *Cat. No. 100-SCCA*	**Protective Covers** Provides protection against unintended manual operation For contactors and front mounted auxiliary contacts, pneumatic timers and latches	100-C all	1	**100-SCCA**
 *Cat. No. 100-SCFA*		100-FA, -FB, -FC, -FP, -FL;	10	**100-SCFA**
 *Cat. No. 105-PW23*	**Reversing Power Wiring Kits** For reversing connection with a solid-state or thermal overload relay	100-C09…C23	1	105-PW23
		100-C30…C37		105-PW37
		100-C43		105-PW43
		100-C60…C97		105-PW85
	**DIN (#3) symmetrical rail** 35 x 7.5 x 1 m	100-C	10	199-DR1

* Must be ordered in multiples of package quantities.

Marking Systems (For 100S-C09…C97 contactors)

	Description	Pkg. Qty.∗	Cat. No.
	**Label Sheet** 105 self-adhesive paper labels each, 6 x 17 mm	10	100-FMS
	**Marking Tag Sheet** 160 perforated paper labels each, 6 x 17 mm, to be used with a transparent cover	10	100-FMP
	Transparent Cover To be used with marking tag sheets	100	100-FMC
	**Marking Tag Adapters** To be used with marking tag: System V4/V5	100	100-FMA1
	Marking Tag Adapters To be used with marking tag: System 1492 W	100	100-FMA2

∗ Must be ordered in multiples of package quantities.

Terminal Kits (For 100S-C09…C97 contactors)

	Description	Max. Current Ratings and Wire Sizes		Pkg. Qty.∗	Cat. No.
	**Stab Connector Kit** Dual stab (0.250 in.) for 100-C coil terminals For 100-C09…C97 contactors			20	199-SC2
	**Stab Connector Kit** Dual stab (0.250 in.) for 100-C power terminals For 100-C09…C23 contactors			100	199-SC10
	**3-Pole Terminal Lug Kit** For Cat. No. 100-C09…C23 (Line side)	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	45 A (4…16 mm²❄, fine stranded w/ferrule) 45 A (4…25 mm², coarse stranded/solid) 40 A (#10…4 AWG, stranded/solid)	1	100-CTN23
	3-Pole Terminal Lug Kit For Cat. No. 100-C09…C23 (Load side)	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	45 A (4…16 mm²❄, fine stranded w/ferrule) 45 A (4…25 mm², coarse stranded/solid) 40 A (#10…4 AWG, stranded/solid)	1	100-CTL23
	3-Pole Terminal Lug Kit For Cat. No. 100-C30…C37 (Line side)	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	60 A (4…16 mm²❄, fine stranded w/ferrule) 60 A (4…25 mm², coarse stranded/solid) 55 A (#10…4 AWG, stranded/solid)	1	100-CT37
	**1-Pole Terminal Lug Kit** For Cat. No. 100-C43	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	90 A (6…35 mm², fine stranded w/ferrule) 90 A (6…50 mm², coarse stranded/solid) 75 A (#8…2 AWG, stranded/solid)	3	100-CT43
	1-Pole Terminal Lug Kit For Cat. No. 100-C60…C97	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	130 A (10…70 mm², fine stranded w/ferrule) 130 A (10…95 mm², coarse stranded/solid) 130 A (#8…2/0 AWG, stranded/solid)	3	100-CT85
	**3-Pole Paralleling Kit** For Cat. No. 100-C09…C23	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	100 A (35…70 mm², fine stranded w/ferrule) 100 A (35…95 mm², coarse stranded/solid) 100 A (#0…2/0 AWG, stranded/solid)	2	100-CP23
	3-Pole Paralleling Kit For Cat. No. 100-C30…C37	IEC @ 40 °C IEC @ 40 °C UL/CSA (Encl.)	150 A (35…70 mm², fine stranded w/ferrule) 150 A (35…95 mm², coarse stranded/solid) 150 A (#0…2/0 AWG, stranded/solid)	2	100-CP37

∗ Must be ordered in package quantities.
❄ 16 mm² max. according to IEC 60947; actual max. 25 mm².

Bulletin 100S-D Safety Contactors





Bulletin 100S-D safety contactors were designed to address the needs of modern safety applications requiring feedback and monitoring of the energy isolating switchgear used in hazardous motion loads. The 100S-D meets these needs through its "mirror contact" design. If a power contact welds, the N.C. auxiliary contacts will not change state. This feature provides reliable indication about the open/closed status of the main power poles. In addition, the gold-plated bifurcated auxiliary contacts are ideally suited for low-energy applications or feedback control circuits with multiple series-connected N.C. auxiliary contacts.

- 63…500 kW @400V
- 75…600 Hp @460V
- 100…700 Hp @575V
- Electronic and conventional coils
  - AC & DC
  - Integrated PLC interface
  - Low power pick-up & hold-in
  - Wide voltage ranges
- Complete range of accessories
- Environmentally friendly
- Compact dimensions

Standards Compliance

IEC 60947-4-1
IEC 60947-4 Annex F
IEC 60947 Type “2” Coordination
CSA C22.2 No. 14
UL 508

Certifications

CE Marked
cULus Listed (File No. E 41850, Guide NLDX, NLDX7)
SUVA Certified

Your order must include: cat. no. of the contactor specified with coil voltage code and, if required, cat. no. of any accessories and/or replacement coils.

Product Selection

3-Pole AC-Operated Contactors

I_e [A]		Switching of 3-phase motors AC-2, AC-3										Coil Type	Auxiliary contacts		Cat. No.➢
60 °C	40 °C	kW (50 Hz)∗						Hp (60 Hz)					N.O.	N.C.❄	
AC-3	AC-1	230V	400V	415V	500V	690V	1000V	200V	230V	460V	575V				
115	250	37	63	66/75§	80	110	55	40	40	75	100	Conventional	2	2	100S-D115⊗22BC
115	250	37	63	66/75§	80	110	55	40	40	75	100	Electronic	2	2	100S-D115⊗22BC
140	250	45	78	82/90§	80/100 ‡	110/132 ‡	75	40	50	100	125	Conventional	2	2	100S-D140⊗22BC
140	250	45	78	82/90§	80/100 ‡	110/132 ‡	75	40	50	100	125	Electronic	2	2	100S-D140⊗22BC
180	250	55	101	100§	90/125 ‡	132/160 ‡	90	50	60	150	150	Conventional	2	2	100S-D180⊗22BC
180	250	55	101	100§	90/125 ‡	132/160 ‡	90	50	60	150	150	Electronic	2	2	100S-D180⊗22BC
210	350	63	118	110§	205	200	110	60	75	150	200	Electronic	2	2	100S-D210⊗22BC
250	350	80	140	150§	250	250	133	75	100	200	250	Electronic	2	2	100S-D250⊗22BC
300	450	90	170	160§	290	300	160	100	125	250	300	Electronic	2	2	100S-D300⊗22BC
420	540	132	238	250	420	425	220	150	175	350	400	Electronic	2	2	100S-D420⊗22BC
630	800	200	355	355	500	500	—	200	250	500	600	Electronic	2	2	100S-D630⊗22BC
860	1000	250	500	500	500	600	—	250	300	600	700	Electronic	2	2	100S-D860⊗22BC

∗ Preferred values according to IEC 60072-1.
❄ The N.C. contacts meet IEC 60947-4 Annex F requirements for mirror contact performance. The N.C. mirror contacts are wired in series or parallel and must be used as monitoring contacts with feedback to the safety circuit.
‡ Higher kW rating only applies to contactors with electronic coil.
➢ If standard cross-stamped front-mount auxiliary contacts are required, remove the letter "B" before the letter "C" in the cat. no. Example: Cat. No. **100S-D95⊗22BC** becomes Cat. No. **100S-D95⊗22C**.
§ 415V: Values for AC-3 and AC-4 lifespan -25%

⊗ **Coil Voltage Codes: see page 6-99**

3-Pole DC-Operated Contactors

I_e [A]		Switching of 3-phase motors AC-2, AC-3										Auxiliary contacts		Coil Type	Conventional Coil Cat. No.❄	Electronic Coil Cat. No.➢
60 °C	40 °C	kW (50 Hz) ✶						Hp (60 Hz)				N.O.	N.C. ❄ ✶			
AC-3	AC-1	230V	400V	415V	500V	690V	1000 V	200V	230V	460V	575V					
115	250	37	63	75	80	110	63	40	40	75	100	3	2/1L	Conventional	100S-D115⊗33LC‡ ❄	100S-D115⊗22BC
140	250	45	78	75	80/100§	110/132§	75	40	50	100	125	3	2/1L	Conventional	100S-D140⊗33LC‡ ❄	100S-D140⊗22BC
180	250	55	101	100	90/125§	132/160§	90	50	60	150	150	3	2/1L	Conventional	100S-D180⊗33LC‡ ❄	100S-D180⊗22BC
210	350	63	118	110	205	200	110	60	75	150	200	2	2	Electronic	—	100S-D210⊗22BC
250	350	80	140	150	250	250	133	75	100	200	250	2	2	Electronic	—	100S-D250⊗22BC
300	450	90	170	160	290	300	160	100	125	250	300	2	2	Electronic	—	100S-D300⊗22BC
420	540	132	238	250	420	425	220	150	175	350	400	2	2	Electronic	—	100S-D420⊗22BC
630	800	200	355	355	500	500	—	200	250	500	600	2	2	Electronic	—	100S-D630⊗22BC
860	1000	250	500	500	500	600	—	250	300	600	700	2	2	Electronic	—	100S-D860⊗22BC

✶ Preferred values according to IEC 60072-1.
❄ The N.C. contacts meet IEC 60947-4 Annex F requirements for mirror contact performance. The N.C. mirror contacts are wired in series or parallel and must be used as monitoring contacts with feedback to the safety circuit.
‡ For conventional DC coil only. The pickup winding must be interconnected with the N.C. late-breaking auxiliary contacts.
§ Higher kW rating only applies to contactors with electronic coil.
➢ If standard cross-stamped front-mount auxiliary contacts are required, remove the letter "B" before the letter "C" in the Cat. No. Example: Cat. No. **100S-D95⊗22BC** becomes Cat. No. **100S-D95⊗22C**.

⊗ Coil Voltage Codes

Conventional Coil	[V]	24	48	100	110	120	200	208	220 …230	230	240	277	380 …400	415	440	480	500	550	600
100S-D115…100S-D180	AC, 50 Hz	K	Y	—	D	—	—	—	A	—	T	—	N	B	G	—	M	C	—
	AC, 60 Hz	J	X	—	—	D	—	H	—	—	A	T	—	—	N	B	—	—	C
100S-D115	AC, 50/60 Hz	—	—	KP	KN	—	KG	—	KL	KF	KA	KT	—	—	—	—	—	—	—

Electronic Coil w/ PLC Interface§	[V]	24	42…64	100	110… 130	200	208… 277	200… 220	230… 250	277	380… 415	380… 440	440… 480	380… 500	500
100S-D115…100S-D300	AC, 50/60 Hz	EJ♣	EY	EP	ED	EG	EA	—	—	—	—	VN	—	EN	—
100S-D420	AC, 50/60 Hz	—	—	EP	ED	EG	EA	—	—	—	—	—	—	EN	—
100S-D630…100S-D860	AC, 50/60 Hz	—	—	EP	ED	EG	—	EG	EA	ET	EN	—	EB	—	EM

Conventional Coil	[V]	24	48	110	125	220	250
100S-D115…100S-D180 ‡	DC	ZJ	ZY	ZD	ZS	ZA	ZT

Electronic Coil w/ EI Interface ♣	[V]	24	48…72	110…130	200…255
100S-D115…100S-D300	DC	EZJ	EZY	EZD	EZA
100S-D420	DC	—	—	EZD	EZA
100S-D630…860	DC	—	—	ED	EA

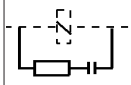
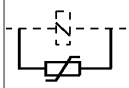
§ Signal voltage of the Cat. No. 100S-D… electronic interface U_e: 24V DC/I^e: 15 mA
Pick-up voltage: 13.0V DC…30.2V DC
Drop-out voltage: -3.0V DC…+5.0V DC
♣ Not available with 100S-D300.

Marking Systems (For 100S-D95…D860 contactors)

	Description	Pkg. Qty.§	Cat. No.
	**Label Sheet** 105 self-adhesive paper labels each, 6 x 17 mm	10	100-FMS
	**Marking Tag Sheet** 160 perforated paper labels each, 6 x 17 mm, to be used with a transparent cover	10	100-FMP
	Transparent Cover To be used with marking tag sheets	100	100-FMC
	**Marking Tag Adapters** To be used with marking tag: System V4/V5 System V4 / V5	100	100-FMA1
	System 1492 W	100	100-FMA2

❧ ★◆▲▼ ❁❄ ❑❒❄❄❒❄❄ ✻■ ❒❁❄❄❁❁❄ ❑◆❁■▼✻▼✻❄▲✎

Suppressor Modules

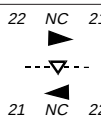
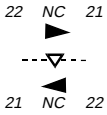
	Description	Connection Diagram	Suppressor Rating	For Use With	Cat. No.
	**Suppressor Module for Bul. 100-D Contactors** • For limiting surge voltage when coil circuits are interrupted • Supplied as standard on all conventional DC coil contactors and all electronic coil contactors (as part of the supply module or delivered with separate suppressor module)		**RC Module (AC control) for contactors with conventional coil** 21...48V, 50 Hz; 24...55V, 60 Hz	100-D115...100-D180	100-DFSC48
			95...110V, 50 Hz; 110...127V, 60 Hz		100-DFSC110
			180...277V, 50 Hz; 208...277V, 60 Hz		100-DFSC240
			380...550V, 50 Hz; 440...600V, 60 Hz		100-DFSC550
			**Varistor Module for contactors with conventional coil** 55V AC	100-D115...100-D180	100-DFSV55
			56...136V AC		100-DFSV136
			137...277V AC		100-DFSV277
			278...600V AC		100-DFSV575
			208...277V AC∗	100-D115...100-D180	100-DFSV550

∗ For overvoltage category IV (IEC 947 for 100-D...-EI) e.g., lightning protection requirements.
Package Quantity = 1

Connecting Components

	Description	For Use With		Cat. No.
	**Terminal Lugs** Set of two Protection class IP2X per IEC 60529 and DIN 40 050	100-D115		100-DTB110
		100-D140, 100-D180, 100-D115E…D180E, 193-EC_F, 193-EE_F		100-DTB180
		100-D210...100-D420, 193-EC_G, 193-EF2C, 193-EE_G		100-DTB420
	**Terminal Lugs (UL/CSA), Copper Frame** Set of three	100-D115		**100-DL110**
		100-D115E, 193-EC_F, 193-EE_F		**100-DLE110**
		100-D140, 100-D180, 193-EC_F, 193-EE_F		**100-DL180**
		100-D210…100-D420, 193-EC_G, 193-EE_G		**100-DL420**
		100-D630, 100-D860, 193-EC_H, 193-EE_H		**100-DL630**
		100-D630, 100-D860, 193-EC_H, 193-EE_H		**100-DL860**
	**Control Circuit Terminal** 2 x 2.5 mm²	Connects to Cat. Nos. 100-D115...D180		100-DAT1
		Connects to Cat. Nos. 100-D210...D420		100-DAT2
	**Terminal Shields** Set of two Protection class IP10 per IEC 60529 and DIN 40 050 For direct-on-line, reversing, two-speed, and wye-delta/star-delta assemblies	100-D115		100-DTS110
		100-D140, 100-D180, 100-D115-E…100-D180-E		100-DTS180
		100-D210...100-D420		100-DTS420
	**Terminal Covers** Protection class IP20 per IEC 60529 and DIN 40 050 For direct-on-line, reversing, two-speed, and wye-delta/star-delta assemblies	100-D115…100-D180, 193-EC_F, 193-EE_F		100-DTC180
		100-D210...100-D420, 193-EC_G, 193-EE_G		100-DTC420
		100-D630…100-D860, 193-EC_H, 193-EE_H		100-DTC860
	**Mounting Plate** Galvanized steel plate for starter combinations For direct-on-line, reversing, two-speed, wye-delta/star-delta, and Dahlander assemblies	100-D115...100-D180	Direct-on-line	100-DMS180
			Reversing, two-speed or changeover	100-DMU180
			Y-Δ or Dahlander	100-DMY180
		100-D210...100-D420	Direct-on-line	100-DMS420
			Reversing, two-speed or changeover	100-DMU420
			Y-Δ or Dahlander	100-DMY420
		100-D630...100-D860	Direct-on-line	100-DMS860
			Reversing, two-speed or changeover	100-DMU860
			Y-Δ or Dahlander	100-DMY860
	Mounting Plate For two-speed or changeover switches	For interlocking between 100-C60…C97 and 100-D115…D180 contactors		100-DMU85

Interlocks

	Description	Circuit Diagram	For Use With	Cat. No.
	**Interlock — Mechanical Only** No additional space required		100-D115…100-D420	100-DMA00
	**Interlock — Dual Electrical/Mechanical** No additional space required Two N.C. auxiliary contacts		100-D115…100-D860	100-DMD02
	Interlock — Mechanical Only No additional space required		100-D115…100-D860	100-DMD00
	Interlock — Mechanical Only Provides interlocking between Bul. 100-C and Bul. 100-D contactors		100-C60…100-C97 between 100-D115…100-D180	100-DMC00
	Interlock — Dual Electrical/Mechanical Provides interlocking between Bul. 100-C and Bul. 100-D contactors Two N.C. auxiliary contacts		100-C60…100-C97 between 100-D115…100-D180	100-DMC02

Package Quantity = 1

Specifications

Coil Type :	Conventional	100S/104S-C										
		09	12	16	23	30	37	43	60	72	85	97
	Conventional	X	X	X	X	X	X	X	X	X	X	X
	Electronic — EI	—	—	—	—	—	—	—	—	—	—	—
Conductor Cross Sections - Main Contacts Terminal type					✶			❄			‡	
(1) conductor [mm²]		1…4				2.5…10		2.5…16	2.5…35			2.5…35
(2) conductors [mm²]		1…4				2.5…10		2.5…10	2.5…25			2.5…35
(1) conductor [mm²]		1.5…6				2.5…16		2.5…25	2.5…50			2.5…50
(2) conductors [mm²]		1.5…6				2.5…16		2.5…16	2.5…35			2.5…50
b max. [mm]		—				—		—	—			
c max. [mm]		—				—		—	—			
s max. [mm]		—				—		—	—			
Ø min. [mm]		—				—		—	—			
Recommended torque	[N•m]	1.5…2.5				2.5…3.5		2.5…3.5	4…6			
Cross section per UL/CSA	[AWG]	16…10				14…4		14…4	14…1			
Recommended torque	[lb•in]	13.3…22				22…31		22…31	40…53			
With terminal lug kit		—				—		—	—			
Cross section per UL/CSA	[AWG]	—				—		—	—			
Recommended torque	[lb•in]	—				—		—	—			
With Frame Terminal Block		—				—		—	—			
top opening [mm²]		—				—		—	—			
bottom opening [mm²]												
top opening [mm²]		—				—		—	—			
bott. opening [mm²]												
b max. [mm]		—				—		—	—			
s top [mm]												
s bottom [mm]												
Recommended torque	[N•m]	—				—		—	—			
Cross section per UL/CSA top	[AWG]	—				—		—	—			
bottom	[AWG]	—				—		—	—			
Recommended torque	[lb•in]	—				—		—	—			

✶ Pozidriv No. 2 / Blade No. 3 screw
❄ Pozidriv No. 2 / Blade No. 4 screw
‡ Hexagonal socket screw

100S-D									
115	115	140	180	210	250	300	420	630	860
X	—	X	X	—	—	—	—	—	—
—	X	X	X	X	X	X	X	X	X
 §	 §			 §				 §	
— —	— —			— —				— —	— —
— —	— —			— —				— —	— —
20	25			30				52	52
10	12.5			15				22	22
5	5			6				2 x 8	2 x 8
6.1	8.3			10.5				13	13
8…10	10…12			16				68	68
—	—			—				—	—
70…90	90…110			130…150				600	600
100-DL110‡	100-DLE110‡	100-DL180‡		100-DL420‡				100-DL630	100-DL860
8…2/0	8…2/0	6…300 MCM		(2x) 4…350 MCM				(2X) 2/0… 500MCM	(4X) 2/0… 500MCM
90	90	250		250				400	400
100-DTB110‡	100-DTB180‡			100-DTB420✶				—	—
16…35 16…70	16…35 16…95			25…240♣ 25…240				—	—
16…50 16…95	16…50 16…120			25…300 25…300				—	—
16 3…9 3…12	20 3…9 3…14			25 4…20 4…20				—	—
8…10	10…12			20…25				—	—
6…1 / 0 AWG	6…1 / 0 AWG			4 AWG…600 MCM				—	—
6…3 / 0 AWG	6 AWG…250 MCM			4 AWG…600 MCM				—	—
70…90	90…110			180…220				—	—

✶ Pozidriv No. 2 / Blade No. 3 screw
‡ Hexagonal socket screw
§ Hexagonal screw
♣ 25…95 mm² with sleeve per DIN 46228

Coil Data

			100S/104S-C										
			09	12	16	23	30	37	43	60	72	85	97
	Conventional		X	X	X	X	X	X	X	X	X	X	X
Coil Type	Electronic — EI		—	—	—	—	—	—	—	—	—	—	—
Operating Limits													
50 Hz, 60 Hz, 50/60 Hz	pick-up	[x *Us*]	0.85…1.1						0.85….1.1				
	dropout	[x *Us*]	0.3…0.6						0.3…0.6				
DC (conventional)	pick-up	[x *Us*]	0.8…1.1						0.8…1.1				
	dropout	[x *Us*]	0.1…0.6						0.1…0.6				
DC (electronic)	pick-up	[x *Us*]	0.7…1.25							—			
	dropout	[x *Us*]	0.1…0.5							—			
Coil Consumption													
50 Hz, 60 Hz, 50/60 Hz	pick-up	[VA/W]	70/50			70/50	80/60		130/90	200/110			
	hold-in	[VA/W]	8/2.6			9/3	9/3		10/3.2	16/4.5			
DC (conventional)	pick-up	[W]	6.5			9.2	9.2		10.1	200			
	hold-in	[W]	6.5			9.2	9.2		10.1	4.5			
DC (electronic)	pick-up (avg/peak)	[W]	10/22				10/22		10.1	—			
	hold-in	[W]	1.5						10.1	—			
Operating Times													
AC	closing delay	[ms]	15…30			15…30	15…30		15…30	20…40			
	opening delay	[ms]	10…60			10…60	10…60		10…60	10…60			
With RC module	opening delay	[ms]	10…60			10…60	10…60		10…60	10…60			
DC (conventional)	closing delay	[ms]	40…70			40…70	50…80		50…80	20…40			
	opening delay	[ms]	7…15			7…15	7…15		7…15	—			
With integ. diode	opening delay	[ms]	14…20			17…23	17…23		17…23	≤ 220V 20…35			
With external diode	opening delay	[ms]	70…95			80…125	80…125		80…125	≤ 220V 80…125			
DC (electronic)	closing delay	[ms]	20…40							—			
	opening delay	[ms]	20…40							—			
Max. Ripple			± 15%							—			

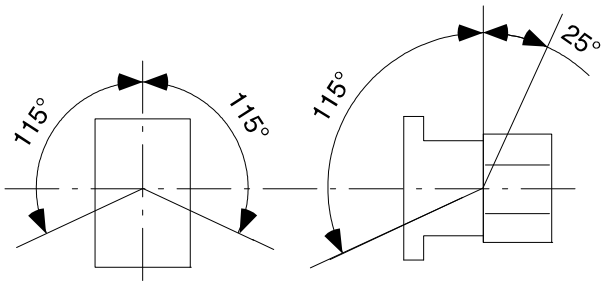
			100S-D										
			115	140/180	95	110	140	180	210	250	300	420	630	860
		Conventional	X	X	—	—	—	—	—	—	—	—	—	—
Coil Type		Electronic — EI	—	—	X	X	X	X	X	X	X	X	X	X
Operating Limits														
50 Hz, 60 Hz, 50/60 Hz	pick-up	[x *Us*]	0.85…1.1		0.85…1.1								0.8…1.1	
	dropout	[x *Us*]	0.3…0.6		0.3…0.5								0.3…0.8	
DC control	pick-up	[x *Us*]	0.85…1.1		0.85…1.1								0.85…1.1	
	dropout	[x *Us*]	0.3…0.6		0.3…0.5								0.3…0.8	
Coil Consumption														
50 Hz, 60 Hz, 50/60 Hz	pick-up	[VA/W]	650/310		380/240∗							490/270∗	1915/1720∗	
	hold-in	[VA/W]	50/10		13/6							18/7	33/30	
DC control	pick-up	[W]	540		265∗							340∗	1980∗	
	hold-in	[W]	8		6							7	30	
Operating Times														
AC	closing delay	[ms]	20…47		20…45								60…100	
	opening delay	[ms]	6…12		25…110								70…145	
With RC module	opening delay	[ms]	9…18		—								—	
DC	closing delay	[ms]	27…47		25…50								60…100	
	opening delay	[ms]	12…20		35…110								70…145	
With integrated diode	opening delay	[ms]	12…20		—								—	
With external diode	opening delay	[ms]	—		—							—	—	

∗ Electronic coil drives are designed to minimize power requirements, but this control may exhibit a higher inrush (540 W, < 10 ms) when energizing. This must be taken into account for the proper sizing of supply devices, all-or-nothing relays and cross-sections of coil supply lines. Please contact your local Rockwell Automation sales office or Allen-Bradley distributor for detailed information.

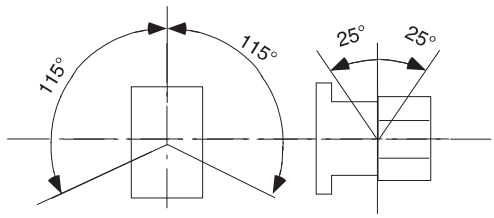
Bulletin 100S-C/104S-C Approximate Dimensions

Approximate dimensions are shown in millimeters (inches) and not intended for manufacturing purposes.

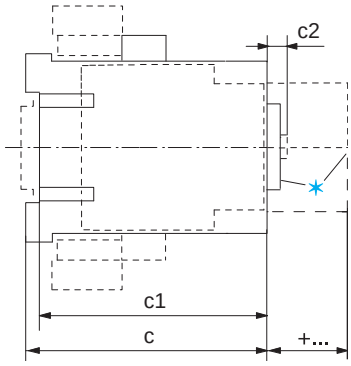
Mounting Position



AC contactors and DC contactors with electronic coils



DC contactors



AC Contactors and DC Contactors with Electronic Coils

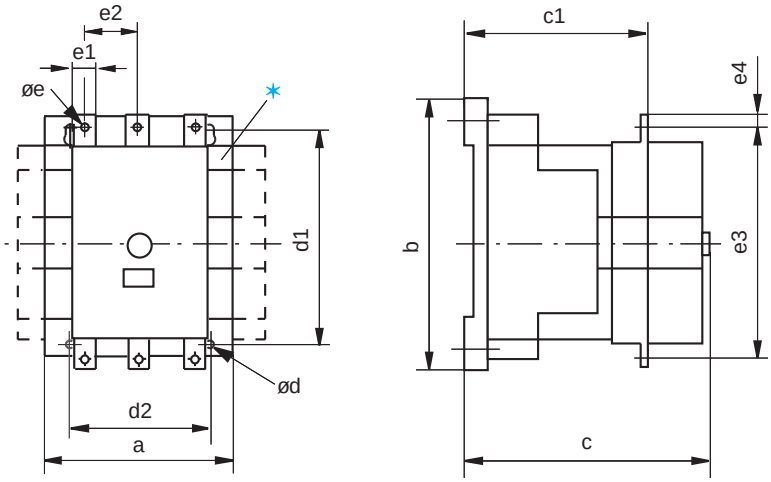
Cat. No.	a	b	c	c1	c2	Ød	d1	d2
100S-C09...100S-C23	45 (1-25/32)	81 (3-3/16)	119.5 (4-3/4)	114.5 (4-43/64)	6 (15/64)	2-4.5 (2-3/16)	60 (2-23/64)	35 (1-3/8)
100S-C30, 100S-C37	45 (1-25/32)	81 (3-3/16)	136.5 (5-37/64)	131.6 (5-11/32)	6.5 (1/4)	2-4.5 (2-3/16)	60 (2-23/64)	35 (1-3/8)
100S-C43	54 (2-1/8)	81 (3-3/16)	139.5 (5-11/16)	134.6 (5-29/64)	6.5 (1/4)	2-4.5 (2-3/16)	60 (2-23/64)	45 (1-25/32)
100S-C60...100S-C97	72 (2-53/64)	122 (4-51/64)	156 (6-11/32)	150.5 (6-1/8)	8.5 (21/64)	4-5.4 (4-7/32)	100 (3-15/16)	55 (2-11/64)

DC Contactors

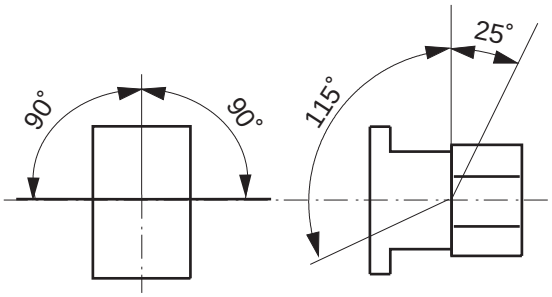
Cat. No.	a	b	c	c1	c2	Ød	d1	d2
100S-C09Z...100S-C16Z	45 (1-25/32)	81 (3-3/16)	145.5 (5-49/64)	140.5 (5-37/64)	6 (15/64)	2-4.5 (2-3/16)	60 (2-23/64)	35 (1-3/8)
100S-C23Z	45 (1-25/32)	81 (3-3/16)	162.5 (6-7/16)	158 (6-1/4)	6 (15/64)	2-4.5 (2 -3/16)	60 (2-23/64)	35 (1-3/8)
100S-C30Z...100S-C37Z	45 (1-25/32)	81 (3-3/16)	180.5 (7-5/32)	175.5 (6-61/64)	6.5 (1/4)	2-4.5 (2-3/16)	60 (2-23/64)	35 (1-3/8)
100S-C43Z	54 (2-1/8)	81 (3-3/16)	183.5 (7-17/64)	179 (7-3/32)	6.5 (1/4)	2-4.5 (2-3/16)	60 (2-23/64)	45 (1-25/32)
100S-C60D...100S-C97D	72 (2-53/64)	122 (4-51/64)	156 (6-11/32)	150.5 (6-1/8)	8.5 (21/64)	4-5.4 (4-7/32)	100 (3-15/16)	55 (2-11/64)

Bulletin 100S-D Contactors and Accessories

Approximate dimensions are shown in millimeters (inches) and not intended for manufacturing purposes.



Mounting Position



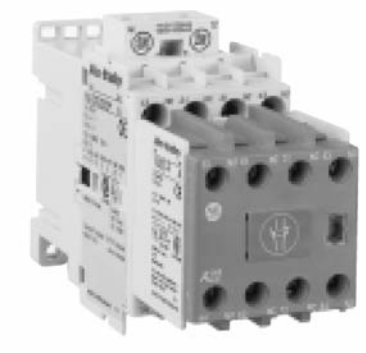
Cat. No.	a	b	c	c1	Ød	d1	d2	Øe	e1	e2	e3	e4
100S-D115	120	170	156	110.5	5.2	145	100	M6	16	38.5	147	8
100S-D115E...100S-D180E, 100S-D140, 100S-D180	120	170	156	110.5	5.2	145	100	M8	20	39	160	10
100S-D210E...100S-D420E	155	205	180	110.5	6.5	180	130	M10	25	48	193	12.5
100S-D630E...100S-D860E	255	310	265	110.5	10	230	225	M12	40	70	291	22

Contactor with		mm
Auxiliary contact block ∗	100-DS1... 100-DS2...	a a + 13.5 each
Mechanical Interlock	100-DM...	a + a
Frame terminal block	100-DTB110 100-DTB180 100-DTB420	b + 7 each b + 7 each b + 8.5 each
Label holder		c...+ 5

∗ Conventional DC coil contactors will have an additional auxiliary contact block that will add 13.5 mm to the “a” dimension on the right-hand side.

Safety Control Relays

Bulletin 700S-CF



Description

Bulletin 700S-CF Safety Control Relays provide mechanically or mirror contact performance, which are required in feedback circuits for safety applications. Bifurcated contacts are ideal for low energy feedback safety dircuits where high contact reliability is required.

Features

- IEC industrial safety relay
- Mechanically linked contacts as per IEC 60947-5-1
- Third party certification SUVA
- Red cover and mechanically linked contact symbol on front face
- Gold plated, bifurcated version for low level switching applications
- Permanently fixed front mounted auxiliary contact block

Standards Compliance

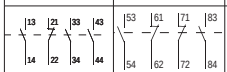
EN/IEC 60947-1, -5-1
UL 508
CSA C22.2 No. 14

Certifications

cULus Listed (File No. E14840, Guide NKCR/NKCR7)
CE Marked

Product Selection

Type CF and CFB Safety Control Relays — 8-Pole AC Coil Voltage (Ratings for 700S-CF Only)

AC-12			AC-15							Connection Diagrams		Contacts		Standard Contacts (Main) Gold-Plated Bifurcated (Front) Cat. No.	Gold-Plated Bifurcated, All Contacts Cat. No.❄
I_{th} [A]			I_e [A]												
	40 °C	60 °C	24/48V	120V	240V	400V	500V	600V	690V	Main Contacts	Auxiliary Contacts	N.O.	N.C.		
Main Contacts	20	20	10	10	10	6	2.5	1	1			4	4	**700S-CF440⊗BC**	**700S-CFB440⊗C**
												5	3	700S-CF530⊗BC	700S-CFB530⊗C
Adder Deck Contacts	10	6	6	6	5	3	1.6	1	1			6	2	**700S-CF620⊗BC**	700S-CFB620⊗C

❄ Ratings for Bulletin 700CFB and CFM are on page 6-104

⊗ AC Coil Voltage Code

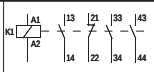
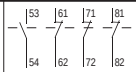
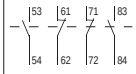
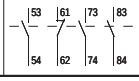
The cat. no. as listed is incomplete. Select a coil voltage code from the table below to complete the cat. no. Example: **Cat. No. 700S-CF440⊗BC** becomes **Cat. No. 700S-CF440DBC** for 120V, 60 Hz.

[V]	12	24	32	36	42	48	100	100-110	110	120	127	200	200-220	208	208-240	220-230
50 Hz	R	K	V	W	X	Y	KP	—	D	P	S	KG	L	—	—	F
60 Hz	Q	J	—	V	—	X	—	KP	—	D	—	—	KG	H	L	—
50/60 Hz	—	KJ	—	—	—	KY	KP	—	KD	—	—	KG	KL	—	—	KL

[V]	230	230-240	240	277	347	380	380-400	400	400-415	440	480	500	550	600
50 Hz	—	VA	T	—	—	—	N	—	G	B	—	M	C	—
60 Hz	—	—	A	T	I	E	—	—	—	N	B	—	—	C
50/60 Hz	KF	—	KA	—	—	—	—	KN	—	KB	—	—	—	—

Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

Type CF and CFB Safety Control Relays — 8-Pole DC Coil Voltage (Ratings for 700S-CF Only)

AC-12			AC-15							Connection Diagrams		Contacts		Standard Contacts (Main) Gold-Plated Bifurcated (Front) Cat. No.∗	Gold Plated Bifurcated, All Contacts Cat. No.∗
I_{th} [A]			I_e [A]												
	40 °C	60 °C	24/48V	120V	240V	400V	500V	600V	690V	Main Contacts	Auxiliary Contacts	No. of N.O. Contacts	No. of N.C. Contacts		
Main Contacts	20	20	10	10	10	6	2.5	1	1			4	4	**700S-CF440⊗BC**	**700S-CFB440⊗C**
												5	3	700S-CF530⊗BC	700S-CFB530⊗C
Adder Deck Contacts	10	6	6	6	5	3	1.6	1	1			6	2	**700S-CF620⊗BC**	700S-CFB620⊗C

∗ Ratings for Bulletin 700-CFB and 700-CFM are on page 6-104

⊗ DC Coil Voltage Code

The cat. no. as listed is incomplete. Select a coil voltage code from the table below to complete the cat. no. Example: **700S-CF440⊗C** becomes **Cat. No. 700S-CF440ZJC** for 24V DC.

[V]	9	12	24	36	48	60	64	72	80	110	115	125	220	230	250
Standard	**ZR**	**ZQ**	**ZJ**	**ZW**	**ZY**	**ZZ**	**ZB**	**ZG**	**ZE**	**ZD**	**ZP**	**ZS**	**ZA**	**ZF**	**ZT**
Standard with diode	—	—	DJ	—	—	—	—	—	—	—	—	—	—	—	—
Electronic with diode	—	—	EJ	—	—	—	—	—	—	—	—	—	—	—	—

Specifications

			Cat. No. 700S-CF	Aux. Contact (Front-mounted)
Mechanical Life		[Mil]	15	15
Electrical Life	AC-15 (240V, 3 A)	[Mil]	1.5	1.5
Weight	AC Coil	[g]	390	—
Terminal Cross-Sections				
Terminal Type				
Terminal Size per IEC 60947-1			2 x A4	2 x A4
 Solid/ Stranded‡	1 Conductor	[mm²]	1.5…6	0.5…2.5
	2 Conductor	[mm²]	1.5…6	0.75…2.5
Max. Wire Size per UL/CSA		**[AWG]**	16…10	18…14
Tightening Torque		[lb·in]	13.3…22	8.9…13.3
Tightening Torque		[N·m]	1.5…2.5	1…1.5

‡ For 16 or more strands, end ferrule is required

DC Switching Ratings for 700S-CF Main Poles in Series (Resistive Load at 60 °C)

	1 pole	2 poles	3 poles
24/48V	25/20 A	25 A	25 A
125V	6 A	25 A	25 A
220V	1.5 A	8 A	25 A
440V	0.4 A	1 A	3 A

Specifications, Continued

			Main Relay Cat. Nos. 700-CF, 700S-CF	Front Mounted Standard Auxiliary Contacts	Main Relay Cat. No. 700-CFB, 700S-CFB	Master Relay Cat. No. 700-CFM	Front Mounted Bifurcated Auxiliary Contacts	Side-mounted Auxiliary Contacts
Contact Ratings — NEMA			A600, P600	A600, Q600	A600, Q600	2 x A600, P600	A600, Q600	A600, Q600
Min. Contact Rating			17V, 10 mA	17V, 5 mA	8V, 5 mA	—	5V, 3 mA	17V, 10 mA
Contact Ratings — IEC AC-15 (solenoids, contactors) at rated voltage IEC 60947-5-1		24V	10 A	6 A	3 A	15 A	3 A	6 A
		48V	10 A	6 A	3 A	15 A	3 A	6 A
		120V	10 A	6 A	3 A	15 A	3 A	6 A
		240V	10 A	5 A	3 A	15 A	3 A	5 A
		400V	6 A	3 A	2 A	7.5 A	2 A	3 A
		480V/500V	2.5 A	1.6 A	1.2 A	5 A	1.2 A	1.6 A
		600V	1 A	1 A	0.7 A	2 A	0.7 A	1 A
		690V	1 A	1 A	0.7 A	2 A	0.7 A	1 A
AC-12 (Control of resistive loads) IEC 60947-5-1	**40 °C**	***I*th**	20 A	10 A	10 A	20 A	10 A	10 A
		230 V	8 kW					
		400 V	14 kW					
		690 V	24 kW					
	60 °C	***I*th**	20 A	6 A	6 A	20 A	6 A	6 A
		230V	8 kW					
		400V	14 kW					
		690V	24 kW					
DC-12 Switching DC Loads L/R < 1ms, Resistive Loads IEC 60947-5-1		24V	15 A	10 A	6 A	20 A	6 A	6 A
		48V	10 A	9 A	3.2 A	20 A	3.2 A	3.2 A
		110V	6 A	3.5 A	1 A	8 A	1 A	1 A
		220V	1 A	0.7 A	0.5 A	1.5 A	0.5 A	0.5 A
		440V	0.4 A	0.2 A	0.2 A	0.4 A	0.2 A	0.2 A
DC-13 IEC 60947-5-1, Solenoids and contactors		24V	5 A	5 A	2.5 A	5 A	2.5 A	5 A
		48V	3 A	3 A	1.5 A	3 A	1.5 A	3 A
		110V	1.2 A	1.2 A	0.6 A	1.2 A	0.6 A	1.2 A
		220V	0.6 A	0.6 A	0.3 A	0.6 A	0.3 A	0.6 A
		440V	0.3 A	0.15 A	0.15 A	0.3 A	0.15 A	0.15 A

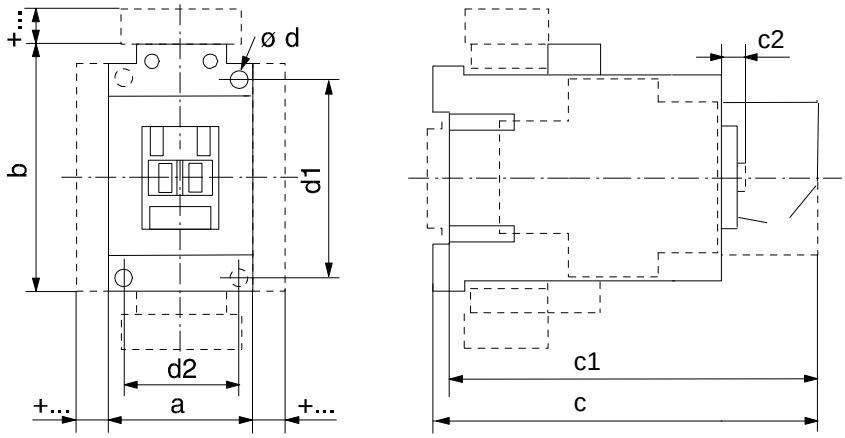
∗ Side mounted auxiliary contacts provide “mirror contact” performance with main poles only.

	Location of welded N.O. contacts	State of N.C. Contacts if N.O. contact welds		
		Main	Front aux.	Side aux.
Mechanically Linked Contacts❄	Main	Open	Open	Open∗
	Front aux.	Open	Open	—

❄ Defined in IEC 60947-5-1 annex L. Mechanically linked is a relationship between contacts of opposite types (i.e., N.O. and N.C.).

Approximate Dimensions

Approximate Dimensions are shown in millimeters (inches). Approximate Dimensions are not intended for manufacturing purposes.



AC and DC EJ Safety Control Relays

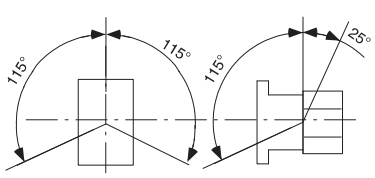
Cat. No.	a	b	c	c1	c2	Ød	d1	d2
700S-CF	45	81	119.5	114.5	6	2 - 4.5	60	35
	(1-25/32)	(3-3/16)	(4-3/4)	(4-43/64)	(1/4)	(2 - 3/16)	(2-23/64)	(1-25/64)

DC Safety Control Relays

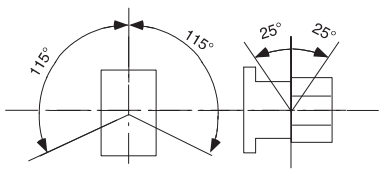
Cat. No.	a	b	c	c1	c2	Ød	d1	d2
700S-CF	45	81	145.5	140.5	6	2 - 4.5	60	35
	(1-25/32)	(3-3/16)	(5-49/64)	(5-37/64)	(1/4)	(2 - 3/16)	(2-23/64)	(1-25/64)

Safety Control Relays with	mm	[in.]
Auxiliary contact block for side mounting 1- or 2-pole	a + 9	(a + 23/64)
Electronic Timing Module on coil terminal side	b + 24	(b + 15/16)
Interface Module on coil terminal side	b + 9	(b + 23/64)
Surge Suppressor on coil terminal side	b + 3	(b + 1/8)
Labeling with label sheet	+ 0	(+ 0)
Marking tag sheet with clear cover	+ 0	(+ 0)
Marking tag adapter for System Bul. 1492W	+ 5.5	(+ 7/32)

Mounting Position



AC and DC E Safety Control Relays



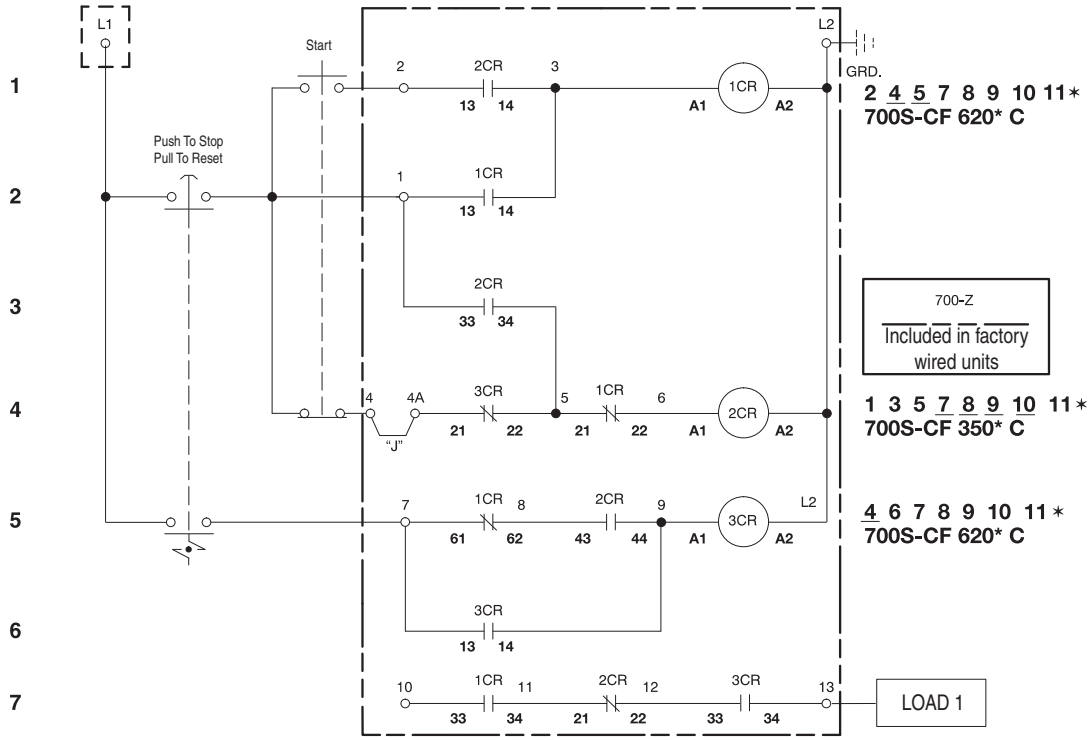
DC Safety Control Relays

Safety Relay Circuit With 5 Safety Outputs

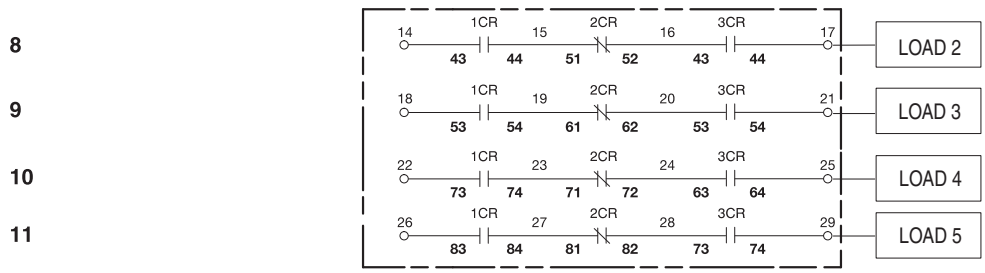
- Use for E-stop control. E-stop will work properly if any one fault occurs (a fault could be one welded contact or one undesired open connection such as a loose wire).
- High output switching capability and long contact life.
- Circuit complies with EN 954 categories 1, 2, 3, 4.
- Helps prevent restart of the 5 safety outputs if there is a single fault anywhere in the system.
- Use (3) 700S-CF relays and this diagram to construct the circuit

Basic Circuit
(1) Output Circuit (3 Relays, 9 Terminal Blocks)

Basic Circuit
(1) Output Circuit (3 Relays, 9 Terminal Blocks)



(5) Output Circuit (3 Relays, 17 Terminal Blocks)



* Numbers shown are the line numbers where the contacts for this relay appear.
Contact your local Rockwell Automation sales office or Allen-Bradley distributor for availability.



Features

- Mechanically linked contacts meet IEC 947-5-1-L
- 2…12 poles – all mechanically linked
- Red cover for easy identification of safety circuits
- Tamper resistant cover helps prevent changes which could jeopardize safety
- IEC mechanically linked contacts symbol displayed on front
- Visual indication of contact state
- Ideal for use in safety circuits

Certifications

cULus Listed (File No. E14840, Guide NKCR/NKCR7)
CE Certified
ABS Certified

Standards Compliance

UL 508
CSA C22.2 No. 14

Product Selection

Bulletin 700S-P (10 A) Safety Control Relays — AC and DC Coil Voltages

Contacts		AC Coils	24V DC Coils	
		Open Type Panel Mount Relay Rail Mount	Open Type Panel Mount Relay Rail Mount	Open Type DIN Rail Mount
N.O.	N.C.	Cat. No.∗	Cat. No.∗	Cat. No.∗
3	1	700S-P310⊗	700S-DCP310Z24	700S-DCP310DZ24
2	2	**700S-P220⊗**	700S-DCP220Z24	700S-DCP220DZ24
7	1	700S-P710⊗	700S-DCP710Z24	700S-DCP710DZ24
6	2	700S-P620⊗	700S-DCP620Z24	700S-DCP620DZ24
5	3	700S-P530⊗	700S-DCP530Z24	700S-DCP530DZ24
4	4	**700S-P440⊗**	700S-DCP440Z24	700S-DCP440DZ24
3	5	700S-P350⊗	700S-DCP350Z24	700S-DCP350DZ24
10	2	700S-P1020⊗	700S-DCP1020Z24	700S-DCP1020DZ24

Bulletin 700S-PK (20 A) Safety Control Relays

Contacts		Coil Voltage	Cat. No.
N.O.	N.C.		
7	1	110V AC	700S-PK710A1
6	2	110V AC	700S-PK620A1
5	3	110V AC	700S-PK530A1
4	4	110V AC	700S-PK440A1
3	5	110V AC	700S-PK350A1
10	2	110V AC	700S-PK1020A1
3	1	110V AC	700S-PK310A1
7	1	24V DC	700S-DCPK710Z24
6	2	24V DC	700S-DCPK620Z24
5	3	24V DC	700S-DCPK530Z24
4	4	24V DC	700S-DCPK440Z24
3	5	24V DC	700S-DCPK350Z24
10	2	24V DC	700S-DCPK1020Z24
3	1	24V DC	700S-DCPK310Z24

⊗AC Coil Voltage Code

The Cat. No. as listed is incomplete. Select a coil voltage code from the table below to complete the Cat. No.
Example: **Cat. No. 700S-P310** becomes **Cat. No. 700S-P310A1** for a 120V AC coil.

[V]	24	115...120	230...240	460...480
60 Hz	A24	**A1**	A2	A4

∗ For other coil voltages, consult your local Rockwell Automation sales office or Allen-Bradley distributor.

IEC 947-5-1 Annex L has 2 requirements for a relay to meet for mechanically linked contacts:
1.) If a N.O. contact welds, all the N.C. contacts will remain open and meet a 2500V impulse test.
2.) If a N.C. contact welds, all the N.O. contacts will remain open and meet a 2500V impulse test.
Bul. Nos. 700S-P and 700S-DCP relays meet these requirements including the 2500V impulse test.
The relays shown on this page are shipped from the factory with the Bul. 700-CPS safety cartridge installed and cannot be converted to N.O. or N.C. in the Field.

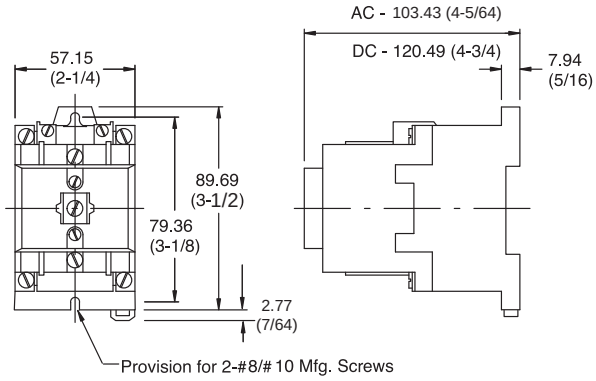
Specifications

Type			700S-P						700S-PK					
Electrical														
Contact Rating Continuous			10 A @ 600V AC 5 A @ 600V DC						20 A @ 600V AC 10 A @ 600V DC					
Ratings Make/Break	AC		NEMA A600						NEMA A600					
	DC		NEMA P600						NEMA P600					
Minimum Contact Switching Ratings			10V, 50 mA						3 Hp @ 240V AC - N.O. 2 Hp @ 240V AC - N.O./N.C. 1 HP @ 120V AC - N.O./N.C. 20 A resistive heating to 600V AC 20 A Tungsten lighting load to 480V AC					
DC Switching	Contacts in Series		Volts DC						Volts DC					
			24V	64V	125V	250V	500V	600V	24V	64V	125V	250V	500V	600V
	1		5 A	2.2 A	1.1 A	0.55 A	0.24 A	0.2 A	10 A	5 A	2.2 A	0.55 A	0.24 A	0.2 A
	2		10 A	10 A	5 A	2 A	0.7 A	0.5 A	20 A	10 A	5 A	2 A	0.7 A	0.5 A
	3		—	—	7 A	3 A	1.5 A	1.0 A	—	15 A	7 A	3 A	1.5 A	1.0 A
	4		—	—	10 A	5 A	2.5 A	1.5 A	—	20 A	10 A	5 A	2.5 A	1.5 A
Coil Voltage Range*	AC		85…110%						85…110%					
	DC		80…110%						80…110%					
	Battery Charging		85…115%						85…115%					
Coil Consumption			50 Hz			60 Hz			50 Hz			60 Hz		
	AC	Inrush	132 VA			138 VA			132 VA			138 VA		
		Sealed	19.3 VA			19 VA			19.3 VA			19 VA		
	DC	Inrush	12.7 W						12.7 W					
		Sealed	12.7 W						12.7 W					
Additional Contact Rating for AC Single-Phase Loads			—						3 HP @ 240V AC - N.O. 2 HP @ 240V AC - N.O./N.C. 1 HP @ 130V AC - N.O./N.C. 20 A Resistive Heating to 600V AC 20 A Tungsten Lighting Load to 480V AC Cartridge Cat. No. Bulletin 700S-CMS					
Mechanical														
Mechanically Linked Contacts			All contacts are mechanically linked per IEC 947-5-1 annex L for 2 to 12 poles						All contacts are mechanically linked per IEC 947-5-1 annex L for 2 to 12 poles					
Operating Time	Pickup		AC – 10…20 ms DC – 30…50 ms						AC – 10…20 ms DC – 30…50 ms					
	Dropout		AC – 10…20 ms DC – 20…33 ms						AC – 10…20 ms DC – 20…33 ms					
Mechanical Life			10 million operations											
Construction														
Contact Arrangement			2 to 12 Poles, Double Break Contacts N.O. or N.C. (8 N.C. Maximum)						2 to 12 Poles, Convertible to N.O. or N.C. (8 N.C. Maximum)					
Contact Material/Design			Silver Nickel/Bifurcated						Silver Cadmium Oxide					
Mounting			Panel mount or mount on 700-MP Relay or DIN Rail Horizontal Mounting Recommended						Panel mount or mount on 700-MP Relay or DIN Rail Horizontal Mounting Recommended					
Environmental														
Temperature	Operating‡		–20…+65 °C (–4…+149 °F)						–20…+65 °C (–4…+149 °F)					
	Storage		–40…+65 °C (–40…+149 °F)						–40…+65 °C (–40…+149 °F)					
Wire Terminations														
Wire size per UL/CSA			#18 AWG…(2) #12 AWG						#18 AWG…(2) #12 AWG					
Tightening Torque			8…12 lb•in (0.9…1.4 N•m)						8…12 lb•in (0.9…1.4 N•m)					

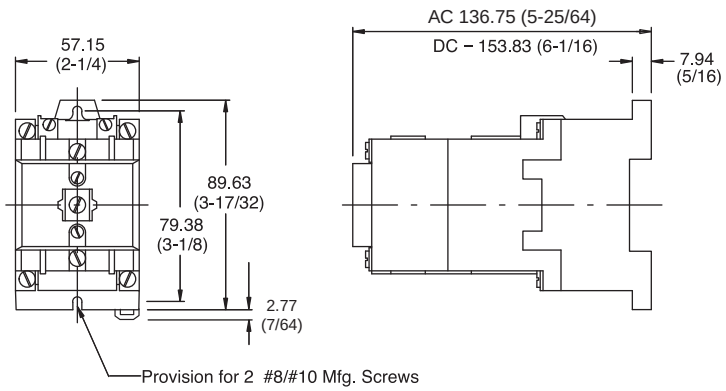
* Coil voltage required for proper operation (percent of rated coil voltage).
‡ Temperature inside the panel.

Approximate Dimensions

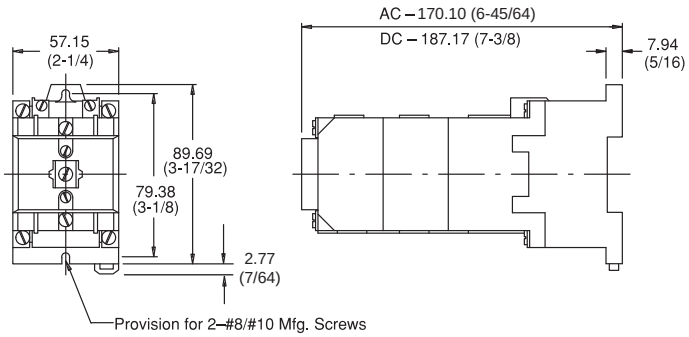
Dimensions are shown in millimeters (inches). Dimensions are not intended for manufacturing purposes.



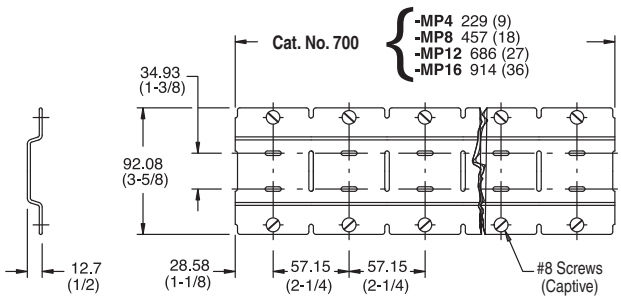
2- and 4-pole Bulletin 700S-P Relay — Approximate Shipping Weight AC – 0.68 kg (1.5 lb), DC – 1.34 kg (2.95 lb)



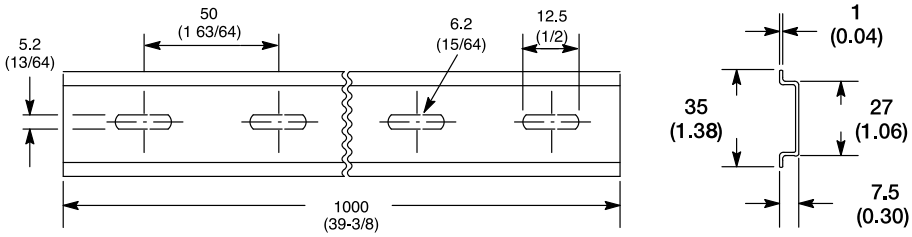
6- and 8-pole Bulletin 700S-P Relay Approximate Shipping Weight AC – 0.79 kg (1.75 lb), DC – 1.45 kg (3.20 lb)



10- and 12-pole Bulletin 700S-P, Approximate Shipping Weight AC – 1.02 kg (2.25 lb), DC – 1.68 kg (3.7 lb)



Relay Rail



DIN Rail

Safety Starter

Bulletin 109S





Description

The Bulletin 109S Safety Starter combines many features of the standard Bulletin 109 Enclosed Starter with a redundant contactor. The redundant safety contactor makes the Bulletin 109S suitable for use in Category 3 and 4 safety circuits. The safety circuit interface is designed to work with Safety Monitoring Relays, Safety PLC and GuardLogix, allowing the typical safety circuit to control higher switching currents and motor loads (9…860 A). This makes the safety system integration quicker and easier to apply by using a modular approach to the safety solution.

Features

- Positive-guided auxiliary contacts (9…85 A) and mirrored auxiliary contacts (95…860 A)
- 24V DC or 120V AC (50/60 Hz) control voltage
- Cover-mounted green pilot light (illuminated when output is on)
- Up to 600V line voltage
- Options similar to the standard Bulletin 109 enclosed starters
- Optional overload relay (E1 Plus and E3)

Specifications

Input Line Voltage Range	600V AC maximum
Control Voltage Range	24V DC or 110/120V AC (50/60 Hz)
Enclosure Rating	Type 12 (IP54) Open frame
System Operational Limits	+10%, -15% of the line voltage
Estimated Component Life	1,000,000 operations
Storage Temperature [C (F)]	-40…+80° (-40…176°)
Operating Temperature, Ambient—C (F)	-25…+40° (-13…104°)
Relative Humidity	90% noncondensing
Approvals	CE Marked for all applicable directives cULus
Standards/Certifications	Redundant contactors suitable for use in Category 3 or 4 systems UL 508A

Product Selection

Bulletin 109S cat. nos. can be configured by selecting the appropriate codes from the tables below.

109S — C30 J 1 1CD — 1E
a b c d e

a

Contactor Size	
Code	Amps [A]
C09	9
C12	12
C16	16
C23	23
C30	30
C37	37
C43	43
C60	60
C72	72
C85	85
D95	95
D110	110
D140	140
D180	180
D210	210
D250	250
D300	300
D420	420
D630	630
D860	860

b

Enclosure Type∗	
Code	Description
J	Type 12/IP54
N	Open (no enclosure) Components are mounted on a sub-panel

∗ Other enclosure types are available upon request.

c

Control Voltage	
Code	Description
1	24V DC DJ = 9…85 A EZJ = 95…300 A 420…860 = Not available
2	120V AC D = 9…85 A ED = 95…860 A

d

E3 Plus Overload Relay (193-ECxxx)❄		
Code	Load Rating Amps [A]	Starter
1PB	0.4…2.0	C09…C23
1AB	1…5	
1BB	3…15	
1CB	5…25	
1AD	1…5	C30…C43
1BD	3…15	
1CD	5…25	
1DD	9…45	
1DE	9…45	C60…C85
1EE	18…90	
1FF	28…140	D95…D180
1GF	42…210	
1GG	42…210	D210…D420
1HG	60…302	
1JG	84…420	
1KH	125…630	D630…D860
1LH	172…860	

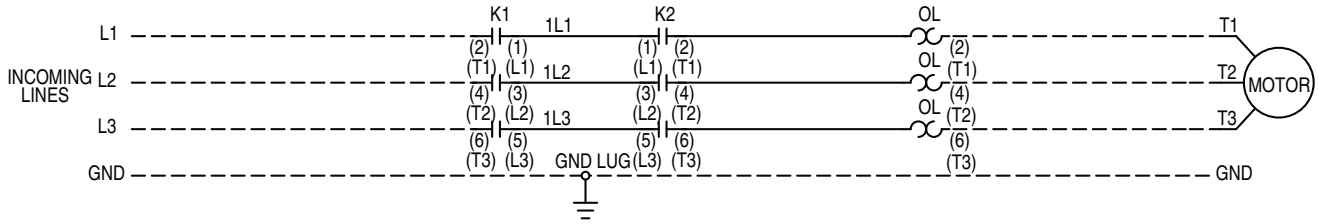
E1 Plus Overload Relay (193-Exxx)❄		
Code	Load Rating Amps [A]	Starter
EAB	0.1…0.5	C09…C23
EBB	0.2…1.0	
ECB	1…5	
EDB	3.2…16	
EEB	5.4…27	
EED	5.4…27	C30…C43
EFD	9…45	
EGE	18…90	C60…C85
EHF	30…150	D95…D180
EJF	40…200	
EJG	40…200	D210…D420
EKG	60…100	
ELG	100…500	
EMH	120…600	D630…D860
ENH	160…800	

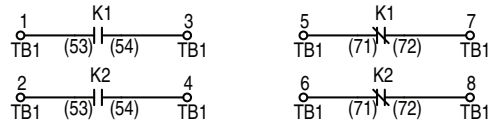
❄ If the overload relay configuration code field is left blank, an overload relay will not be provided.

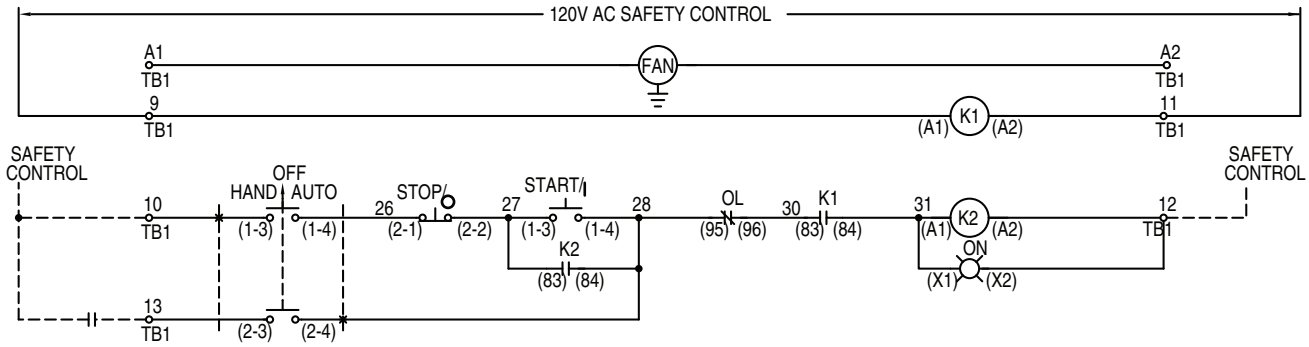
e

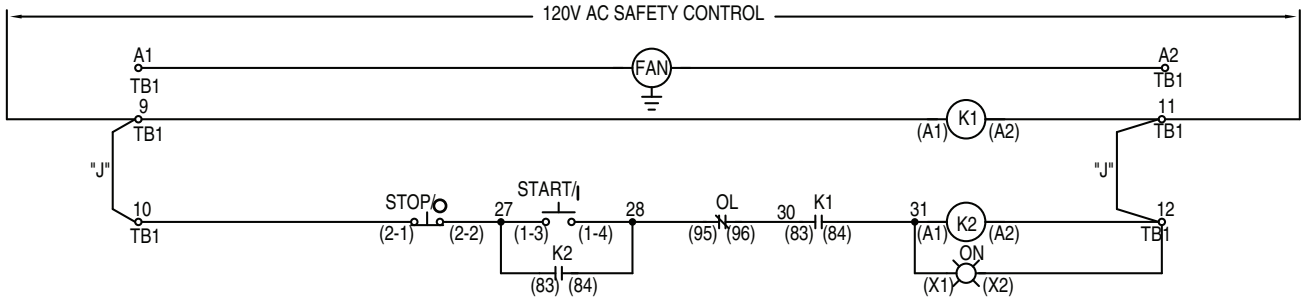
Operator Devices	
Code	Description
1	Stop/Start PB
1E	On/Off PB
3	Hand/Off/Auto SS
3E	On/Off SS
4R	Red Pilot Light
Blank	No options

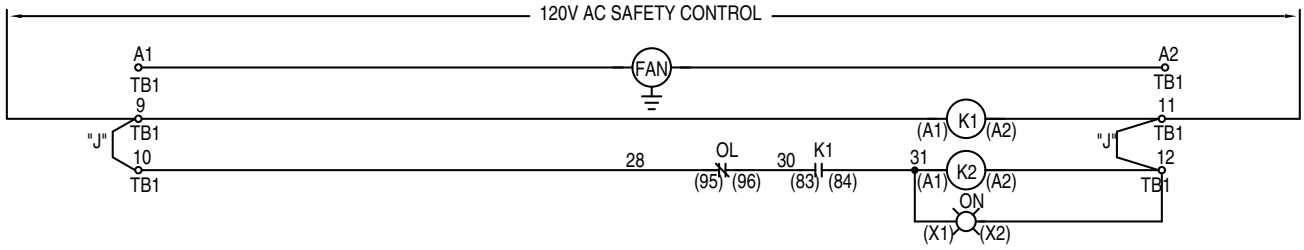
Typical Wiring Diagrams













Description

The Bulletin 2041 Safety Power Control combines safety circuits and power control of the redundant contactors and a safety relay. The Bulletin 2041 is TÜV certified for category 4 safety circuits. The safety circuit interface is designed to work with either light curtain outputs or safety interlock switches. The Bulletin 2041 also interfaces with Safety Monitoring Relays, Safety PLC, and GuardLogix solutions to allow for control of power circuits from 9…860 A at 600V maximum. This makes system integration quicker and easier by using a modular approach to the safety solution.

Features

- Positive-guided auxiliary contacts (9…85 A) and mirrored auxiliary contacts (95…860 A)
- 24V DC or 120V AC (50/60 Hz) control voltage
- Cover-mounted green pilot light (illuminated when output is on)
- Up to 600V line voltage
- Optional overload relay (E1 Plus and E3)

Specifications

Input Line Voltage Range	600V AC maximum
Control Voltage Range	24V DC or 110/120V AC (50/60 Hz)
Enclosure Rating	Type 12 (IP54) Open Frame
System Operational Limits	+10%, -15% of the line voltage
Estimated Component Life	1,000,000 operations
Storage Temperature [C (F)]	-40…+80° (-40…176°)
Operating Temperature, Ambient [C (F)]	-25…+40° (-13…104°)
Relative humidity	90% noncondensing
Approvals	CE Marked for all applicable directives TÜV Category 4 cULus
Standards/Certifications	Category 4 systems UL 508A

Product Selection

Bulletin 2041 cat. nos. can be configured by selecting the appropriate codes from the tables below.

2041 — C30 J 1 1CD — 7B
a b c d e

a

Contactor Size	
Code	Amps [A]
C09	9
C12	12
C16	16
C23	23
C30	30
C37	37
C43	43
C60	60
C72	72
C85	85
D95	95
D110	110
D140	140
D180	180
D210	210
D250	250
D300	300
D420	420
D630	630
D860	860

b

Enclosure Type	
Code	Description
J	Type 12/IP54
N	Open (no enclosure) components are mounted on a sub-panel

c

Control Voltage	
Code	Description
1	24V DC DJ = 9…85 A EZJ = 95…300 A 420…860 = Not available
2	120V AC D = 9…85 A ED = 95…860 A

d

E3 Plus Overload Relay (193-ECxxx)*		
Code	Load Rating Amps [A]	Starter
1PB	0.4…2.0	C09…C23
1AB	1…5	
1BB	3…15	
1CB	5…25	
1AD	1…5	C30…C43
1BD	3…15 A	
1CD	5…25	
1DD	9…45	
1DE	9…45	C60…C85
1EE	18…90	
1FF	28…140	D95…D180
1GF	42…210	
1GG	42…210	D210…D420
1HG	60…302	
1JG	84…420	
1KH	125…630	D630…D860
1LH	172…860	

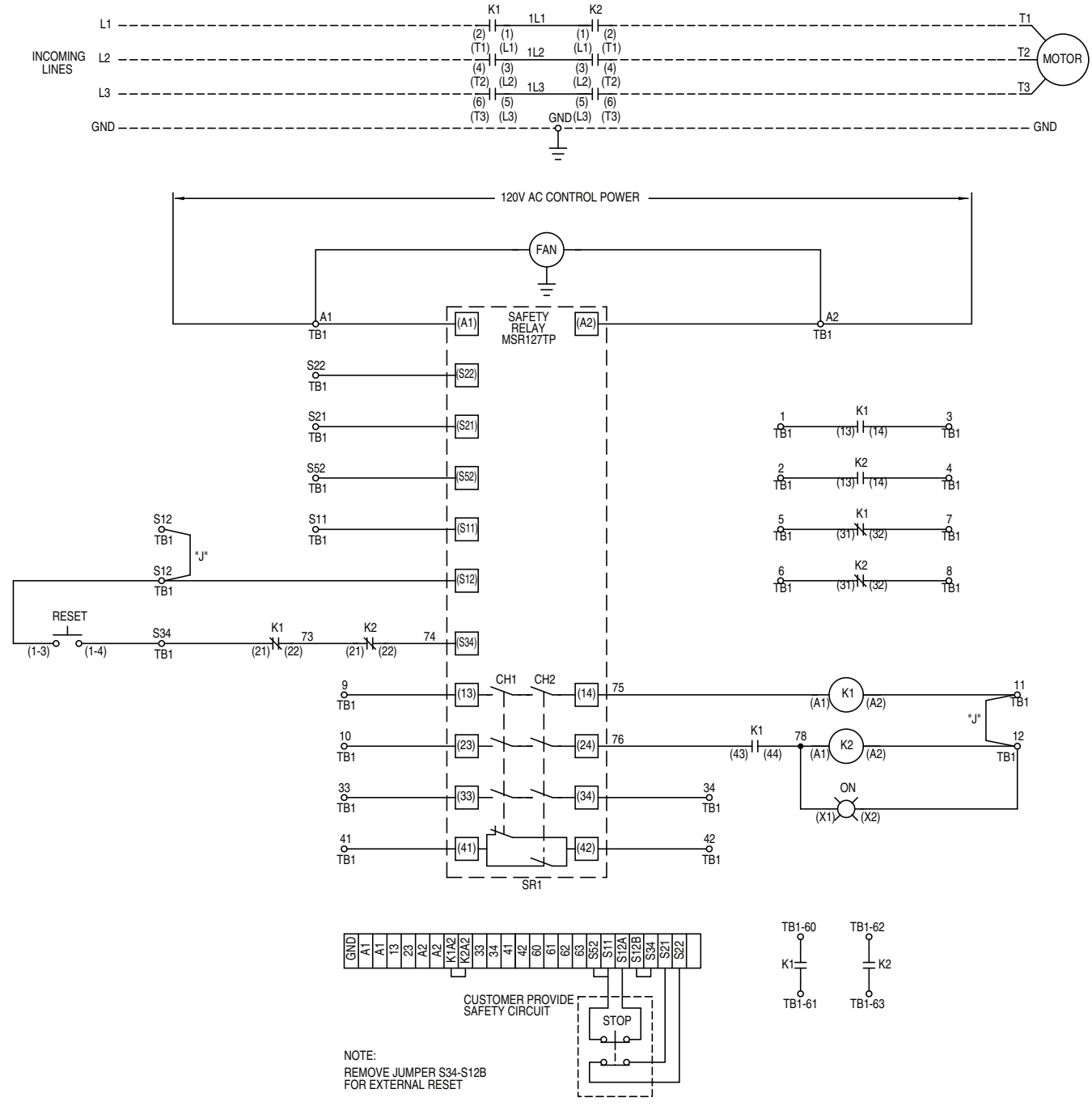
E1 Plus Overload Relay (193-Exxx)*		
Code	Load Rating Amps [A]	Starter
EAB	0.1…0.5	C09…C23
EBB	0.2…1.0	
ECB	1…5	
EDB	3.2…16	
EEB	5.4…27	
EED	5.4…27	C30…C43
EFD	9…45	
EGE	18…90	C60…C85
EHF	30…150	D95…D180
EJF	40…200	
EJG	40…200	D210…D420
EKG	60…100	
ELG	100…500	
EMH	120…600	D630…D860
ENH	160…800	

* If the overload relay configuration code field is left blank, an overload relay will not be provided.

e

Operator Devices	
Code	Description
Blank	No options
7B	Front mount safety reset
4R	Red pilot light (replaces standard green)

Typical Wiring Diagram

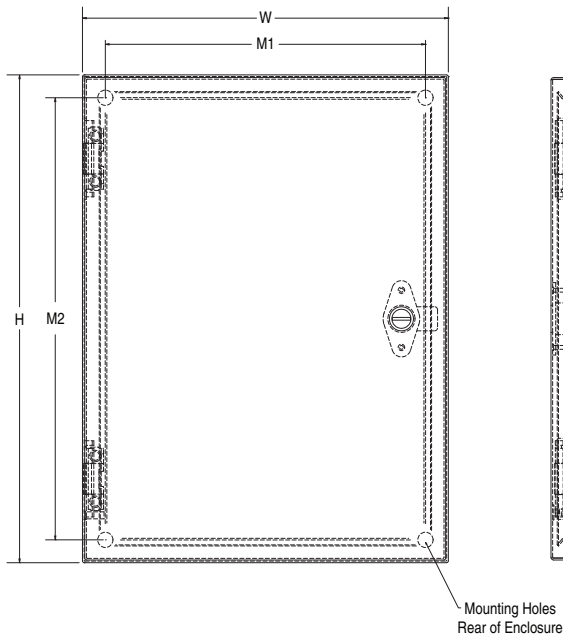


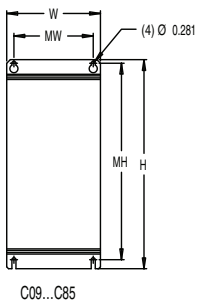
Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for manufacturing purposes.

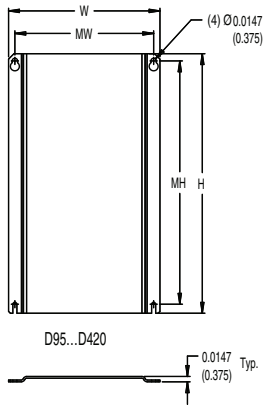
Type 12 Enclosure				
Contactor Size	Panel Dimensions (H x W x D)	(M2) Height [mm (in.)]	(M1) Width [mm (in.)]	Mounting Holes [mm (in.)]
C09…C16	12 x 10 x 8	324 (12.75)	203 (8.0)	8 (0.31)
C23…C30	16 x 12 x 10	368 (14.5)	267 (10.5)	13 (0.5)
C37…C43	16 x 12 x 10	368 (14.5)	267 (10.5)	13 (0.5)
C60…C85	16 x 12 x 10	368 (14.5)	267 (10.5)	13 (0.5)
C95…D180	24 x 24 x 10	572 (22.5)	572 (22.5)	13 (0.5)
D210	24 x 24 x 10	572 (22.5)	572 (22.5)	13 (0.5)
D250…D300	24 x 24 x 10	572 (22.5)	572 (22.5)	13 (0.5)
D420	24 x 24 x 10	572 (22.5)	572 (22.5)	13 (0.5)
D630…D860	36 x 30 x 12	572 (22.5)	724 (28.5)	13 (0.5)

Open Panel				
Contactor Size	Panel Dimensions (H x W x D)	(MH) Height [mm (in.)]	(MW) Width [mm (in.)]	Mounting Holes [mm (in.)]
C09…C16	14.5 x 6.5 x 6.1	349 (13.75)	140 (5.5)	7 (0.281)
C23…C30	14.5 x 6.5 x 7.5	349 (13.75)	140 (5.5)	7 (0.281)
C37…C43	14.5 x 6.5 x 7.6	349 (13.75)	140 (5.5)	7 (0.281)
C60…C85	14.5 x 6.5 x 6.5	349 (13.75)	140 (5.5)	7 (0.281)
C95…D180	18 x 10.5 x 6.5	429 (16.875)	242 (9.525)	9.5 (0.375)
D210	23 x 12 x 7.5	538 (21.175)	283 (11.125)	9.5 (0.375)
D250…D300	23 x 12 x 7.5	538 (21.175)	283 (11.125)	9.5 (0.375)
D420	23 x12 x 7.5	538 (21.175)	283 (11.125)	9.5 (0.375)
D630…D860	35 x 17 x 11.3	432 (17.0)	410 (16.125)	9.5 (0.375)

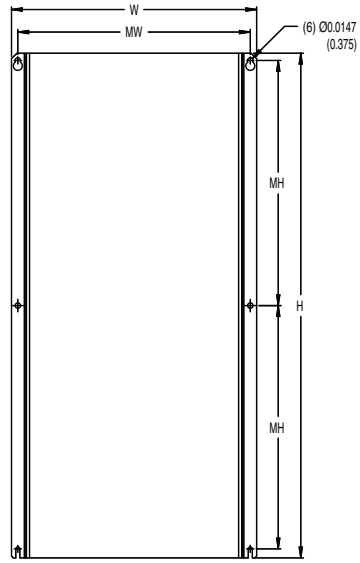




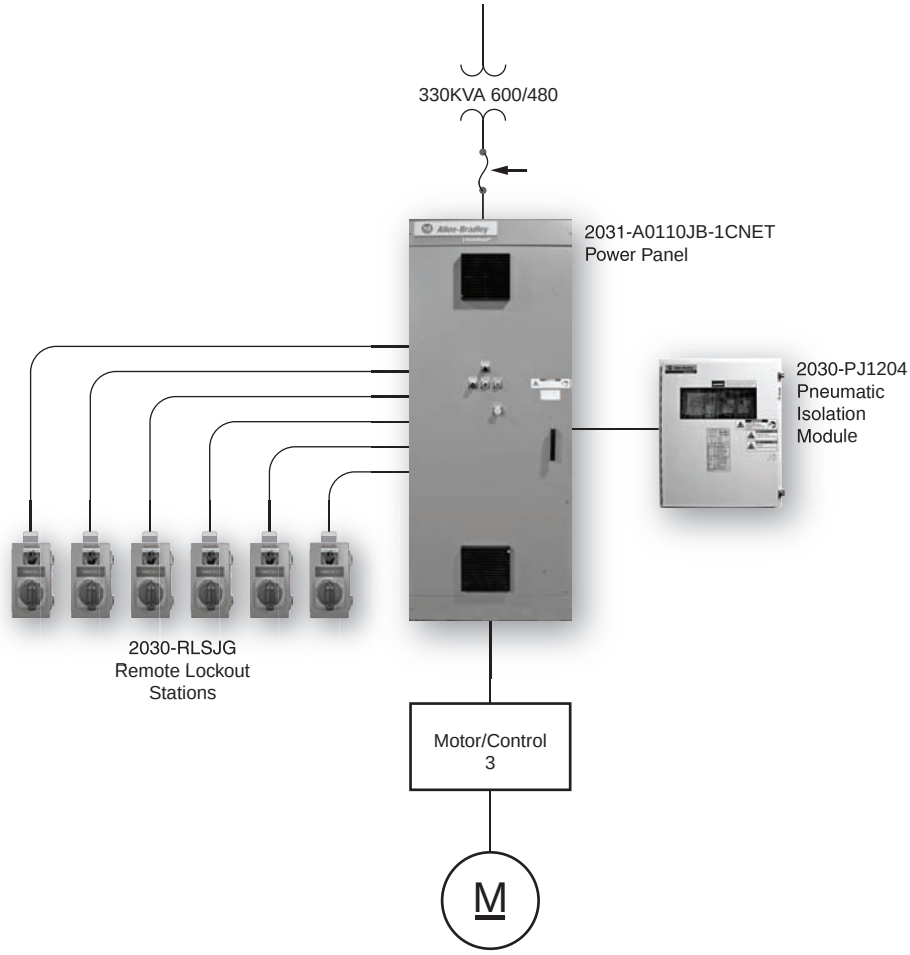
C09...C85



D95...D420



D630...D860



Typical System

Description

The ElectroGuard system is designed to simplify the Lock Out/Tag Out (LOTO) task performed by a machine operator or maintenance personnel. The ElectroGuard system can control single or multiple energy sources simultaneously. Simplifying the procedure helps increase the likelihood that personnel will perform the LOTO on large processors or drive systems.

The ElectroGuard system can be configured with modules to provide:

- Electrical energy isolation (ElectroGuard Power Panel).
- Pneumatic energy isolation (Pneumatic Isolation Module).
- Hydraulic energy isolation (Hydraulic Isolation Module).
- Multiple lockout points (Remote Lockout Stations).
- Control of multiple systems (System Multiplexer/Permissive or Dual RLS).
- Interface to safety-gate interlocks (Verification Module).

The ElectroGuard allows the system engineer to design LOTO into the system. Locating the Remote Lockout Stations (RLS) at hazard entry points can result in the shortest down time during set-up or maintenance.

Standard Features

- System is designed to prevent accumulation of faults.
- Standard system provides for four RLS on the 23…85 A systems and up to six RLS on the 110…1200 A systems.
- Verification light on the RLS (no light means no entry).
- Meets International Standard EN 954-1/ISO 13849-1, TÜV certified Category 4 system.
- Pneumatic and hydraulic ready.

Optional Features

- Expansion modules allow for additional RLS connections.
- Pneumatic and hydraulic energy isolation.
- System multiplexer/permissive module allows for control of multiple energy sources simultaneously.
- Network communication option provides the control system with status.

Specifications

Certifications	cULus TÜV Rheinland Certified CE marked for all applicable directives
Standards	IEC/EN 60204-1 IEC/EN 60439-1 Category 4 to EN 954-1/ISO 13849-1 98/37/EC Machinery Directive 89/336/EC EMC Directive 73/23/EC Low Voltage Directive UL508A
Estimated Component Life Remote Lockout Station Power Contactors (Isolation & Grounding)	23… 85 A: 2,000,000 operations 110…1200 A: 1,000,000 operations
Storage Temperature [C (F)]	-10…+60° (14…140°)
Operating Temperature [C (F)]	0…+40° (32…104°)
Relative Humidity (noncondensing)	90% (Ambient)
Power Panel Construction	NEMA Type 12/IP54 UL Type 4/IP66 UL Type 4x MCC (Bulletin 2100) with and without Bus
Expansion Module Construction	4-port: Supports up to 4 remote lockout stations 10 port: Supports up to 10 remote lockout stations
Safety Isolation System Inputs	Remote Lockout Stations
Input Options	Safety Mats, Light Curtains, and E-Stop Stations
System Operational Limits	+10%, -15% of the line voltage

Sequence of Operation

After using the normal stopping method of the machine or process, the machine operator turns a Remote Lockout Station (RLS) handle from the ON to the OFF position.

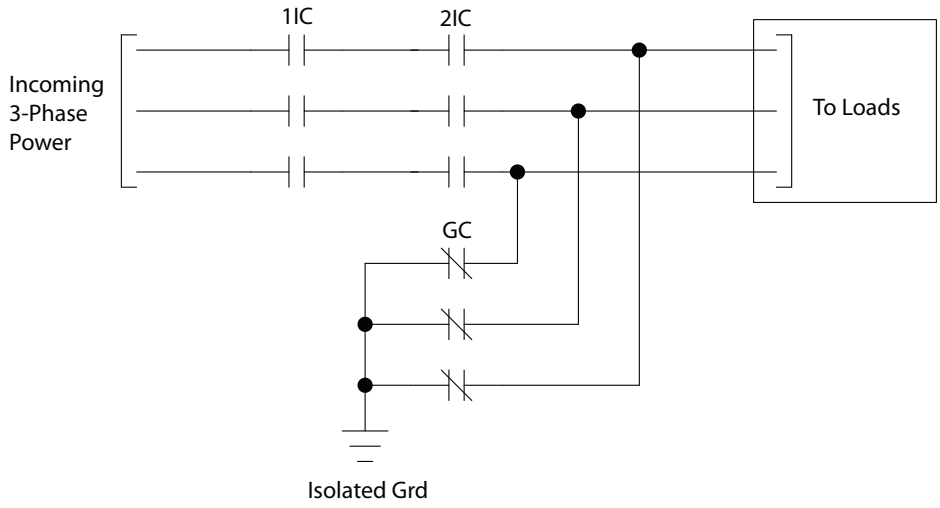
The RLS signals the:

1. Isolation contactors (1IC and 2IC) to drop out, isolating the supply voltage from the loads (see Power Circuit below).

2. The grounding contactor (GC) is then energized, connecting the load to ground (see Power Circuit). The grounding contactor and the isolation contactors are both electrically and mechanically interlocked.

3. The System Isolated light will then illuminate on the RLS to indicate the system is isolated.

4. The person performing the LOTO then applies a lock to the RLS, locking it in the OFF position. The equipment is now locked out.



Power Circuit

Communication

The optional Communication Module allows the ElectroGuard system to communicate status to the process or machine control system. Although the communication module can be field installed, it is recommended that this option be ordered as part of the ElectroGuard system. The customer is responsible for configuring and programming their control system to receive the status signals from the ElectroGuard.

Status signals available:
- Overall system status
- Remote lockout station (status of each station)
- Pneumatic or hydraulic isolation modules (if used)
- Other optional safety input devices

Current networks available*:
- DeviceNet™
- Remote I/O
- ControlNet™
- Ethernet IP
- PROFIBUS

See the ElectroGuard or accessories for ordering instructions.

IMPORTANT	The communication option allows a remote PLC to receive status signals from the ElectroGuard safety isolation system.

Door Mounted Metering

Optional door mounted ampere meter, volt meter, or both, are available as factory installed options. They provide visual indication of line side system current and voltage. See the ElectroGuard or accessories for ordering instructions.

Expansion Module

Expansion Modules are used to add more Remote Lockout Stations in addition to the base inputs (four remote lockout stations for 23…85 A units and six for the 110…1200 A systems). See expansion module section for details.

Multiplexer and Multiplexer Permissive

The Multiplexer Module allows the Remote Lockout Station to control two or more ElectroGuard systems. The permissive function allows the equipment control system to determine if the ElectroGuard can be locked out. See Multiplexer and Multiplexer Permissive section for sequence of operation and details.

IMPORTANT	Only one of these options can be installed in the power panel, and are not available on the 23…85 A units, or 2031-A0630JX or 2031-A860JX units.

Product Selection

ElectroGuard cat. nos. can be configured by selecting the appropriate codes from the tables below.

2302	—	A	0420	J	B	—	29J	—	1TD
a		*b*	*c*	*d*	*e*		*f*		*g*

a

Safety Type	
Code	Description
2031	Noncombination
2032	Fusible Disconnect
2033	Thermal-Magnetic Circuit Breaker

b

Construction Code	
Code	Description
A	Free-standing enclosure
B§	Motor control center enclosure for North America with line side incoming power cables and 1200 A load side outgoing bus∗.
F§	Motor control center enclosure for North America with line side incoming power cables and 600 A load side outgoing bus∗.
M§	Motor control center enclosure for North America with 600 A line side incoming bus∗ and outgoing power cables.
S§	Motor control center enclosure for North America with 1200 A line side incoming bus∗ and outgoing power cables.

∗ Bus Type: copper with tin plating.
§ Only available in NEMA Type 12/IP54.

c

Ampere Rating (AC-3)	Ratings∗ 3-Phase Max. Hp rating (60Hz)				3-Phase Max. kW rating (50 Hz)				2032 Fuse Clip Options❄	2033 Circuit Breaker Options‡
	200V	230V	460V	575V	230V	400V	500V	600V		
0023	5	7.5	15	15	7.5	11	11	11	24B, 24J, 25B, 25J	39, 39k, 40, 40k, 41, 41k, 42, 42k
0043	10	15	30	30	13	22	22	22	25B, 25J, 26B, 26J	40, 40k, 41, 41k, 42, 42k, 43, 43k, 44, 44k, 45
0085	25	30	60	60	25	45	45	45	26B, 26J, 27B, 27D, 27J	42, 42k, 43, 43k, 44, 44k, 45, 46, 46k, 47, 47k, 48, 48k
0110	40	40	74	100	32	55	63	100	27B, 27D, 27J, 28B, 28D, 28J	45, 46, 46k, 49, 49k, 50k
0180	50	60	150	150	55	90	110	160	27B, 27D, 27J, 28B, 28D, 28J	47, 47k, 48, 48k, 50k, 51, 51k, 52, 52k, 55k
0210	60	75	—	200	63	110	150	200	28B, 28D, 28J	48, 48k, 49, 49k, 53, 53k, 54, 54k, 59k
0300	100	125	250	300	90	160	200	300	28B, 28D, 28J, 29B, 29D, 29J	49, 49k, 50k, 51, 51k, 53, 53k, 54, 54k, 55k, 56, 56k, 57, 57k, 58, 58k, 59, 59k
0420	150	175	350	400	132	220	300	425	29B, 29D, 29J, 30B, 30D, 30L	51, 51k, 52, 52k, 53, 53k, 55k, 57, 57k, 58, 58k, 59, 59k, 60, 60k, 61, 61k, 62, 62k, 63, 63k, 64k
0630	200	250	500	600	200	355	450	500	30B, 30D, 30L, 31B, 31D, 32B, 34L	53, 53k, 54, 54k, 55k, 56, 56k, 59, 59k, 60, 60k, 61, 61k, 62, 62k, 63, 63k, 64k, 65k, 66k
0860	250	300	600	700	250	500	560	600	31D, 32B, 34L	56, 56k, 57, 57k, 58k, 59k, 60k, 61k, 62k, 63, 63k, 64k, 65k, 66k
1200	450	450	900	900	391	710	888	1043	31D, 34L	57, 57k, 58, 58k, 59, 59k, 60, 60k, 61k, 62k, 63, 63k, 64k, 65k, 66k

∗ Consult your local Rockwell Automation sales office or Allen-Bradley distributor for additional options.
❄ Available for 2032 fusible discconect only.
‡ Available for 2033 Thermal-Magnetic circuit breaker. Consult your local Rockwell Automation sales office or Allen-Bradley distributor for additional options.

d

Enclosure Type	
Code	Description
C§	Type 4X watertight stainless steel
F§	Type 4 watertight painted steel/IP65
J	Type 12 dusttight/IP54

§ Cooling to be supplied by customer.

e

Input Line Voltage	
Code	Description
A	240V 60 Hz/220V 50 Hz
B	480V 60 Hz/440V 50 Hz
C	600V 60 Hz/550V 50 Hz
G	400…415V 50 Hz
H	208V/60 Hz
M	500V 50 Hz
N	380…400V 50 Hz

f

2032 Fuse Clip Rating/Type♣		
Code	Rated Amps [A]	Fuse Type
24B	32 A	BS88
24J	30 A	Class J
25B	60 A	BS88
25J	60 A	Class J
26B	100 A	BS88
26J	100 A	Class J
27B	200 A	BS88
27D	160 A	DIN
27J	200 A	Class J
28D	250 A	DIN
28J	400 A	Class J
29B	400 A	BS88
29D	400 A	DIN
29J	600 A	Class J
30B	600 A	BS88
30D	630 A	DIN
30L	800 A	Class L
31B	800 A	BS88
1D	1600 A	DIN
32B	1250 A	BS88
34L	2000 A	Class L

♣ Fuse to be supplied by customer per local electrical code.

f

2033 Circuit Breaker Hp/kW Rating➢			
Code	Hp	Code	Power
39	5 Hp	39k	4 kW
40	7.5 Hp	40k	5.5 kW
41	10 Hp	41k	7.5 kW
42	15 Hp	42k	11 kW
43	20 Hp	43k	13 kW
44	25 Hp	44k	15 kW
45	30 Hp	—	—
46	40 Hp	46k	22 kW
47	50 Hp	47k	25 kW
48	60 Hp	48k	32 kW
49	75 Hp	49k	37 kW
—	—	50k	45 kW
51	125 Hp	51k	55 kW
52	150 Hp	52k	63 kW
53	175 Hp	53k	75 kW
54	200 Hp	54k	90 kW
—	—	55k	100 kW
56	250 Hp	56k	110 kW
57	300 Hp	57k	132 kW
58	350 Hp	58k	150 kW
59	400 Hp	59k	160 kW
60	450 Hp	60k	185 kW
61	500 Hp	61k	200 kW
62	600 Hp	62k	220 kW
63	700 Hp	63k	250 kW
—	—	64k	300 kW
—	—	65k	355 kW
66	900 Hp	66k	390 kW

➢ Consult your local Rockwell Automation sales office or Allen-Bradley distributor for additional circuit breaker options.

g

Factory-Installed Options	
Code	Description
1AM⌘	Single-phase ampere meter
3AM⌘	3-phase ampere meter
1VM✦	Single-phase voltmeter
3VM✦	3-phase voltmeter
1COM❖	Remote I/O module (16 points of I/O)
1CNET❖	ControlNet™ module (16 points of I/O)
1DNET❖	DeviceNet™ module (16 points of I/O)
1ENET❖	EtherNet module (16 points of I/O)
1PNET❖	PROFIBUS module (16 points of I/O)
1TD	Control module with factory-set 30-second time delay
1EUF♠	Four port expansion module
1EUT♠	Ten port expansion module
1SYS♠	System multiplexer module
1SYSP♠	System multiplexer permissive module
1HPM♠	Hydraulic/pneumatic multiplexer module

⌘ Only one can be selected for current monitoring.
✦ Only one can be selected for voltage monitoring.
❖ Only one of these can be installed in ElectroGuard.
♠ No module can be installed in the 23 A, 43 A and 85 A units and the 2031-x0630xx and 2931-x860xx units.

Replacement Control Module

2030-CH0085x

2030-CH0085x-ITD

2030-CH1200x

2030-CH1200x-ITD

x = See table "e" for input line voltages



1-1/2 in. Pneumatic Isolation Module

Pneumatic Isolation Module

The ElectroGuard Safety Isolation System is available with an optional means of isolating the pneumatic energy source for the machine or process. The Pneumatic Isolation Module is designed to work in conjunction with the power panel. This option blocks the pneumatic line leading to the pneumatic hazard. The valve then bleeds or dumps the residual pneumatic energy leading to the machine. After the valve is in the blocked position and the pressure drops to less than five psi (pounds per square inch), a signal is sent to the power panel indicating the pneumatic energy is isolated. The system isolated light, located on the Remote Lockout Station (RLS) that was switched to the OFF position, is then illuminated.



Hydraulic Isolation Module

Hydraulic Isolation Module

The ElectroGuard Safety Isolation System is available with an optional means of isolating the hydraulic energy source for the machine or process. The Hydraulic Isolation Module is designed to work in conjunction with the power panel. The valve blocks the hydraulic line leading to the hydraulic hazard. Then the residual hydraulic energy is returned to the tank. After the valve is in the blocked position and the pressure drops to less than 100 psi (pounds per square inch), a signal is sent to the power panel indicating the hydraulic energy is isolated. The system isolated light, located on the RLS that was switched to the OFF position, is then illuminated.

Bulletin 2030 Pneumatic and Hydraulic Isolation Modules

2030—	P	J	120	4
	a	*b*		*c*

a

Product Descriptor	
Code	Description
P	Pneumatic isolation module
H	Hydraulic isolation module

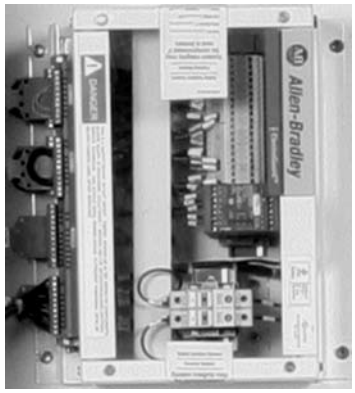
b

Enclosure Type	
Code	Description
C	Type 4X watertight stainless steel
F	Type 4 watertight painted steel/IP65
J	Type 12 dusttight/IP54

c

Port Size			
Code	Description	Pneumatic CFM at 90 PSI	Hydraulic GPM
2	1/2 in. NPT	160	❄
3	3/4 in. NPT	380	25
4	1 in. NPT	650	❄
5	1-1/4 SAE #20 straight thread	✶	120
6	1-1/2 in. NPT	1750	❄

✶ Not available in Pneumatic Isolation Module
❄ Not available in Hydraulic Isolation Module
CFM = Cubic feet per minute
GPM = Gallons per minute
NPT = National pipe thread
SAE = Society of Automotive Engineers



4-Port Expansion Module

Optional Expansion Module

Optional Expansion Modules are available for applications requiring more than the maximum allowable Remote Lockout Stations (RLS) (e.g. more than four for 23…85 A systems or more than six for 110…1200 A systems). The Expansion Modules are available in 4- or 10-port configurations. This allows up to four RLSs for a 4-port and ten RLSs for a 10-port module. An example would be adding a 4-port expansion module to a 23A ElectroGuard. This then allows up to seven RLSs to connect to the system.

Expansion Modules may be ordered with an adjustable time-delay feature (1…30 seconds) in order to allow time for the machine operator to shut down drives or other equipment that requires a controlled stop after a RLS handle has been turned to the OFF position. Consult your Rockwell Automation sales office or Allen-Bradley distributor for other time settings. Enclosed Expansion Modules are available with optional Flex modules to provide status communication to a remote PLC. Communication can be via ethernet, ControlNet, DeviceNet, Profibus or Remote I/O.

NOTE: The status communication option allows a remote PLC to receive status signals from the Expansion Module.

Bulletin 2030 Expansion Module

2030—	EU	N	F	1CNET	1TD
	a	*b*	*c*	*d*	*d*

a

Product Descriptor	
Code	**Description**
EU	Expansion module

b

Enclosure Type	
Code	**Description**
C	Type 4X watertight stainless steel
F	Type 4 watertight painted steel/IP65
J	Type 12 dusttight/IP54
N	Open type

c

Number of Expansion Ports	
Code	**Description**
F	4-port
T	10-port

d

Options	
Code	**Description**
1COM	Flex I/O module (16 points of I/O)
1CNET	ControlNet™ module
1DNET	DeviceNet™ module
1ENET	EtherNet module
1PNET	PROFIBUS module
1TD	Expansion module with factory-set 30-second time delay



Remote Lockout Station

Remote Lockout Station

The Remote Lockout Station (RLS) is a key component of the ElectroGuard system. The RLS is typically located at the hazard location and provides the signal to the power panel to initiate the LOTO process. The RLS is available in several configuration and enclosure types.

Dual Remote Lockout Station

The Dual Remote Lockout Station functions the same as a single or standard Remote Lockout Station. The difference between a single and a dual RLS is that the dual RLS can be used to control two ElectroGuard systems from the same RLS. A good example of this is a machine that has two separate incoming power sources. Using a dual RLS and two ElectroGuard both ElectroGuard can be controlled from the same station.

Bulletin 2030 Remote Lockout Station

2030 — RLS	J	G	D
	a	*b*	*c*

a

Enclosure Type	
Code	Description
C	Type 4X watertight stainless steel
F	Type 4 watertight painted steel/IP65
J	Type 12 dusttight/IP54
E	Type 7 and 9 hazardous location bolted

b

System Isolated Light Color	
Code	Color
G	Green

c

Dual RLS	
Code	Description
D	Dual
Blank	Single

Replacement Switch Module: 2030-RSA1



Verification Module

Bulletin 2030 Verification Module

2030 — VM (*a*) C (*b*)

a

Product Description	
Code	Description
VM	Verification module

b

Enclosure Type	
Code	Description
C	Type 4X watertight stainless steel
J	Type 12 dusttight/IP54

Verification Module

The optional Verification Module (VM) is connected between the solenoid locking safety switch, similar to a Guardmaster Atlas™ 5 and the Remote Lockout Station (RLS) input on an ElectroGuard system. When the VM receives the system isolated signal from the ElectroGuard, the VM provides the signal to the solenoid on the Atlas 5, unlocking the Atlas 5 and allowing access to the machine.

Once the Atlas 5 is unlocked, the VM provides a redundant signal to the ElectroGuard emulating a RLS that has been switched to the OFF position. The emulated signal is then switched to the on state, to indicate the gate has been closed. If all of the RLSs connected to the ElectroGuard are switched to the ON position and the safety gate is closed, the ElectroGuard will attempt to lock the gate and restore energy the machine. If the verification module has not verified the gate is locked, the energy is removed from the machine and the locking process is repeated.

Specifications

Dry Contact (B300 6A/125V AC or P300 3A/24V DC) provided to control solenoid voltage.

Multiplexer/Permissive Module

When multiple energy sources must be controlled simultaneously or the system must be stopped at a pre-determined stopping point, the LOTO process becomes more complicated with multi-step procedures and locks. The Hydraulic/Pneumatic Multiplexer and the system Multiplexer/Permissive Module were developed to help provide simultaneous control of multiple hazards from a single lockout point.

Coordination between the process or drive system control and the LOTO process, is a concern. In a typical system, a signal from the LOTO device is sent to the control system. This provides indication that the device has been switched to the OFF position. This requires the person switching the device to ensure the process or machine has stopped. Ideally this would be coordinated so the power is not disconnected until the process or drive system is at an acceptable stopping point. The addition of the Permissive function to the System Multiplexer allows the control system to signal the ElectroGuard system when it is at the desired stopping point. This function would only allow the stopping function (i.e., the control system can not restore power). That function can only be accomplished via the RLSs attached to the System Multiplexer/Permissive Module.

The diagram below depicts a system with multiple motors or drives that require a synchronized lockout. This system also requires that the power to the drives must be maintained during certain phases of the process. The control system is interfaced with the ElectroGuard systems via the Permissive option in the System Multiplexer/Permissive Module. This allows the control system to delay disconnecting power until the drives are at an allowable point in the process.

Functional Description

The System Multiplexer Module allows a Remote Lockout Station (RLS) to control up to four ElectroGuard systems simultaneously. The System Multiplexer Module will accept up to six RLS inputs. If there is a need to control more than four ElectroGuard systems, the System Multiplexer Modules can be daisy-chained as shown in the drawing below. For applications where more than four RLSs are required, an expansion module may be used.

The System Multiplexer Module is also available with a Permissive option. The Permissive option allows the machine controlling the process or drive system to bring the machine or process to a pre-determined stopping point prior to removal of power by the ElectroGuard system. Once the ElectroGuard system isolates the energy, the machine control can not re-energize the ElectroGuard.

Bulletin 2030 Multiplexer/Permissive Module

2030-MLX — J (a) F (b) SYS (c)

a

Enclosure Type	
Code	Description
C	Type 4X watertight stainless steel
F	Type 4 watertight painted steel/IP65
J	Type 12 dusttight/IP54
N	Open
M	Open Type installed in ElectroGuard∗

∗ Can be installed in most 110…1200 A systems

b

Number of Systems to Control	
Code	Description
F	4 systems

c

System Type	
Code	Description
SYS	EG system
SYSP	EG system with permissive option
HPM	Hydraulic/pneumatic module

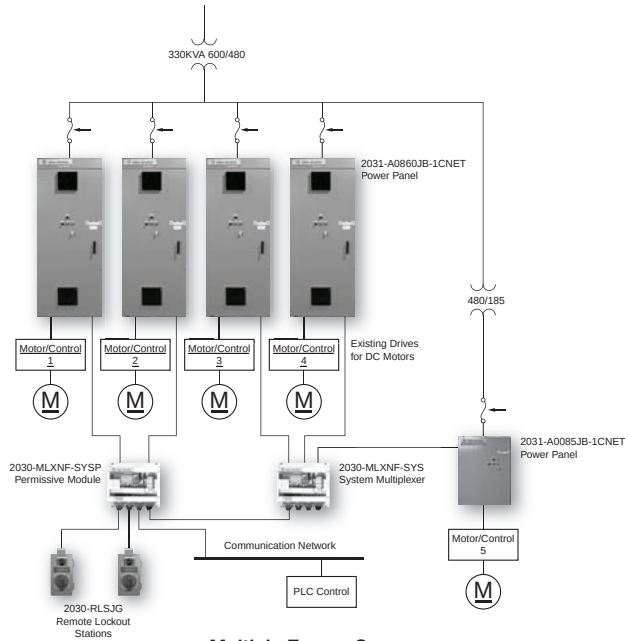
Sequence of Events for System Multiplexer Module:

1. When a RLS is turned OFF, the outputs of the System Multiplexer Module are switched to the off or open state, see diagram below.
2. This signal is connected to the input of the ElectroGuard systems initiating the isolation process.
3. When all of the ElectroGuard systems are in the isolated state the System Multiplexer Module sends the Isolated signal to the RLS and the RLS System Isolated pilot light will be illuminated.

Sequence of Events for System Multiplexer Module with Permissive Option:

1. A PLC output is connected to the System Multiplexer/Permissive Module. This signal is used by the System Multiplexer/Permissive Module as a heart beat. This holds the output of the System Multiplexer/Permissive Module in the on or closed state, holding the ElectroGuard system in the on or non-isolated state.
2. When a RLS is turned OFF, a signal is transmitted to the control system via a PLC connection on the RLS auxiliary contacts, see diagram below. Note that the outputs of the System Multiplexer/Permissive Module remain in the on or closed state.
3. When the customer's control system is at a predetermined stopping point, the control system, via the PLC output, is turned to an off state (no heart beat) and the outputs of the System Multiplexer/Permissive Module are then switched to the off or open state.
4. The system isolation function is then initiated on all of the ElectroGuard systems simultaneously.
5. When all of the ElectroGuard systems are in the isolated state, the System Multiplexer/Permissive Module sends the Isolated signal to the RLS and the RLS System Isolated pilot light on the RLS will be illuminated. The RLS now has control of the ElectroGuard and the energy can only be restored to the machine or process by switching all of the RLSs connected to the multiplexers to the on state.

   NOTE: Modification to the logic in the customer's control system is required if the Permissive option is used. See user manual for details.



Multiple Energy Sources

System Selection Process

1. Determine the catalog number of the Safety Isolation System based on the rating of the load(s) to which it will be connected as follows:
   — If the Safety Isolation System is connected to a single motor load, the horsepower or kilowatt rating of the system should be determined as follows:
   a. Select the Safety Isolation System that meets or exceeds the horsepower or kilowatt rating of the load at the required voltage and frequency.
   — If the Safety Isolation System is connected to two or more motors or one or more motors in combination with other loads; the horsepower or kilowatt rating of the system should be determined as follows:
   b. Identify the types of loads (i.e. motor, resistive) and the values of the currents of each of the loads (i.e. steady-state current for resistive loads, full-load and locked-rotor currents for motor loads) to be connected to the Safety Isolation System.
   c. Sum the full-load currents of all the motor loads to be connected to the Safety Isolation System. To this value add the current values of all resistive loads to be connected to the Safety Isolation System. This value is the combined load full-load current.
   d. Find the horsepower or kilowatt rating of a single motor with a full-load current value greater than or equal to the combined load full-load current value determined in step b.
   e. Select the Safety Isolation System that meets or exceeds this horsepower or kilowatt rating at the required voltage and frequency.
   f. Sum the locked-rotor currents of all the motor loads to be connected to the Safety Isolation System. To this value add the current values of all resistive loads to be connected to the Safety Isolation System. This value is the combined load locked-rotor current.
   g. Find the horsepower or kilowatt rating of a single motor with a locked-rotor current value greater than or equal to the combined load locked-rotor current value determined in step e.
   h. Select the Safety Isolation System that meets or exceeds this horsepower or kilowatt rating at the required voltage and frequency.
   i. Compare the ratings of the Safety Isolation Systems selected in steps d and g. Select the larger of the two systems for your application.
2. Determine how many Remote Lockout Stations are required for the application.
3. Determine how many Expansion Modules (if any) are required for the application.
4. Pick suitable enclosure type(s) for the Safety Isolation System Power Panel, Remote Lockout Stations and enclosed modules (e.g., Expansion Modules, Pneumatic and Hydraulic Isolation Module).
5. Determine what, if any, factory-installed options are required for the application (e.g. Pneumatic Isolation, Hydraulic Isolation, Status Communication to remote PLC, metering).

Bulletin 194E IEC Load Switches



Description

Bulletin 194E load switches are designed for use as local motor isolation and disconnect switch applications. Available with 3- and 6-pole versions with add-on additional poles, grounding and neutral terminals and auxiliary contacts, Bulletin 194Es share the same operating handles as the Bulletin 194L Control and Load Switches. Bulletin 194E switches are offered in two mounting styles, Front/Door and Base/DIN configurations for a variety of installations. Switch body styles for Bulletin 194E base-mounted switches include standard interlock shaft; Bulletin 194E front-mounted switches include standard shaft. Two-position OFF-ON switch is used to connect or disconnect a variety of inductive loads, including solenoids, valves, magnetic starters, relays, and motors. Handles featuring marked legend plates are available in Selector-Knob, Disk-Style, Rectangular-Style and Key-Operated versions. Selector-Knob versions are available in three sizes. Most handles are available in colors of Grey/Black or Red/Yellow and have padlockable versions.

- Suitable as At-Motor Disconnect Switch (UL508)
- 16, 25, 32, 40, 63, 80, 100 A Inductive Load-Rated Switches
- IP66/ UL Type 1/3/3R/12 Operating Handles
- IP2LX Finger-Safe Terminals
- 3- and 6-Pole Versions; Add-on Accessory Poles to Make 4-, 5-, 7- and 8-Pole Units
- Front/Door or DIN/Base Mounting Configurations
- Available in OFF-ON and Changeover Configurations
- 3- and 6-Pole Enclosed Switches
- Optional Thermoplastic Enclosures
- Positive-Guided Actuation
- Padlockable Handles Available (up to 3 padlocks)

Standards Compliance

IEC 60947-1
IEC 60947-3 Low-voltage switchgear and control gear part 3
UL 508
CSA: C22.2 No. 14

Certifications

UL Listed (File No. E14841, Guide NLRV)
CSA Certified (LR 13908)
IEC, VDE and BS
CE
RINA — Italian Naval Registry

Cat. No. Explanation

194E 16…100 A Small-Frame Switches (Handles listed on page 6-137)



3-Pole Base Mount



3-Pole Front Mount



6-Pole Base Mount



6-Pole Front Mount

194E – A 32 –1753

a b c

a

Installation Type	
Code	Description
A	Base/DIN Mounting
E	Front/Door Mounting

b

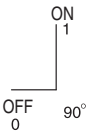
Load Size	
Code	Description
16	16 A
25	25 A
32	32 A
40	40 A
63	63 A
80	80 A
100	100 A

c

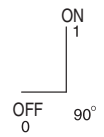
Function/Circuit Diagram Ref. #		
Code	Function	Description
1753	OFF/ON	3-Pole, 2-Position (90°)
1756	OFF/ON	6-Pole, 2-Position (90°)
1783	OFF/ON	3-Pole, 2-Position (90° - inverted)
3753	Changeover	3-Pole, 3-Position (90°)

Product Selection

Frequently Ordered* OFF-ON 3-Pole Switch (includes operating shaft) (Handles listed on page 6-137)

Function Switching Angle	Contact Target Configuration X = Contact Closed O = Contact Open			Rated Current [A]	AC23A Rated Power [kW] at 690V AC 50 Hz	Hp @ 480V AC 60 Hz 3 Ø	OFF-ON 3-Pole Switch (includes operating shaft)	
		Handle Position					Base-Mounted	Front-Mounted
	No. of Circuits	OFF/0	ON/1				Cat. No.	Cat. No.
	1 2 3	O O O	X X X	16	7.5	7.5	194E-A16-1753	194E-E16-1753
				25	11	10	194E-A25-1753	194E-E25-1753
				32	15	15	194E-A32-1753	194E-E32-1753
				40	18.5	20	194E-A40-1753	194E-E40-1753
				63	22	25	194E-A63-1753	194E-E63-1753
				80	37	40	194E-A80-1753	194E-E80-1753
				100	45	50	194E-A100-1753	194E-E100-1753

Frequently Ordered* OFF-ON 6-Pole Switch (includes operating shaft) (Handles listed on page 6-137)

Function Switching Angle	Contact Target Configuration X = Contact Closed O = Contact Open			Rated Current [A]	AC23A Rated Power [kW] at 690V AC 50 Hz	Hp @ 480V AC 60 Hz 3 Ø	OFF-ON 6-Pole Switch (includes operating shaft)	
		Handle Position					Base-Mounted	Front-Mounted
	No. of Circuits	OFF/0	ON/1				Cat. No.	Cat. No.
	1 2 3 4 5 6	O O O O O O	X X X X X X	16	7.5	7.5	**194E-A16-1756**	**194E-E16-1756**
				25	11	10	**194E-A25-1756**	**194E-E25-1756**
				32	15	15	**194E-A32-1756**	**194E-E32-1756**
				40	18.5	20	**194E-A40-1756**	**194E-E40-1756**
				63	22	25	**194E-A63-1756**	**194E-E63-1756**
				80	37	40	**194E-A80-1756**	**194E-E80-1756**
				100	45	50	**194E-A100-1756**	**194E-E100-1756**

* See Catalog No. Explanation for more load size and change-over switch options.

Bulletin 194E/194L Handles (for use with Bulletin 194E Switches)

Color	Handles (Includes Legend Plate and Control Knob)			
Red/Yellow (Emergency Stop colors)	 *Type I (IP66, UL Type 3/3R/12)*	 *Type L (IP66, UL Type 3/3R/12) With Locking For One Padlock (Padlock Not Included)*	 *Type N (IP66, UL Type 3/3R/12)*	**Bulletin 194L handles are available in both screw fixing and 22.5 mm mounting hole style.**
Black/Grey (Standard Operation colors)	 *Type A (IP66, UL Type 3/3R/12)*	 *Type E (IP66, UL Type 3/3R/12) With Locking For One Padlock (Padlock Not Included)*	 *Type G (IP66, UL Type 3/3R/12)*	 *Type S (IP66, UL Type 3/3R/12)*

Cat. No. Explanation

194L – HE 6 N – 175

a b c d

a

Code	Installation Type
HC	22.5 mm Mounting Hole Style Handle✶ (for use with front-mounted switches)
HE	Screw-Mounting Handle (for use with front- and base-mounted switches)

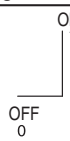
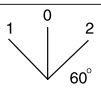
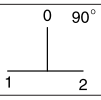
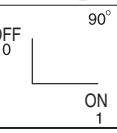
b

Code	Use with Handle Type	Handle Legend Plate Size	Use With 194E Switch Size
4	A, E, I, L❄	48 x 48 mm (1-57/64 x 1-57/64 in.)	194E-16…63 A
	S	48 x 62 mm (1-57/64 x 2-7/16 in.)	194E-25…63 A
6	A, E, I, L	64 x 64 mm (2-33/64 x 2-33/64 in.)	194E-25…100 A
	G, N❄‡	67 x 67 mm (2-41/64 x 2-41/64 in.)	194E-25…100 A
	S	64 x 78 mm (2-33/64 x 3-5/64 in.)	194E-25…100 A
8	A, I	88 x 88 mm (3-15/32 x 3-15/32 in.)	194E-40…100 A
	G, N	90 x 90 mm (3-35/64 x 3-35/64 in.)	194E-40…100 A

c

Code	Legend Plate Type	Color
A	Square	Grey/Black
I	Square	Red/Yellow
E	Square/Lockable	Grey/Black
L	Square/Lockable	Red/Yellow
G	Disc/Lockable (up to 3 locks)	Grey/Black
N	Disc/Lockable (up to 3 locks)	Red/Yellow
S	Large Square with extra legend area	Grey/Black

d

Code	Description	Legend Marking
175	O-I	
175I	OFF-ON	
350	1-0-2 (Reversing)	
375	0-1-2 (90 degrees) (Changeover)	
178	O-I	
178I	OFF-ON	

✶ For 22.5 mm mounting hole style handle (code HC), select either handle type A, E, I, or L with 48 x 48 mm legend plate size (code 4) only or handle type G or N with 64 x 64 mm legend plate size (code 6) only.

❄ Order 194E- 16A Type G and N handles as Cat. No. 194**E**-HE4N-175 or 194**E**-HE4G-175

‡ Use Type G and N with ON-OFF function only (table "d", code -175)

Frequently Ordered 194L Handles — OFF-ON Base/Front-Mounted 3- and 6-Pole Switch Handles (Switch Body listed on page 6-136)

Handle Type	Degree of Protection	Handle Color	Bezel Plate Size	For Use With	Legend Plate Marking	Cat. No.
E	IP66 (UL Type 1) (UL Type 3/3R/12)	Black/Grey	48 x 48 mm (1-57/64 x 1-57/64 in.)	194E-16…63 A 194L-E12…40 A, -1753 194L-A12…40 A, -1753	0-1	194L-HE4E-175
					OFF-ON	**194L-HE4E-175I**
L		Red/Yellow	48 x 48 mm (1-57/64 x 1-57/64 in.)	194E-16…63 A 194L-E12…40 A, -1753 194L-A12…40 A, -1753	0-1	194L-HE4L-175
					OFF-ON	**194L-HE4L-175I**
G	IP66 (UL Type 3/3R/12)	Black/Grey	54 x 54 mm (2-1/8 x 2-1/8 in.)	194E-16 A	0-1 OFF-ON	194E-HE4G-175
			67 x 67 mm (2-41/64 x 2-41/64 in.)	194E-25…100 A 194L-E12…40 A, -1753 194L-A12…40 A, -1753	0-1 OFF-ON	194L-HE6G-175
			88 x 88 mm (3-15/32 x 3-15/32 in.)	194E-40…100 A	0-1 OFF-ON	194L-HE8G-175
N		Red/Yellow	54 x 54 mm (2-1/8 x 2-1/8 in.)	194E-16 A	0-1 OFF-ON	194E-HE4N-175
			67 x 67 mm (2-41/64 x 2-41/64 in.)	194E-25…100 A 194L-E12…40 A, -1753 194L-A12…40 A, -1753	0-1 OFF-ON	194L-HE6N-175
			88 x 88 mm (3-15/32 x 3-15/32 in.)	194E-40…100 A	0-1 OFF-ON	**194L-HE8N-175**
L	IP66 (UL Type 3/3R/12)	Red/Yellow	48 x 48 mm (1-57/64 x 1-57/64 in.)	194L-E12…40 A, -1753	0-1	194L-HC4L-175
					OFF-ON	**194L-HC4L-175I**

Bulletin 194E Open and Enclosed Switch Kits Cat. No. Explanation

194E – Y 32 –1753– 6N

a b c d

a

Code	Installation Type
A	Base/DIN Mounting, open type switch
E	Front/Door Mounting, open type switch
Y	Enclosed Base Mounting Switch With Handle (Uses IP66 ABS thermoplastic enclosure)

c

Code	Configuration
1753	3-Pole OFF/ON (90°)
1756	6-Pole OFF/ON (90°)

b

Code	Load Size
16	16 A*
25	25 A
32	32 A
40	40 A
63	63 A
80	80 A
100	100 A

* For 16 A Enclosed Switch: use "16M" (3-pole enclosure has M16/20 knockouts, 6-pole 16 A enclosure has M25/32 knockouts). For 25/32 A Enclosed Switch with M20/25 metric knockouts: use “25M” or “32M”.

d

Code	Handle Style
4N	194E-HE4N-175 (use with 16 A Switch)
4G	194E-HE4G-175 (use with 16 A Switch)
4A	194L-HE4A-175 (use with 16…100 A Switch)
6N	194L-HE6N-175 (use with 25…100 A Switch)
6G	194L-HE6G-175 (use with 25…100 A Switch)
6A	194L-HE6A-175 (use with 25…100 A Switch)

Frequently Ordered Switch Kits — OFF-ON Front- and Base-Mounted 3-Pole Switch With Cat. No. 194L-HE6N-175 Red/Yellow Handle

	Function Switching Angle	Rated Current [A]	AC23A Rated Power [kW] at 690V AC	HP @ 480V AC 60 Hz, 3-Phase	Base-Mounted Cat. No.	Front-Mounted Cat. No.
		25	7.5	10	**194E-A25-1753-6N**	**194E-E25-1753-6N**
		32	11	15	**194E-A32-1753-6N**	**194E-E32-1753-6N**
		63	18.5	25	194E-A63-1753-6N	**194E-E63-1753-6N**

Base-Mounting Distribution Switches (handles are pre-assembled to switch)

	Function Switching Angle	No. of Circuits	Contact Target OFF/0	Contact Target ON/1	Handle Color	Legend Plate Marking	Lockable (One Padlock)	Rated Current [A]	AC23A Rated Power [kW] at 690V AC	Hp @ 480V AC 60 Hz, 3-Phase	Cat. No.
		1 2 3	O O O	X X X	Red/Yellow	0-1	Yes	25	11	—	**194E-A25-1753-R**
					Black/Grey	0-1	No			—	**194E-A25-1753-Q**
					Red/Yellow	0-1	Yes	32	15	—	**194E-A32-1753-R**
					Black/Grey	0-1	No			—	**194E-A32-1753-Q**

Frequently Ordered Enclosures — 3- and 6-Pole Enclosed Switches With Cat. No. 194L-HE6N-175 Red/Yellow Operating Handles

	No. of Poles	Function Switching Angle	Rated Current [A]	Handle Color	Cat. No.
 *Uses Base-Mounted Switches*	3		16	Red/Yellow	**194E-Y16-1753-4N**
			25		**194E-Y25-1753-6N**
			32		**194E-Y32-1753-6N**
			40		**194E-Y40-1753-6N**
	6		25	Red/Yellow	**194E-Y25-1756-6N**

IEC Load Switches

Bulletin 194E

Bulletin 194E Enclosed Disconnect Load Switches with 194R Handles (with Defeater, suitable for 3 padlocks)

194E-FA Painted Steel Enclosure UL Type 3/4/12, IP66	194E-CA Stainless Steel Enclosure UL Type 4/4X, IP66	194E-KA Non-Metallic Enclosure UL Type 3/4/4X, IP66	194E-AA Metallic Enclosure UL Type 1, IP54	194E-GA Painted Steel Enclosure UL Type 3/4/12, IP66	194E-DA Stainless Steel Enclosure UL Type 4/4X, IP66
					

Cat. No. Explanation ⁎❄

194E – FA 32 E – P11 – P11 – 6

a b c d d e

a

Code	Enclosure Type
FA	UL Type 3/4/12, IP66 Painted Steel, Hinged, for 16…100 A switches
GA	UL Type 3/4/12, IP66 Painted Steel, Hinged, in 6 x 6 x 4 in. size, for 16…32 A 3-pole switches ‡
CA	UL Type 4/4X, IP66 Stainless Steel, Hinged, for 16…100 A switches
DA	UL Type 4/4X, IP66 Stainless Steel, Hinged, in 6 x 6 x 4 in. size, for 16…32 A 3-pole switches ‡
KA	UL Type 3/4/4X, IP66 Non-Metallic, for 16…100 A switches
AA	UL Type 1, IP54 Painted Steel, Hinged, for 16…100 A switches (Same enclosure as FA without gasketing)

b

Code	Load Size
16	16 A
20	25 A
32	32 A
40	40 A
63	63 A
80	80 A
00	100 A

c

Code	Handle Color (194R-HS _ _)
Blank	Grey/Black
E	Red/Yellow

d

Code	Left Side + Right Side Modifications⁎
Blank	No Option
-P11	1 N.O. + 1 N.C. Auxiliary Contacts
-PL11	1 N.O. + 1 N.C.L.B. Auxiliary Contacts
-P22	2 N.O. + 2 N.C. Auxiliary Contacts
-PD10	1 N.O. E.B.
-NP	Additional Pole
-PE	Grounding Pole
-TN	Neutral Pole

e

Code	Switch Type
Blank	3-pole switch
-6	6-pole switch§

⁎ Modifications: Up to two suffix codes may be added to an enclosed disconnect load switch. See Guidelines, page 6-141. If only one accessory is chosen, it is mounted on the left side of the switch.
❄ To order the cat. no. 194E-FA40/FA63 or 194E-CA40/CA63 in the larger 80/100A sized enclosure, add an "X" after the handle color. For example, Cat. No. **194E-FA40E** becomes Cat. No. **194E-FA40**EX.
‡ GA and DA type enclosures: use with 3-pole 16…32 A switches only.
§ Special order; allow for longer delivery time.

Frequently Ordered Bulletin 194E Enclosed Switches with Bulletin 194R Handle

Description	Rated Current [A]	Dimension Reference	Handle Color	Cat. No.⁎
Stainless steel enclosure, IP66/Type 4/4X	25	A1	Black	194E-CA20
			Red/Yellow	194E-CA20E
	32	A1	Black	194E-CA32
			Red/Yellow	194E-CA32E
	63	A1	Black	194E-CA63
			Red/Yellow	194E-CA63E
	25	A1	Black	194E-FA20
			Red/Yellow	194E-FA20E
	32	A1	Black	194E-FA32
			Red/Yellow	194E-FA32E
	40	A1	Black	**194E-FA40**
			Red/Yellow	194E-FA40E
	25	C1	Black	194E-KA20
			Red/Yellow	194E-KA20E

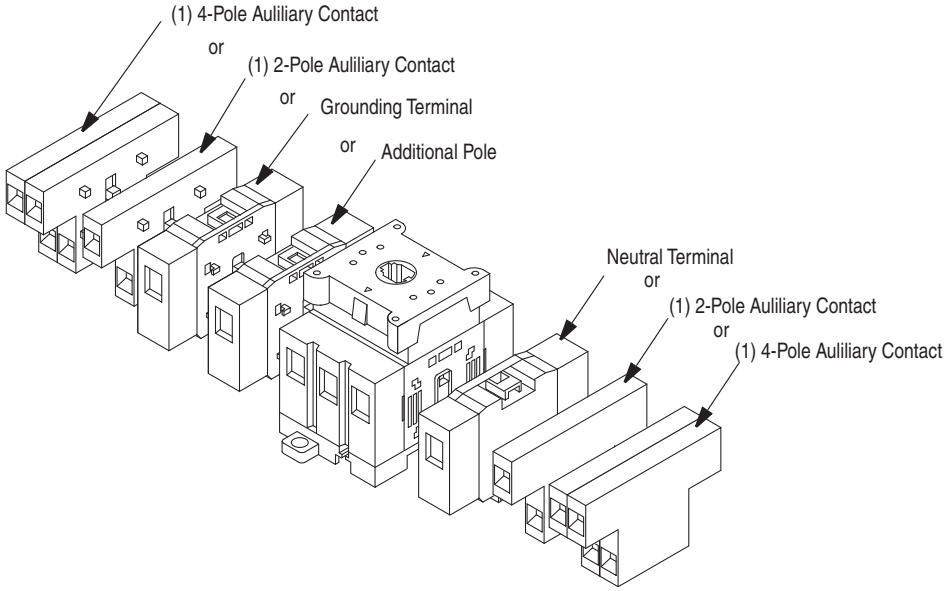
⁎ Modifications: Up to two suffix codes may be added to an enclosed disconnect load switch. See Guidelines, page 6-141. If only one accessory is chosen, it is mounted on the left side of the switch.

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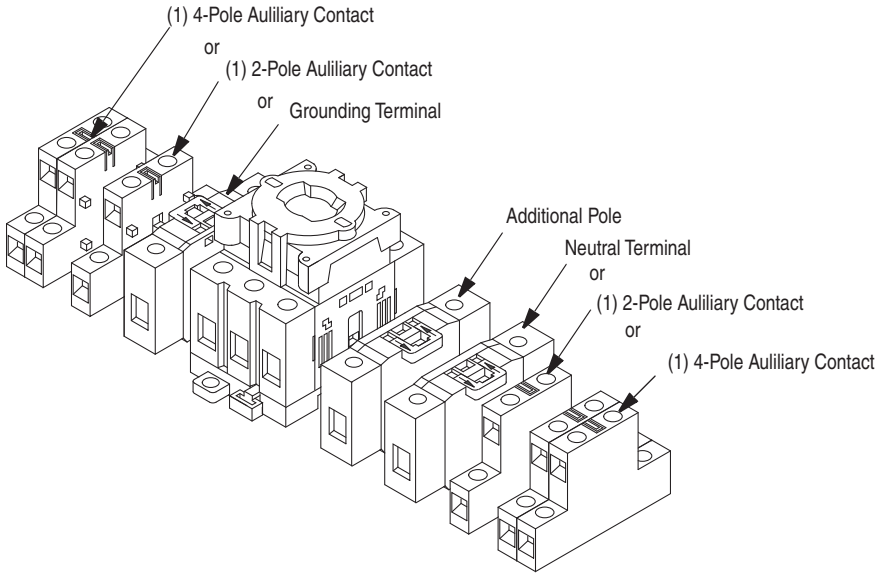
Accessories

IEC Load Switch Accessories

194E-E16...100 A, Front/Door Mounting



194E-A16...100 A, Base/DIN Rail Mounting



Accessory Configuration Guidelines

Accessory drawings represent modular, snap-on features of Bulletin 194E accessories. They are not suggesting possible accessory configurations. Use the following guidelines for choosing 194E accessory configurations.

- Up to two accessories may be added to the Bulletin 194E switch body.
- For the 194E 25, 32, 40, or 63 A switches, the early break auxiliary contact (-PD10) may only be used in the following configurations:
  As a single unit on either side of the switch
  As a single unit on a side when used with a switch + 4th pole (-NP)
  As a single unit on a side when used with a switch + ground terminal (-PE)
  As a single unit on a side when used with a switch + neutral terminal (-TN)
  No other auxiliary contact may be used in combinations with an early break auxiliary contact (-PD10)
- Other combinations of auxiliary contacts are permissable.
- For the 194E 80 and 100 A switches, any combination of auxiliary contacts, 4th pole, ground terminal, neutral terminal, and -PD10 is permissable.

IEC Load Switches

Bulletin 194E

Auxiliary Contacts	No. of Auxiliary Contacts	For Use With	Cat. No.∗
	1 N.O. + 1 N.C.	194E-A16...100	194E-A-P11
		194E-E16...100	194E-E-P11
	1 N.O. + 1 N.C.L.B.	194E-A16...100	194E-A-PL11
		194E-E16...100	194E-E-PL11
	2 N.O. + 2 N.C.	194E-A16...100	194E-A-P22
		194E-E16...100	194E-E-P22
	1 N.O.E.B.	194E-A16	194E-A16-PD10
		194E-A25...100	194E-A-PD10
		194E-E16	194E-E16-PD10
		194E-E25...100	194E-E-PD10

Additional Pole, 1 N.O.	For Use With	Cat. No.∗
	194E-A16	194E-A16-NP
	194E-A25	194E-A25-NP
	194E-A32	194E-A32-NP
	194E-A40	194E-A40-NP
	194E-A63	194E-A63-NP
	194E-A80	194E-A80-NP
	194E-A100	194E-A100-NP
	194E-E16	194E-E16-NP
	194E-E25	194E-E25-NP
	194E-E32	194E-E32-NP
	194E-E40	194E-E40-NP
	194E-E63	194E-E63-NP
	194E-E80	194E-E80-NP
	194E-E100	194E-E100-NP

Earthing/Grounding Terminal	For Use With	Cat. No.∗
	194E-A16	194E-A16-PE
	194E-A25/32	194E-A32-PE
	194E-A40/63	194E-A63-PE
	194E-A80/100	194E-A100-PE
	194E-E16	194E-E16-PE
	194E-E25/32	194E-E32-PE
	194E-E40/63	194E-E63-PE
	194E-E80/100	194E-E100-PE

Neutral Terminal	For Use With	Cat. No.∗
	194E-A16	194E-A16-TN
	194E-A25/32	194E-A32-TN
	194E-A40/63	194E-A63-TN
	194E-A80/100	194E-A100-TN
	194E-E16	194E-E16-TN
	194E-E25/32	194E-E32-TN
	194E-E40/63	194E-E63-TN
	194E-E80/100	194E-E100-TN

∗ A maximum of two side-mount accessories may be added to a Bulletin 194E switch (one on each side).

6-Pole Mechanical Coupling∗❄	For Use With	Cat. No.
	194E-16	**194E-G3821**
	194E-25/32	**194E-G3660**
	194E-40/63	**194E-G3661**
	194E-80/100	**194E-G3662**

∗ User must order (2) Bulletin 194E 3-Pole Switches separately.

❄ Coupling for changeover switch not available. Changeover switch must be ordered as a factory-assembled device (e.g., 194E-A25-3753).

ABS Thermoplastic Enclosure — IP66, For High-Impact Applications (grounding screw included)	No. of Poles	For Use With	Cat. No.
	3…4	194E-A25/32	**194L-G3572**
	3…4	194EA-40/63	**194E-G3663**
	6	194EA-25/32	
	6	194EA-40/63	**194E-G3665**
	3…4	194EA-80/100	

Noryl Thermoplastic Enclosures — IP66, For Corrosion-Prone Applications (grounding screw included)	No. of Poles	For Use With	Cat. No.
	3…4	194E-A25/32	**194L-G3576**
	6	194EA-25/32	**194E-G3664**
	3…4	194EA-40/63	
	6	194EA-40/63	**194E-G3666**
	3…4	194EA-80/100	

Description	For Use With	Pkg. Qty.	Cat. No.
Additional Earth/Ground and Neutral Terminals — For Thermoplastic Enclosure	194L-G3663, G3664, G3665, G3666	5	**194E-G3673**
	194L-G3572 and G3676	5	**194E-G3653**

Terminal Covers	No. of Poles	For Use With	Cat. No.
	1	194E-16	194E-16-C1
	3	194E-16	194E-16-C3
		194E-25/32	194E-25-C3
		194E-40/63	194E-40-C3
		194E-80/100	194E-80-C3
	4	194E-25/32	194E-25-C4
		194E-40/63	194E-40-C4
		194E-80/100	194E-80-C4

Operating Shafts

	Length	Construction	Pkg. Qty.	Cat. No.
 *Standard Shaft (for front-mount switches)*	34 mm (1-11/32 in.)	Plastic	5	**194L-G3380**
	36.5 mm (1-7/16 in.)	Metal	5	**194E-G3688**
 *Interlock Shaft (for base-mount switches)*	44 mm (1-47/64 in.) (Standard Length)	Plastic	5	194L-G2830
		Metal		**194E-G3687**
	52 mm (2-3/64 in.)	Plastic		194L-G3194
		Metal		**194E-G3707**
	57 mm (2-15/64 in.)	Plastic		194L-G3195

Bulletin 194E Load Switch Cat. No. Shaft Selection for use with 194E and 194L Thermoplastic Enclosures

Rated Current [A]	3-Pole Switches (-1753 suffix)		6-Pole Switches (-1756 suffix)		Changeover Switches (-3753 suffix)	
	194E-E…	194E-A…	194E-E…	194E-A…	194E-E…	194E-A…
16	plastic shaft (Cat. No. 194L-G3380)	plastic shaft (Cat. No. 194L-G2830)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)
25	plastic shaft (Cat. No. 194L-G3380)	plastic shaft (Cat. No. 194L-G2830)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)
32	plastic shaft (Cat. No. 194L-G3380)	plastic shaft (Cat. No. 194L-G2830)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)
40	plastic shaft (Cat. No. 194L-G3380)	plastic shaft (Cat. No. 194L-G2830)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)
63	plastic shaft (Cat. No. 194L-G3380)	plastic shaft (Cat. No. 194L-G2830)	metallic shaft (Cat. No. 194L-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)
80	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)
100	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)	metallic shaft (Cat. No. 194E-G3688)	metallic shaft (Cat. No. 194E-G3687)

Shaft Extension Kits



Shaft Extension

Length	For Use With	Pkg. Qty.	Cat. No.
24 mm (15/16 in.) Per Extension	194E-A…	10	194L-G2853



Length	For Use With	Pkg. Qty.	Cat. No.
110…235 mm (4-21/64…9-1/4 in.)	194E-A…	1	194L-G3393
230…350 mm (9-3/64…13-51/64 in.)			194L-G3394

Metal Shaft Adaptor Kits — For use with 194R Type 4/4X Handles

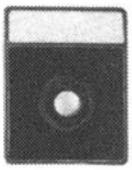
	For Use With	Pkg. Qty.	Cat. No.
 Metal shaft adaptor kits — for use with 194R Type 4/4X handles kit includes bezel adapter and 194R-R1 operating shaft. Operating handle (Cat. No. 194R-HS4) must be ordered separately.	194E-A…	1	**194E-G3675**
 Metal Shaft Extension For modification of Cat. No. 194L-G3393/ G3394 when used with any switches other than 2-position, 90° rotation.	194E-A…	10	**194L-G3399**

Other Accessories

194L/194E 22.5 mm Mounting Hole Style Handles (Type B, D) (For Front-Mounted Switches)

	Description		Cat. No.
 *Type B*	22.5 mm Mounting Hole Style Handles (IP65) Handle Style: Knob Lever with Latch (For Use With 194E-E25…100 A, -1753) or 194L-E12…40 A		194L-HCB-001
 *Type D*	22.5 mm Mounting Hole Style Handles Key Removal Position (Includes Latch) For Use With 194L-E 12…40 A, 194E-E16…63 A, -1753		194L-HCDC-001
	22.5 mm Mounting Hole Style Handles Key Removal Position (Includes Latch) For Use With 194L-E 12…40 A, 194E-E16…63 A, -1753		194L-HCDD-001
	22.5 mm Mounting Hole Style Handles Key Removal Position (Includes Latch) For Use With 194L-E 12…40 A, 194E-E16…63 A, -1753		194L-HCDG-001

Accessory Description		Pkg. Qty.	Cat. No.
	Control Knob, Black, with Locking Facility (Use 1/4 in. max. hasp lock.) (Locks in 0°, 90°, 180°, and 270° positions)	10	**194L-G2864N**
	Control Knob, Red, with Locking Facility (Use 1/4 in. max. hasp lock)		**194L-G2864R**

Accessory Description			Pkg. Qty.	Cat. No.
		Control Knob, Type P Control Knob, Black, 31 mm (1-7/32 in.) Diameter	5	**194L-G2888N**
		Control Knobs, Type P Control Knob, Red, 31 mm (1-7/32 in.) Diameter		**194L-G2888R**
 *Standard Black Control Knob*	 *Rectangular Front Frame*	Control Knob, Black, L = 37.5 mm (1-31/64 in.)	5	**194L-G3154N**
		Control Knob, Black, L = 48 mm (1-57/64 in.)		**194L-G3155N**
		Control Knob, Red, L = 37.5 mm (1-31/64 in.)		**194L-G3154R**
		Control Knob, Red, L = 48 mm (1-57/64 in.)		**194L-G3155R**
		Rectangular front frame with blank nameplate L = 48 x 62 mm (1-57/64 x 2-7/16 in.)	10	**194L-G3196**
		Rectangular front frame with blank nameplate L = 64 mm x 78 mm (2-33/64 in. x 3-5/64 in.)		**194L-G3197**

Additional Legend Plates/Frames



Color	Legend Size	For Use With	Pkg. Quantity	Legend Plate Marking	Cat. No.
Black/Grey	19.2 mm x 49 mm 3/4 in. x 1-59/64 in.	Size 6 Type G and N style handles, Cat. Nos. 194L-HE6G/N	5	(Blank)	194L-G3667
				MAIN SWITCH	**194L-G3667A**
				HAUPSCHALTER	**194L-G3667B**
				INTERR. PRINCIPALE	**194L-G3667C**
				INTERR. PRINCIPAUX	**194L-G3667D**
				INTERR. PRINCIPAL	**194L-G3667E**
				HUVUDBRYTARE	**194L-G3667F**
				WAHLSCHALTER	**194L-G3667G**
				EMERGENCY OFF	**194L-G3667H**
Black/Grey	18 mm x 84 mm 11/16 in. x 3-5/16 in.	Size 8 Type G and N style handles, Cat. Nos. 194L-HE8G/N	5	(Blank)	194L-G3515
				MAIN SWITCH	**194L-G3515A**
				HAUPTSCHALTER	**194L-G3515B**
				INTERR. PRINCIPALE	**194L-G3515C**
				INTERR. PRINCIPAUX	**194L-G3515D**
				INTERR. PRINCIPAL	**194L-G3515E**
				HUVUDBRYTARE	**194L-G3515F**
				WAHLSCHALTER	**194L-G3515G**
				EMERGENCY OFF	**194L-G3515H**

Legend Plates with Bezel	Legend Plate Color	Pkg. Quantity	Legend Plate Marking ∗		
			0-1	OFF-ON	Blank Legend Plate
			Cat. No.	Cat. No.	Cat. No.
	Silver	10	**194L-A4-175**	**194L-A4-175I**	**194L-A4-000**
			194L-A6-175	**194L-A6-175I**	**194L-A6-000**
			194L-A8-175	**194L-A8-175I**	**194L-A8-000**
	Yellow		**194L-I4-175**	**194L-I4-175I**	**194L-I4-000**
			194L-I6-175	**194L-I6-175I**	**194L-I6-000**
			194L-I8-175	**194L-I8-175I**	**194L-I8-000**

∗ Custom-Engraved legend plates available. To order, use publication 194L-PP002*.

Shaft for Enclosures

Enclosure Type	Suitable For			Suitable For		
	194L (Base-Mounted Switches)	No. of Contacts	Shaft	Use with 194E Switch	No. of Poles	Shaft Required
194L-G3572	194L-A12(16)	1/2	194L-G3195	194E-A25(32)	3 and 4	194L-G3194
194L-G3576	194L-A12(16)	3/4	Standard			
	194L-A20(25)	1/2	194L-G3194			
(95 x 150 x 86 mm)	194L-A20(25)	3/4	Standard			
194L-G3573	194L-A12(16)	5/6	194L-G3195			
194L-G3577	194L-A12(16)	7/8	194L-G3194			
	194L-A12(16)	9/10	Standard	—	—	—
	194L-A20(25)	5/6	194L-G3194			
(95 x 150 x 111 mm)	194L-A20(25)	7/8	Standard			
194E-G3663				194E-A40(63)	3 and 4	194L-G3194
194E-G3664	—	—	—	194E-A25(32)	6	Standard
(125 x 180 x 105 mm)						
194E-G3665				194E-A80(100)	3 and 4	194E-G3707
194E-G3666	—	—	—	194E-A40(63)	6	Standard
(175 x 230 x 120 mm)						

Accessory Combinations in Enclosure

Enclosure Type	Switch	No. of Poles	Shaft	Aux. Contacts (single or double)	Additional Pole Block	On Switch		On Enclosure	
						Neutral Terminal Block	Ground Terminal Block	Neutral Terminal Block	Ground Terminal Block
194L-G3572 (ABS) 194L-G3576 (Noryl) (95 x 150 x 86 mm)	194E-A25(32)	3	194L-G3194	X	X				
				X		X			
				X			X		
					X		X		
						X	X		
				X				X	
				X					X
								X	X
194E-G3663 (ABS) 194E-G3664 (Noryl) (125 x 180 x 105 mm)	194E-A40(63)	3	194L-G3194	X	X			X	X
				X		X		X	X
				X			X	X	X
					X		X	X	X
						X	X	X	X
					X		X	X	X
	194E-A25(32)	6	194E-G3707					X	X
194E-G3665 (ABS) 194E-G3666 (Noryl) (175 x 230 x 120 mm)	194E-A80(100)	3	194E-G3707	X	X			X	X
				X		X		X	X
				X			X	X	X
					X		X	X	X
						X	X	X	X
					X		X	X	X
	194E-A40(63)	6	194E-G3707	1L+1R				X	X

Electrical Ratings

Performance Data				16 A	25 A	32 A	40 A	63 A	80 A	100 A	Aux. Contacts
IEC Applications											
Rated operational voltage (U_e): IEC✶			[V]	690	690	690	690	690	690	690	690
Rated operational voltage (U_e): UL, CSA			[V]	600	600	600	600	600	600	600	600
Rated isolation voltage (U_i): IEC/UL, CSA			[V]	690/600	690/600	690/600	690/600	690/600	690/600	690/600	690/600
Rated impulse voltage (U_{imp}): UL, CSA			[kV]	8	8	8	8	8	8	8	8
Test voltage, (U_i) 1 minute			[kV]	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Lost power per pole			[W]	0.58	1.0	1.5	1.6	2.4	3.6	5.5	0.4
Rated frequency			[Hz]	50/60	50/60	50/60	50/60	50/60	50/60	50/60	50/60
Conventional free air thermal current I^{th}✶			[A]	25	40	50	63	75	100	120	12
Conventional enclosed thermal current I^e✶			[A]	20	32	40	50	63	80	100	10
Rated current I^e✶											
AC-1/ AC-21A	Non-inductive or only slightly inductive loads / Switching of resistive loads with slight overload		[A]	16	25	32	40	63	80	100	10
Rated power P_e											
AC-23A	Occasional switching of 3Ø motors and other highly inductive loads (criterion for selecting main switches)	230V	[kW]	5.5	7.5	7.5	15	18.5	22	30	—
		400V	[kW]	7.5	11	15	22	30	37	55	—
		690V	[kW]	7.5	11	15	18.5	22	37	45	—
AC-3	Squirrel-cage motors; starting and stopping of running motors	230V	[kW]	4	5.5	7.5	11	15	18.5	22	—
		400V	[kW]	5.5	7.5	11	15	18.5	30	37	—
		690V	[kW]	5.5	7.5	11	15	18.5	30	22	—
Short circuit current (co-ordination type 2)			[kA]	20	20	15	20	15	30	25	—
Rated conditional short-circuit current			[A]	20	25	35	50	63	80	100	—
Maximum fuse rating of circuit (type g,G)		400/415V	[A]	800	900	900	1300	1300	2500	2500	—
Rated short-time current I_{cw} (1 s)											
Rated breaking capacity AC23A (cosϕ 0.45)		230V	[A]	156	296	296	484	484	780	780	—
		400V	[A]	120	256	256	504	504	800	800	—
		690V	[A]	70	136	136	196	196	376	376	—
DC switching capacity											
Rated current I^e	1 pole	48V	[A]	20	25	32	40	63	80	100	—
		110V	[A]	5	5	6	8	10	16	20	
		220V	[A]	1	1	1	1.5	15	3	3	
		440V	[A]	0.5	0.5	0.5	0.6	0.6	0.7	0.7	
DC-21A	For resistive loads, T ≤ 1 ms U_e max = 660V	2 poles in series	96V	[A]	20	25	32	40	63	80	100	—
			110V	[A]	20	23	25	32	50	70	80	
			220V	[A]	5	5	6	8	10	16	20	
			440V	[A]	1	1	1	1.5	1.5	3	3	
			600V	[A]	0.6	0.6	0.6	0.8	0.8	1	1	
		3 poles in series	110V	[A]	20	25	32	40	63	80	100	—
			220V	[A]	13	13	15	20	28	50	63	
			440V	[A]	2.2	2.2	2.2	3.6	3.6	6.5	6.5	
			600V	[A]	1.3	1.5	1.5	2	2	3	3	
Rated power P_e											
DC-23A, DC-3, DC-5		3 poles in series	90V	[kW]	1	1.3	1.5	2.9	4.1	5.1	7.2	—
	For inductive loads, T ≤ 15 ms		110V	[kW]	1	1.1	1.3	2.2	3.3	5.5	7	
			220V	[kW]	0.8	0.9	1.1	1.7	2	3.5	4.4	
			440V	[kW]	0.6	0.6	0.6	0.9	0.9	1.1	1.1	
			600V	[kW]	0.4	0.4	0.4	0.5	0.5	0.9	0.9	

✶ See standards compliance listed on page 6-134.
❄ Suitable also for SEV 500.

Electrical Ratings, Continued

Performance Data			16 A	25 A	32 A	40 A	63 A	80 A	100 A	Aux. Contacts
UL/CSA Applications										
Continuous current		[A]	16	25	32	40	63	80	100	—
Heavy Pilot Duty		[AC]	A600	A600	A600	—	—	—	—	A600
Standard Duty		[DC]	—	—	—	—	—	—	—	Q600
Motor rating 60 Hz	120V, 1P	FLA	16	16	16	24	34	56	80	
		Hp	1	1	1	2	3	5	7.5	
	240V, 1P	FLA	12	12	17	17	28	50	68	
		Hp	2	2	3	3	5	10	15	—
Single-phase (2 poles)	480V, 1P	FLA	8.5	8.5	14	21	26	34	68	
		Hp	3	3	5	7.5	10	15	30	
	600V, 1P	FLA	11.2	11.2	11.2	16	20	27	44	
		Hp	5	5	5	7.5	10	15	25	
Three-phase	120V, 3P	FLA	13.6	13.6	19.2	30.4	40	56	84	
		Hp	2	2	3	5	7.5	10	15	
	240V, 3P	FLA	9.6	15.2	22	28	42	68	80	
		Hp	3	5	7.5	10	15	25	30	
	480V, 3P	FLA	11	14	21	27	34	52	65	—
		Hp	7.5	10	15	20	25	40	50	
	600V, 3P	FLA	11	11	17	22	27	52	52	
		Hp	10	10	15	20	25	50	50	

Mechanical Data

Performance Data			16 A	25…32 A	40…63 A	80…100 A	Aux. Contacts
Protection class according to IEC 529							
Motor rating 60 Hz							
handles			IP66	IP66	IP66	IP66	IP66
switch bodies			IP20	IP20	IP20	IP20	IP20
Mechanical life		[million operations]	0.2	0.2	0.2	0.2	0.2
Max wire gauges							
Terminal size per IEC 947-1			A4	A6	A7	A9	2xA2
rigid wire	1/2 conductor	AWG mm²	(1)16…10/(2)16…12 (1)1…10/(2)1…4	(1)14…8/(2)14…10 (1)1.5…16/(2)1.5…6	(1)12…4/(2)12…8 (1)2.5…25/(2)2.5…16	(1)10…1/(2)10…4 (1)4…50/(2)4…25	18…14 0.75…2.5
fine strands	1/2 conductor	AWG mm²	(1)16…8/(2)16…12 (1)1.5…6/(2)1.5…4	(1)14…8/(2)14…10 (1)1.5…10/(2)1…6	(1)12…4/(2)12…8 (1)2.5…16/(2)2.5…10	(1)10…1/(2)10…6 (1)4…35/(2)4…16	18…14 0.5…2.5

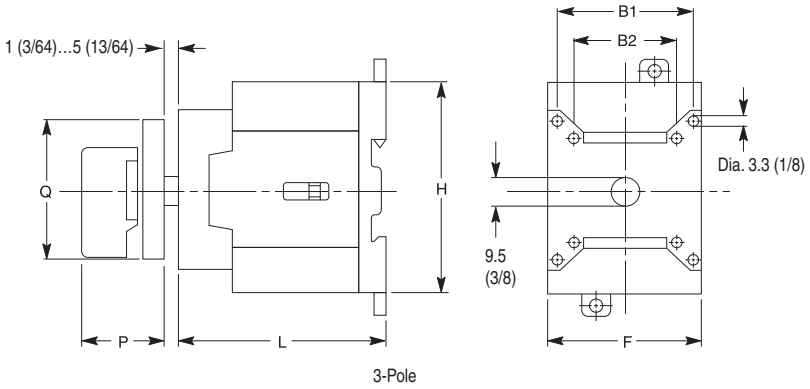
Environmental Data

Storage	–40…+80 °C (–40…+176 °F)
Operation	–25…+60 °C (–13…+140 °F)

Approximate Dimensions

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Front Installation Cat. No. 194E-E...

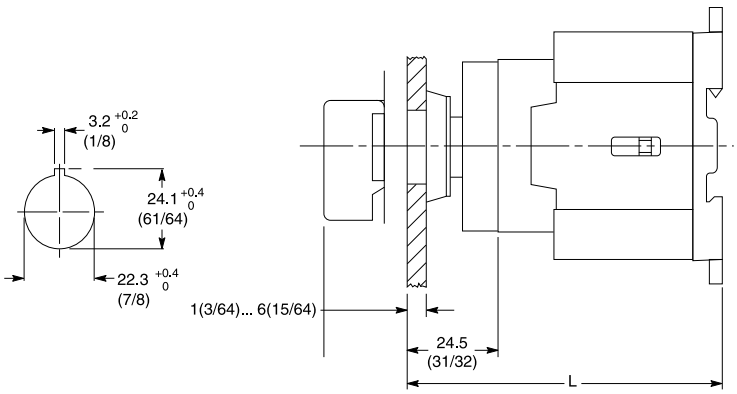


Handles		
Cat. No.	P	Q
194L-HE4A	28 (1-7/64)	48 x 48 (1-57/64 x 1-57/64)
194L-HE4I	28 (1-7/64)	48 x 48 (1-57/64 x 1-57/64)
194L-HE4S	28 (1-7/64)	48 x 62 (1-57/64 x 2-7/16)
194E-HE4N	34 (1-11/32)	54 x 54 (2-1/8 x 2-1/8)
194E-HE4G	34 (1-11/32)	54 x 54 (2-1/8 x 2-1/8)
194L-HE6A	28 (1-7/64)	64 x 64 (2-33/64 x 3-5/64)
194L-HE6I	28 (1-7/64)	64 x 64 (2-33/64 x 3-5/64)
194L-HE6S	28 (1-7/64)	64 x 78 (2-33/64 x 3-5/64)
194L-HE6N	34 (1-11/32)	67 x 67 (2-41/64 x 2-41/64)
194L-HE6G	34 (1-11/32)	67 x 67 (2-41/64 x 2-41/64)

Switch Body						
Use with Cat. No.	B1✶	B2	F	H	L ❄	G
194E-E16	28 (1-7/64)	N/A	36 (1-37/64)	63 (2-31/64)	51 (2)	90 (3-35/64)
194E-E25/32	36 (1-27/64)	N/A	45 (1-25/32)	64 (2-33/64)	60 (2-3/8)	90 (3-1/2)
194E-E40/63	48 (1-57/64)	36 (1-27/64)	54 (2-1/8)	72 (2-27/32)	74 (2-29/32)	108 (4-1/4)
194E-E80/100	48 (1-57/64)	36 (1-27/64)	72 (2-27/32)	90 (3-35/64)	90 (3-35/64)	144 (5-11/16)

✶ Does not apply to 194E-40/63A, 6-Pole Switches. Use B2 dimensions for 6-pole devices.
❄ For 6-pole switches, add 1 in. to the "L" dimension.

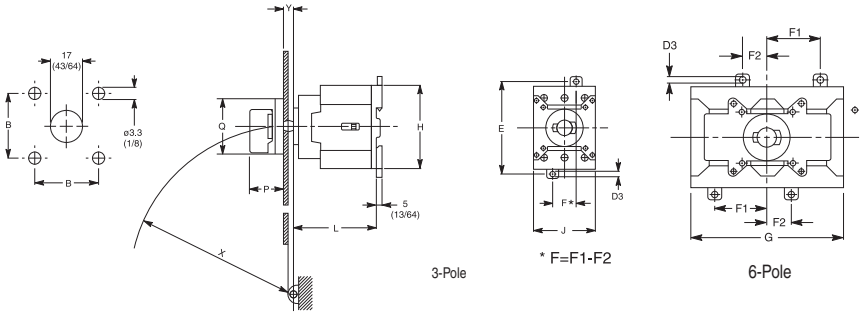
Cat. No. 194E-E Switch Body with Cat. No. 194L-HC4A Handle for 22.5 mm Hole Mounting Style



Type	L
194E-E16	76 (3)
194E-E25/32	84.5 (3-21/64)
194E-E40/63	98.5 (3-7/8)
194E-E80/100	114.5 (4-33/64)

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Base Mounting Cat. No. 194E-A...



Handles		
Cat. No.	P	Q
194L-HE4A	28 (1-7/64)	48 x 48 (1-57/64 x 1-57/64)
194L-HE4I	28 (1-7/64)	48 x 48 (1-57/64 x 1-57/64)
194L-HE4S	28 (1-7/64)	48 x 62 (1-57/64 x 2-7/16)
194E-HE4N	34 (1-11/32)	54 x 54 (2-1/8 x 2-1/8)
194E-HE4G	34 (1-11/32)	54 x 54 (2-1/8 x 2-1/8)
194L-HE6A	28 (1-7/64)	64 x 64 (2-33/64 x 3-5/64)
194L-HE6I	28 (1-7/64)	64 x 64 (2-33/64 x 3-5/64)
194L-HE6S	28 (1-7/64)	64 x 78 (2-33/64 x 3-5/64)
194L-HE6N	34 (1-11/32)	67 x 67 (2-41/64 x 2-41/64)
194L-HE6G	34 (1-11/32)	67 x 67 (2-41/64 x 2-41/64)

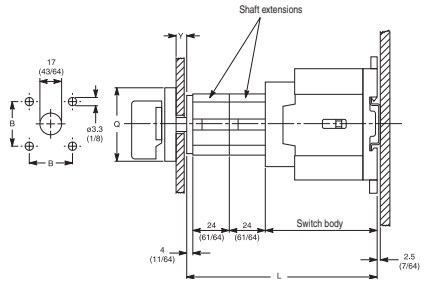
Cover Requirements				
For Use With	Y min.	X ≥	Y max.	X ≥
194E-A16	5 (13/64)	142 (5-19/32)	9.5 (3/8)	90 (3-35/64)
194E-A25/32	5 (13/64)	142 (5-19/32)	9.5 (3/8)	90 (3-35/64)
194E-A40/63	2.5 (7/64)	150 (5-29/32)	9.5 (3/8)	90 (3-35/64)
194E-A80/100	2.5 (7/64)	150 (5-29/32)	9.5 (3/8)	90 (3-35/64)

Switch Body								
Use With Cat. No.	D3	E	F1	F2	G	H	L❄	J
194E-A16	4.5 (3/16)	70 (2-49/64)	45 (1-25/32)	12.5 (31/64)	90 (3-35/64)	63 (2-31/64)	80 (3-5/32)	36 (1-27/64)
194E-A25/32	4.5 (3/16)	70 (2-49/64)	30 (1-3/16)	15 (19/32)	90 (3-1/2)	64 (2-33/64)	59 (2-5/16)	45 (1-25/32)
194E-A40/63	4.5 (3/16)	80 (3-5/32)	37 (1-15/32)	17 (43/64)	108 (4-1/4)	72 (2-27/32)	73 (2-55/64)	54 (2-1/8)
194E-A80/100	5.6 (7/32)	95 (3-3/4)	48.5 (1-29/32)	23.5 (59/64)	144 (5-11/16)	90 (3-35/64)	89 (3-1/2)	72 (2-27/32)

❄ For 6-pole switches, add 1 in. to the "L" dimension.

Base Mounting Cat. No. 194E-A...

Cat. No. 194E-A... Switch Body with Cat. No. 194L-G2853 Shaft Extension



Shaft	Y
194L-G2830	2.5...9.5 (7/64...3/8)
194L-G3194	9...18 (23/64...23/32)
194L-G3195	14...23 (9/16)...(29/32)

Switch Body				
	Cat. No.			
L ✶	194E-A 16	194E-A 25/32	194E-A 40/63	194E-A 80/100
With 1 shaft extension	79 (3-7/64)	88 (3-15/32)	102 (4-1/32)	118 (4-21/32)
With 2 shaft extensions	103 (4-37/64)	112 (4-27/64)	126 (4-31/32)	142 (5-19/32)
With 3 shaft extensions	127 (5)	136 (5-23/64)	150 (5-29/32)	166 (6-35/64)
With 4 shaft extensions	151 (6-61/64)	160 (6-5/16)	174 (6-55/64)	190 (7-31/64)
With 5 shaft extensions	175 (7-57/64)	184 (7-1/4)	198 (7-51/64)	214 (8-7/16)
With 6 shaft extensions	199 (8-27/32)	208 (8-13/64)	222 (8-3/4)	238 (9-3/8)

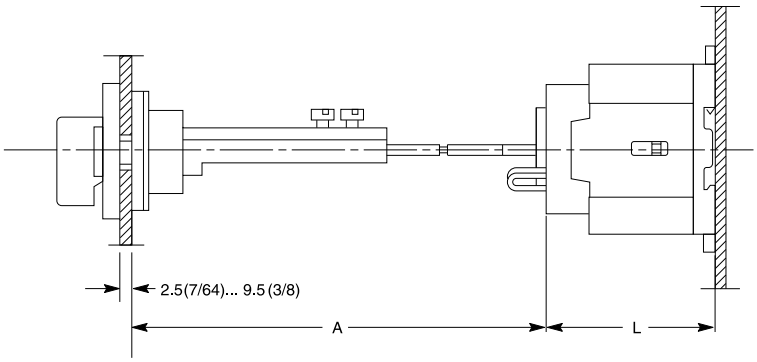
✶ For 6-pole switches, add 1 in. to the "L" dimension.

Handles			
Type	B	Q	P
194L-HE4A	36 (1-27/64)	48 x 48 (1-57/64 x 1-57/64)	28 (1-7/64)
194L-HE4I	36 (1-27/64)	48 x 48 (1-57/64 x 1-57/64)	28 (1-7/64)
194E-HE4G	28 (1-7/64)	54 x 54 (2-1/8 x 2-1/8)	34 (1-11/32)
194E-HE4N	28 (1-7/64)	54 x 54 (2-1/8 x 2-1/8)	34 (1-11/32)
194L-HE6A	48 (1-57/64)	64 x 64 (2-33/64 x 2-33/64)	28 (1-7/64)
194L-HE6I	48 (1-57/64)	64 x 64 (2-33/64 x 2-33/64)	28 (1-7/64)
194L-HE6N	48 (1-57/64)	67 x 67 (2-41/64 x 2-41/64)	34 (1-11/32)
194L-HE6G	48 (1-57/64)	67 x 67 (2-41/64 x 2-41/64)	34 (1-11/32)

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Base Installation Cat. No. 194E-A...

Cat. No. 194E-A Switch Body with Metal Shaft Extension



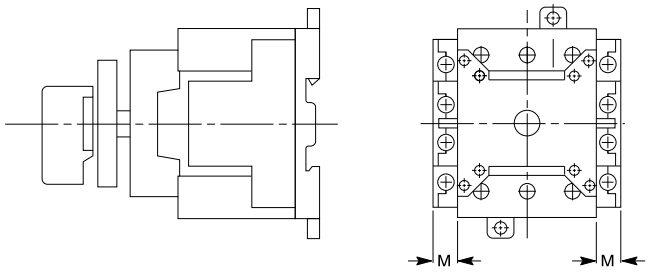
Cat. No.	A
194L-G3393	110...235 (4-11/32...9-1/4)
194L-G3394	230...350 (9-1/16...13-25/32)

Cat. No.	L*
194E-A16	51 (2)
194E-A25/32	60 (2-3/8)
194E-A40/63	74 (2-59/64)
194E-A80/100	90 (3-35/64)

* For 6-pole switches, add 1 in. to the "L" dimension.

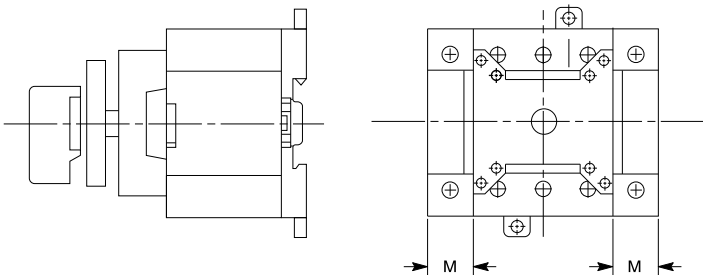
Base and Front Installation

Cat. No. 194E... with Auxiliary Contact Block Installed



Contacts	M
1 N.O. + 1 N.C.	9 (23/64)
2 N.O. + 2 N.C.	18 (23/32)

Cat. No. 194E... with 4-Pole, Ground and Neutral Terminals

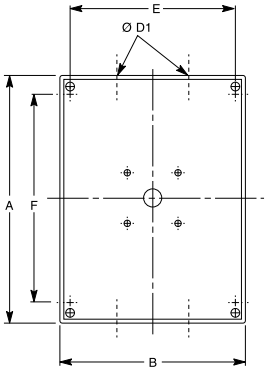


Cat. No.	M
194E-16	12.5 (31/64)
194E-25/32	14 (9/16)
194E-40/63	17.5 (11/16)
194E-80/100	22 (7/8)

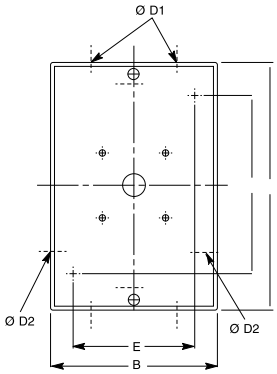
Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Base Mounting Cat. No. 194E-A...

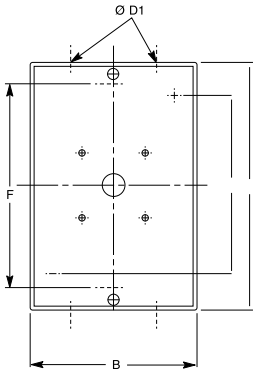
Thermoplastic Enclosures



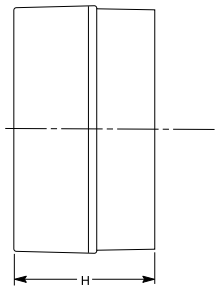
Cat. No. 194L-3665



Cat. No. 194L-3572



Cat. No. 194L-3563



Enclosure Base View

Complete Switches		Enclosures		Height A	Width B	Knockouts❄ ØD1		Mounting Holes‡ E	Mounting Holes‡ F	Depth H
Cat. No.	Poles	ABS Cat. No.	Noryl Cat. No.							
194E-Y16	3 and 4	✶	✶	118 (4-21/32)	66 (2-19/32)	M16/M20 16/20 mm	PG11/PG16 18.5/22.5 mm	50 (1-31/32)	105 (4-9/65)	70 (2-49/65)
	6	194E-G3663	194E-G3664	180 (7-3/32)	125 (4-59/64)	M25/M30 25/30 mm	PG21/PG29 28.5/37.5 mm	On Center	145 (5-23/32)	105 (4-1/8)
194E-Y25/32	3 and 4	194L-G3572	194L-G3576	150 (5-29/32)	95 (3-3/4)	PG16/PG21 22.5/28.5 mm		60 (2-3/8)	115 (4-17/32)	86 (3-3/8)
	6	194E-G3663	194E-G3664	180 (7-3/32)	125 (4-59/64)	PG21/PG29 28.5/37.5 mm		On Center	145 (5-23/32)	105 (4-1/8)
194E-Y40/63	3 and 4	194E-G3663	194E-G3664	180 (7-3/32)	125 (4-59/64)	PG21/PG29 28.5/37.5 mm		On Center	145 (5-23/32)	105 (4-1/8)
	6	194E-G3665	194E-G3666	230 (9-1/16)	175 (6-57/64)	PG29/PG36 37.5/47.5 mm		155 (6-3/32)	195 (4-11/16)	120 (4-47/64)
194E-Y80/100	3 and 4	194E-G3665	194E-G3666	230 (9-1/16)	175 (6-57/64)	PG29/PG36 37.5/47.5 mm		155 (6-3/32)	195 (4-11/16)	120 (4-47/64)

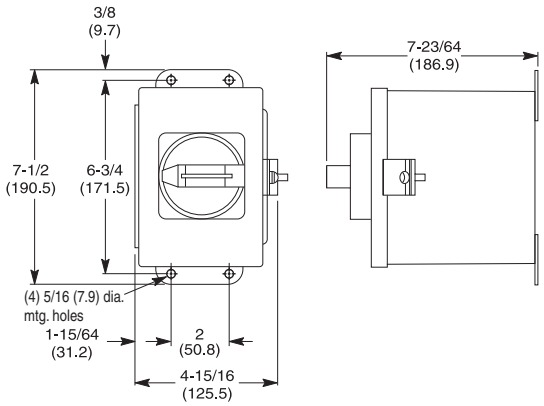
✶ Empty enclosures not available for purchase.
❄ Cat. No. 194E-A16 units have 1 knockout on each end. all others have 2 knockouts on each end. A letter "M" in the catalog number indicates metric knockouts; the unit is otherwise supplied with PG knockouts.
‡ All mounting holes have a 4.2 mm (5/32 in.) diameter.

No. of Extensions	Cat. No. 194E-A 20/32...	Cat. No. 194E-A 40/63...	Cat. No. 194E-A 80/00...
With 1 extension	96 (3-25/32)	107 (4-7/32)	114 (4-31/64)
With 2 extensions	120 (4-23/32)	131 (5-5/32)	138 (5-7/16)
With 3 extensions	144 (5-43/64)	155 (6-7/64)	162 (6-3/8)
With 4 ✶ extensions	168 (6-39/64)	179 (7-3/64)	186 (7-21/64)
With 5 ✶ extensions	192 (7-9/16)	203 (8)	210 (8-17/64)
With 6 ✶ extensions	216 (8-1/2)	227 (8-15/16)	234 (9-7/32)

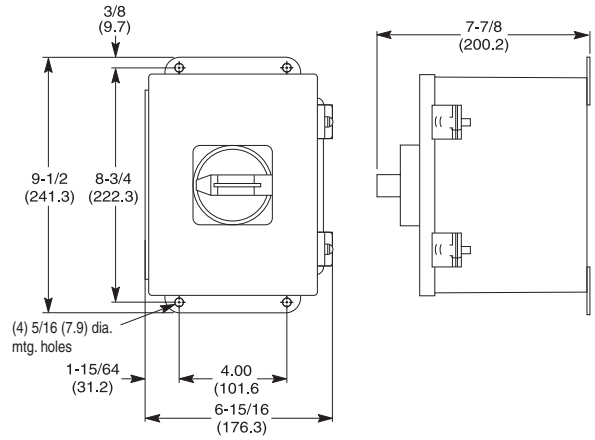
✶ When more than 4 modules are used, attach the first one to the switch body using the screws supplied with the extension (Cat. No. 194L-G2853).

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

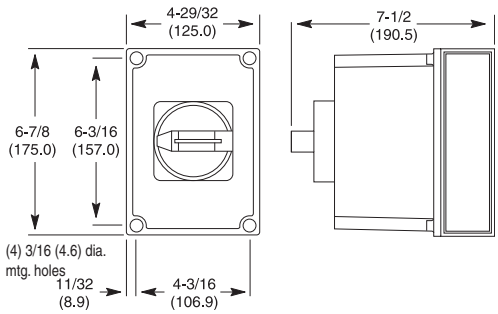
194E Enclosed Switches with 194R Handles



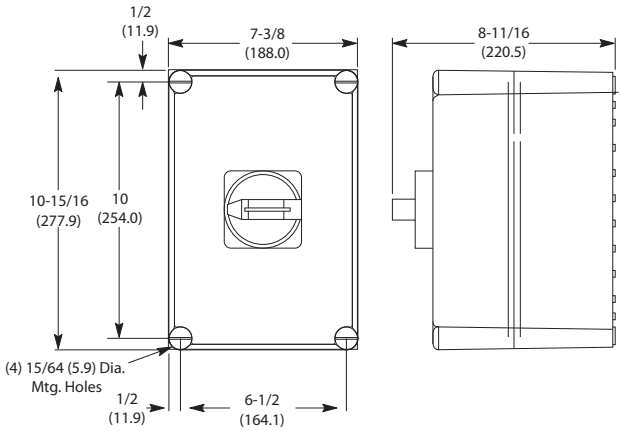
Cat. Nos. 194E-CA16...63, 194E-FA16...63, 194E-AA16...63



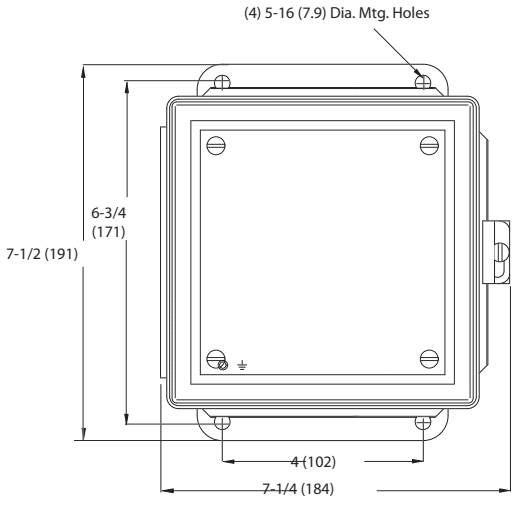
Cat. Nos. 194E-CA80...00, 194E-FA80...00, 194E-AA80...00
Cat. Nos. 194E-CA40X...63X, 194E-FA40X...63X, 194E-AA40X...63X

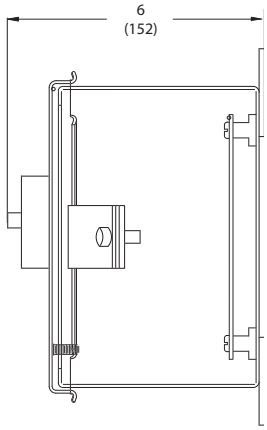


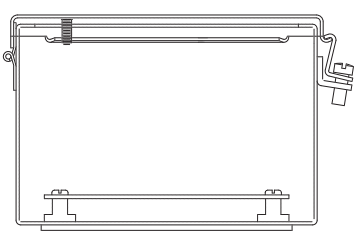
Cat. No. 194E-KA16...63



Cat. No. 194E-KA80...00







Cat. No. 194E-DA16...32, 194E-GA16...32

Bulletin 194E IEC Load Switches



Bulletin 194E load switches are designed for use as local motor isolation and for disconnect switch applications. They are available in 3- and 4-pole versions with add-on grounding and neutral terminals and auxiliary contacts.

Bulletin 194E switches are offered in two mounting styles, Front/Door and Base/DIN configurations, for a variety of installations. Switch body styles for Bulletin 194E base-mounted switches include standard interlock shaft; Bulletin 194E front-mounted switches include standard shaft.

- At-Motor Disconnect Switch (UL508)
- 125, 160, 250, 315 A Versions of Inductive Load-Rated Switches
- IP66/UL Type 1/3/3R/12 Operating Handles
- IP2LX Finger-Safe Terminals
- 3- and 4-Pole Versions
- Front/Door or DIN/Base Mounting Configurations
- OFF-ON Configurations
- Box Lug and Bolt-on Terminals Available
- Switches Include Operating Shaft
- Suitable as Motor Disconnect

Standards Compliance

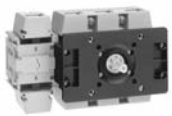
IEC 207
IEC 60947-1
IEC 60947-3 Low-voltage switchgear and control gear part 3
UL 508
CSA C22.2, No. 14

Certifications

cULus Listed (Box Lug Version) (UL File No. E14841, Guide NLRV, NLRV7)
UR Recognized (Bolt-on Version) (UL File No. E 14841 NLRV2, NLRV8)
CE

Overview

Bulletin 194E Switches — 125...315 A

OFF-ON Switch — with Box Lugs (UL Listed)		OFF-ON Switch — with Bolt-on Wiring (UR Recognized))	
 *3-pole Base Mounted*	 *3-pole Front Mounted*	 *3-pole Base Mounted*	 *3-pole Front Mounted*
 *4-pole Base Mounted*	 *4-pole Front Mounted*	 *4-pole Base Mounted*	 *4-pole Front Mounted*

Cat. No. Explanation

194E – A 125 –1753
a b c

a

Installation Type	
Code	Description
A	Base Mounting w/Box Lugs — UL Listed*
B	Base Mounting w/Bolt-on Wiring — UR Recognized*
E	Front Mounting w/Box Lugs — UL Listed
F	Front Mounting w/Bolt-on Wiring — UR Recognized

* 20 cm shaft included with switch

b

Load Size	
Code	Description
125	125 A
160	160 A
250	250 A
315	315 A

c

Configuration		
Code	Function	Description
1753	OFF-ON	3-Pole, 2-position (90 degrees)
1754	OFF-ON	4-Pole, 2-position (90 degrees)

Product Selection

Frequently Ordered 194E Switches

(see Cat. No. Explanation for additional load sizes in 3- and 4-pole configurations)

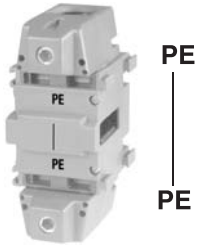
Description	No. of Poles	Rated Current	AC23 Rated kw 690V AC 50 Hz	Hp @ 480V AC 60 Hz 3 Ø	Cat. No.
Base-mounting switch w/ box lugs — 125 A	3	125	45	60	* 194E-A125-1753
Base-mounting switch w/ box lugs — 160 A		160	55	60	* 194E-A160-1753
Base-mounting switch w/ box lugs — 250 A		250	90	75	* 194E-A250-1753
Base-mounting switch w/ box lugs — 315 A	4	315	110	100	* 194E-A315-1754
Base-mounting switch w/ bolt-on wiring — 250 A	3	250	45	75	* **194E-B250-1753**
Base-mounting switch w/ bolt-on wiring — 315 A		315	45	100	* **194E-B315-1753**
Front-mounting switch w/ box lugs — 160 A		160	37	60	194E-E160-1753
Front-mounting switch w/ bolt-on wiring — 160 A	4	160	37	60	**194E-F160-1754**
Front-mounting switch w/ bolt-on wiring — 250 A		250	45	75	**194E-F250-1754**
Front-mounting switch w/ bolt-on wiring — 315 A		315	45	100	**194E-F315-1754**

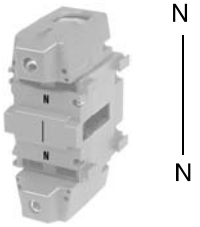
* 20 cm shaft included with switch.

Accessories
Handles 194E - 125...315 A

Handles with Screw Fixing (Includes Legend Plate and Control Knob)	Degree of Protection	Color	Legend Plate Size	For Use With	Legend Marking	Cat. No.
 *Type A*	IP65 (UL Type 3/3R/12)	Black/Grey	88 x 88 mm 3-15/32 x 3-15/32 in.	194E-125...315 A		194E-HE8A-175
			130 x 130 mm 5-1/8 x 5-1/8 in.			194E-HE13A-175
 *Type I*		Red/Yellow	88 x 88 mm 3-15/32 x 3-15/32 in.			194E-HE8I-175
			130 x 130 mm 5-1/8 x 5-1/8 in.			194E-HE13I-175
 *Type G*		Black/Grey	90 x 90 mm 3-35/64 x 3-35/64 in.	194E-125...315 A		194E-HE8G-175
			135 x 135 mm 5-5/16 x 5-5/16 in.			194E-HE13G-175
 *Type N*		Red/Yellow	90 x 90 mm 3-35/64 x 3-35/64 in.			194E-HE8N-175
			135 x 135 mm 5-5/16 x 5-5/16 in.			194E-HE13N-175

Auxiliary Contacts - 2 N.O. / 1 N.C.	For Use With	Cat. No.
	194E-A125-160,194E-B125-160	194E-AB-P21-160
	194E-A250-315,194E-B250-315	194E-AB-P21-315
	194E-E125-160,194E-F125-160	194E-EF-P21-160
	194E-E250-315,194E-F250-315	194E-EF-P21-315

Earthing/Grounding Terminal	For Use With	Cat. No.
	194E-A125-160,194E-E125-160	194E-AE160-PE
	194E-A250-315,194E-E250-315	194E-AE315-PE
	194E-B125-160,194E-F125-160	**194E-BF160-PE**
	194E-B250,194E-F250	**194E-BF250-PE**
	194E-B315,194E-F315	**194E-BF315-PE**

Neutral Terminal	For Use With	Cat. No.
	194E-A125-160,194E-E125-160	194E-AE160-TN
	194E-A250-315,194E-E250-315	194E-AE315-TN
	194E-B125-160,194E-F125-160	**194E-BF160-TN**
	194E-B250,194E-F250	**194E-BF250-TN**
	194E-B315,194E-F315	**194E-BF315-TN**

Shaft Extension	Length	For Use With	Cat. No.
	40 cm	194E-A or 194E-B 125…315 A Base-Mounted Switches	194E-AB40

Terminal Cover	For Use With		Cat. No.
	194E-A125-160 194E-E125-160	2 covers per pole	194E-AE125-C1
	194E-A250-315 194E-E250-315	2 covers per pole	194E-AE250-C1
	194E-B125-160 194E-F125-160	2 covers per pole	194E-BF125-C1
	194E-B250-315 194E-F250-315	2 covers per pole	194E-BF250-C1

Legend

Additional Name Plate and Frame

	Color	Legend Size	For Use With	Legend Marking	Pkg. Qty.	Cat. No.
	Black/Grey	18 x 84 mm 11/16 x 3-5/16 in.	Size 8 Type G and N Style Handles, Cat. Nos. 194L-HE8G/N 88 mm x 88 mm 90 mm x 90 mm 130 mm x 130 mm 135 mm x 135 mm legend frames	MAIN SWITCH	5	**194L-G3515A**
				HAUPTSCHALTER		**194L-G3515B**
				INTERR. PRINCIPALE		**194L-G3515C**
				INTERR. PRINCIPAUX		**194L-G3515D**
				INTERR. PRINCIPAL		**194L-G3515E**
				HUVUDBRYTARE		**194L-G3515F**
				WAHLSCHALTER		**194L-G3515G**
	Black/Grey			EMERGENCY OFF		**194L-G3515H**

Specifications

IEC Performance Data for 194E

				194E-125	194E-160	194E-250	194-315
Rated insulation voltage U_i: ✶			[V]	1000	1000	1000	1000
Rated impulse withstand voltage U_{imp}			[kV]	8	8	8	8
Test voltage 1 min			[kV]	3.5	3.5	3.5	3.5
Rated voltage U_e ✶❄			[V]	1000	1000	1000	1000
Rated frequency			[Hz]	50/60	50/60	50/60	50/60
Rated thermal current I^{th} open			[A]	125	160	250	315
Rated thermal current I_{the} enclosed			[A]	125	160	250	315
Rated current I^e							
AC-1 /	Non-inductive or slightly induc. load		[A]	125	160	250	315
AC-21A	Switching of resistive loads with slight overload						
Rated power P_e							
AC-23A	Occasional switching of motor and other highly inductive loads	230V	[kW]	30	30	37	55
		400V	[kW]	45	55	90	110
		690V	[kW]	37	37	45	45
AC-3	Squirrel-cage motors: starting and stopping of running motors	230V	[kW]	22	30	37	45
		400V	[kW]	37	45	55	75
		690V	[kW]	30	37	45	45
Conditional rated short-circuit current		400/415V	[kA]	30	30	30	30
Max. fuse rating of circuit (type gG)			[A]	125	160	250	315
Rated short-time current I_{cw} 1S			[A]	2500	3000	4600	5800
Rated breaking capacity		230V	[A]	800	900	1600	1800
AC-23A (cos ϕ 0.45)		400V	[A]	750	850	1380	1650
		690V	[A]	340	340	400	400

✶ Valid for line with grounded common neutral termination, overvoltage category III, pollution degree 3. Other values on request.
❄ Not suitable for load-switching applications (AC-20 A) above 690V.

IEC Performance Data for 194E, Continued

DC Switching Capacity							
				194E-125	194E-160	194E-250	194E-315
Rated current I^e							
	Rated voltage [V]	No. Poles in series					
DC-21A	60	3	[A]	125	160	250	315
For resistive loads T≤1 ms	110	3	[A]	110	140	220	280
	220	3	[A]	45	55	85	110
	Rated voltage [V]	No. Poles in series					
	110	4	[A]	125	160	250	315
	220	4	[A]	80	100	150	200
	440	4	[A]	16	20	32	40
Rated power P_e							
	Rated voltage [V]	No. Poles in series					
DC-22A, DC-3	24	4	[kW]	3	3.8	6	7.5
For Inductive loads T≤2.5 ms	48	4	[kW]	6	7.5	12	15
	60	4	[kW]	7.5	9.5	15	19
	110	4	[kW]	10	12.5	20	25
	220	4	[kW]	4.5	5.5	8	10
Rated Power P_e							
	Rated voltage [V]	No. Poles in series					
DC-23A, DC-5	24	4	[kW]	3	3.8	6	7.5
For Inductive loads T≤15 ms	48	4	[kW]	6	7.5	12	15
	60	4	[kW]	7.5	9.5	15	19
	110	4	[kW]	8.8	11	17.5	22
	220	4	[kW]	2.5	3.5	5.5	7

UL CSA Performance Data for 194E

			194E-125	194E-160	194E-250	194E-315
Rated Insulation Voltage		[V]	600	600	600	600
Rated voltage		[V]	600	600	600	600
Continuous current		[A]	150	200	250	300
Ampere rating for general use		[A]	150	200	250	300
Heavy Pilot Duty		[AC]				
Standard Duty		[DC]				
Motor rating 60Hz						
1-phase (2 poles)	120V, 1 P	[FLA]	80	100	135	180
		[Hp]	7.5	10	15	20
	240V, 1 P	[FLA]	88	110	136	155
		[Hp]	20	25	30	35
	480V, 1 P	[FLA]	78	88	99	108
		[Hp]	35	40	45	50
	600V, 1 P	[FLA]	62	70	86	104
		[Hp]	35	40	50	60
3-Phase	120V, 3 P	[FLA]	84	108	160	208
		[Hp]	15	20	30	40
	240V, 3 P	[FLA]	8	104	154	192
		[Hp]	30	40	60	75
	480V, 3 P	[FLA]	77	77	96	124
		[Hp]	60	60	75	100
	600V, 3 P	[FLA]	62	62	77	99
		[Hp]	60	60	75	100

Mechanical Data

				194E-125	194E-160	194E-250	194E-315
Handles				IP66	IP66	IP66	IP66
Protection class according to IEC 529				—	—	—	—
Front side Front unit				IP66	IP66	IP66	IP66
Box lugs∗				IP20	IP20	IP20	IP20
Bolt-on	straight version∗			IP20	IP20	IP20	IP20
	bent version			—	—	—	—
Mechanical life			[Million operations]	0.1	0.1	0.075	0.075
Box lugs — max. wire gauges				—	—	—	—
Terminal sizes according to IEC 947-1		Gauge No.		B11	B11	B14	B14
Fine strands, 1 conductor		Max.	mm^2	70	70	150	150
		Min.	mm^2	16	16	25	25
Rigid wire, 1 conductor		Max.	mm^2	95	95	185	185
		Min.	mm^2	10	10	16	16
Wire gauges according to UL/CSA		Max.	AWG	3/0	3/0	—	—
			MCM	—	—	350	350
		Min.	AWG	8	8	4	4

∗ When provided with terminal covers.

Certifications

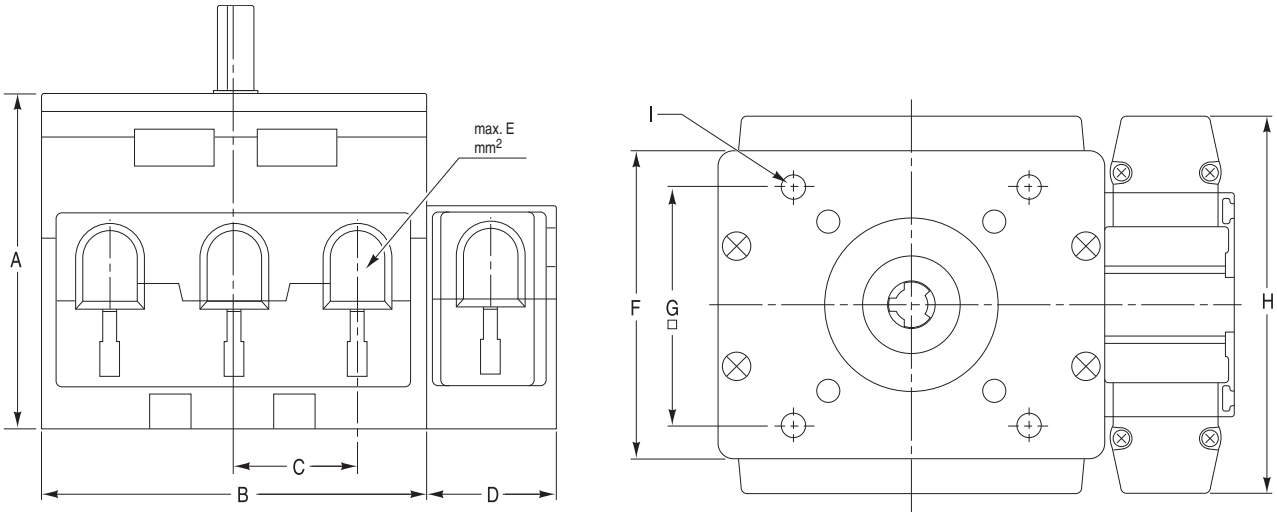
Catalog No. or Designation		UL-Listed (marked with UL)	UR-Recognized (marked with UR)	UL-Listed for Canada (marked with cUL)	UR-Recognized for Canada (marked with cUR)	CE
194E-A125	194E-E125	A	—	A	—	A
194E-A160	194E-E160	A	—	A	—	A
194E-A250	194E-E250	A	—	A	—	A
194E-A315	194E-E315	A	—	A	—	A
194E-B125	194E-F125	—	A	—	A	A
194E-B160	194E-F160	—	A	—	A	A
194E-B250	194E-F250	—	A	—	A	A
194E-B315	194E-F315	—	A	—	A	A
Aux. switch blocks		Z	Z	Z	Z	Z
Ground terminal		Z	Z	Z	Z	Z
Neutral terminal		Z	Z	Z	Z	Z

A = Certified
Z = accessories are covered by the approval for the switch

Approximate Dimensions

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Front-Installation Box Lugs, 3- and 4-Pole

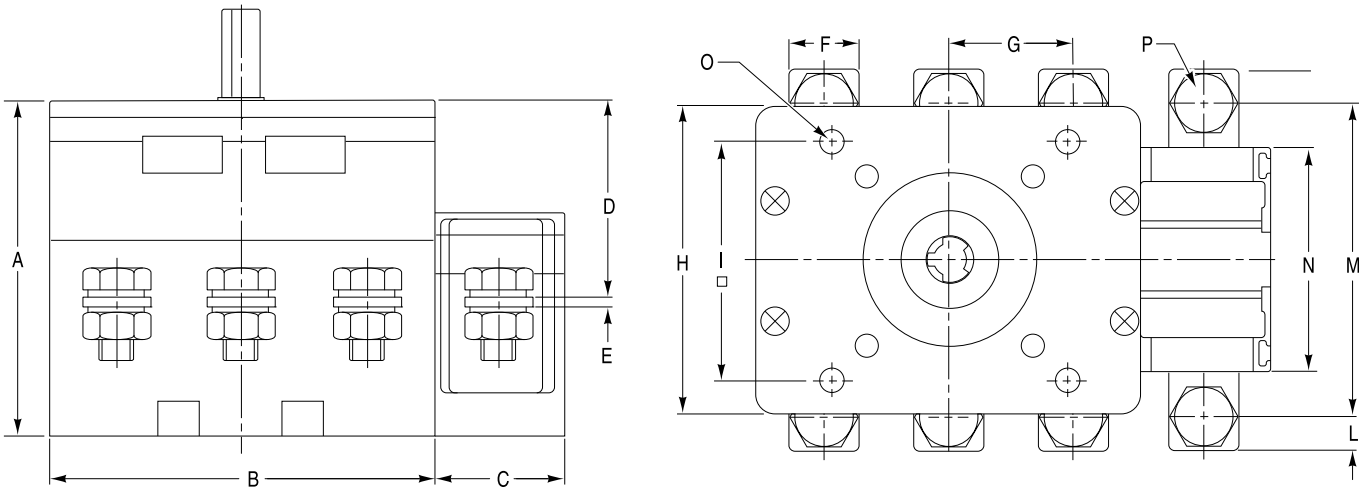


Switch Body 194E-E

[A]	A	B	C	D	E	F	G	H	I∗
125	91 (3-19/32)	112 (4-13/32)	36 (1-13/32)	38 (1-1/2)	95 (3-23/64)	88 (3-7/16)	68 (2-11/16)	108 (4-1/4)	M5
160	91 (3-19/32)	112 (4-13/32)	36 (1-13/32)	38 (1-1/2)	95 (3-23/64)	88 (3-7/16)	68 (2-11/16)	108 (4-1/4)	M5
250	103 (4-3/64)	145 (5-23/32)	44 (1-23/32)	52.5 (2-1/16)	185 (7-9/32)	88 (3-7/16)	68 (2-11/16)	120 (4-11/16)	M5
315	103 (4-3/64)	145 (5-23/32)	44 (1-23/32)	52.5 (2-1/16)	185 (7-9/32)	88 (3-7/16)	68 (2-11/16)	120 (4-11/16)	M5

∗ M5 x 0.8 bolts supplied with switch. Threaded hole.

Front-Installation Bolt-on Terminals, 3- and 4-Pole



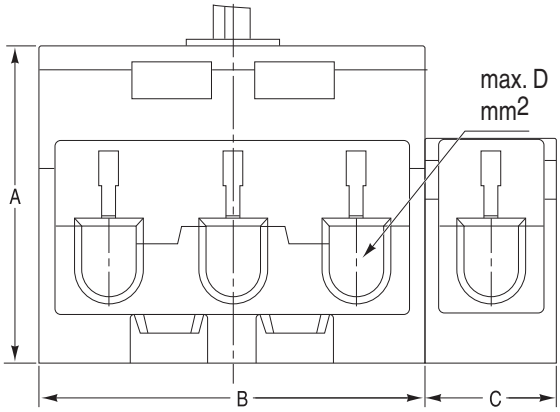
Switch Body 194E-F

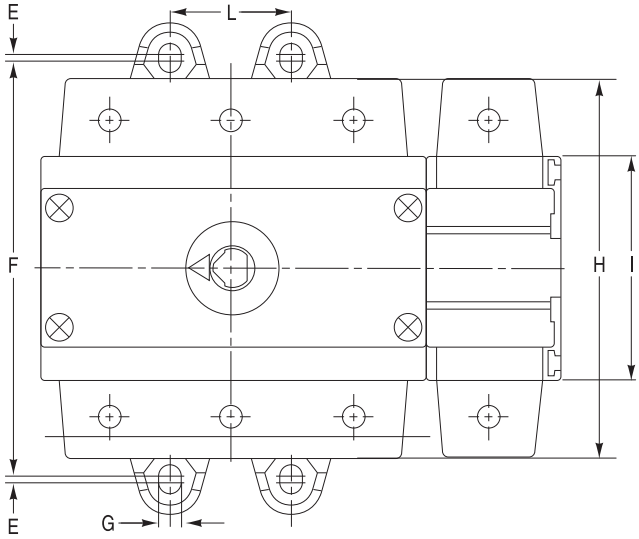
[A]	A	B	C	D	E	F	G	H	I	L	M	N	O∗	P❄
125	91 (3-19/32)	112 (4-3/32)	38 (1-1/2)	65.5 (2-9/16)	3 (1/8)	2 (3/32)	36 (1-13/32)	88 (3-7/16)	68 (2-11/16)	10 (13/32)	90 (3-17/32)	64 (2-17/32)	M5	M10
160	91 (3-19/32)	112 (4-3/32)	38 (1-1/2)	65.5 (2-9/16)	3 (1/8)	2 (3/32)	36 (1-13/32)	88 (3-7/16)	68 (2-11/16)	10 (13/32)	90 (3-17/32)	64 (2-17/32)	M5	M10
250	103 (4-3/64)	145 (5-23/32)	52.5 (1-22/32)	60.4 (2-3/8)	4 (5/32)	2 (3/32)	44 (1-23/32)	88 (3-7/16)	68 (2-11/16)	13 (1/2)	100 (3-15/16)	70 (2-3/4)	M5	M12
315	103 (4-3/64)	145 (5-23/32)	52.5 (1-22/32)	60.4 (2-3/8)	4 (5/32)	2 (3/32)	52 (2-1/16)	88 (3-7/16)	68 (2-11/16)	13 (1/2)	100 (3-15/16)	70 (2-3/4)	M5	M12

∗ M5 x 0.8 bolts supplied with switch. Threaded hole.
❄ Bolts and nuts supplied with switch. Through-hole.

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Base-Mounting Box Lugs, 3- and 4-Pole

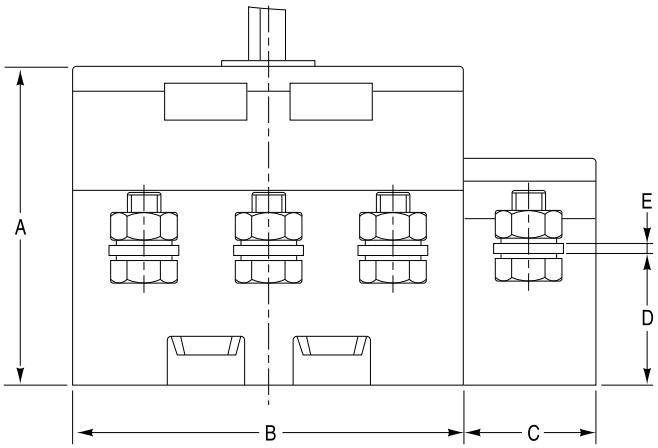


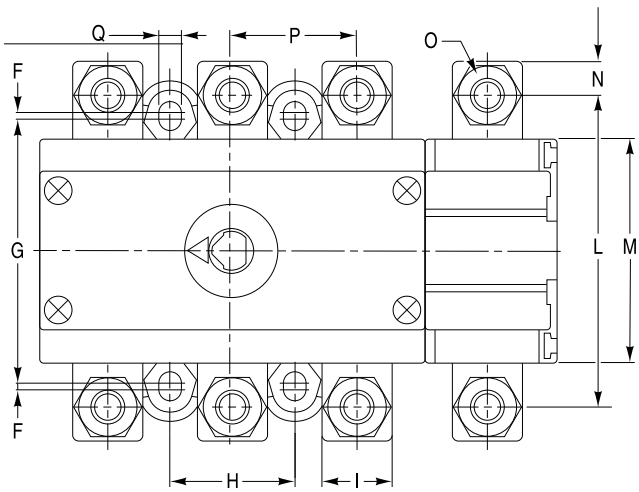


Switch Body 194E-A

[A]	A	B	C	D	E	F	G	H	I	L
125	91 (3-19/32)	112 (4-13/32)	38 (1-1/2)	95 (3-23/64)	2 (3/32)	118 (4-5/8)	6.4 (1/4)	108 (4-1/4)	64 (2-17/32)	36 (1-13/32)
160	91 (3-19/32)	112 (4-13/32)	38 (1-1/2)	95 (3-23/64)	2 (3/32)	118 (4-5/8)	6.4 (1/4)	108 (4-1/4)	64 (2-17/32)	36 (1-13/32)
250	98 (3-27/32)	145 (5-23/32)	52.5 (1-23/32)	185 (7-9/32)	2 (3/32)	140 (5-1/2)	6.4 (1/4)	126 (4-15/16)	70 (2-3/4)	44 (2-1/16)
315	98 (3-27/32)	145 (5-23/32)	52.5 (1-23/32)	185 (7-9/32)	2 (3/32)	140 (5-1/2)	6.4 (1/4)	126 (4-15/16)	70 (2-3/4)	44 (2-1/16)

Base-Mounting Bolt-on Terminals, 3- and 4-Pole



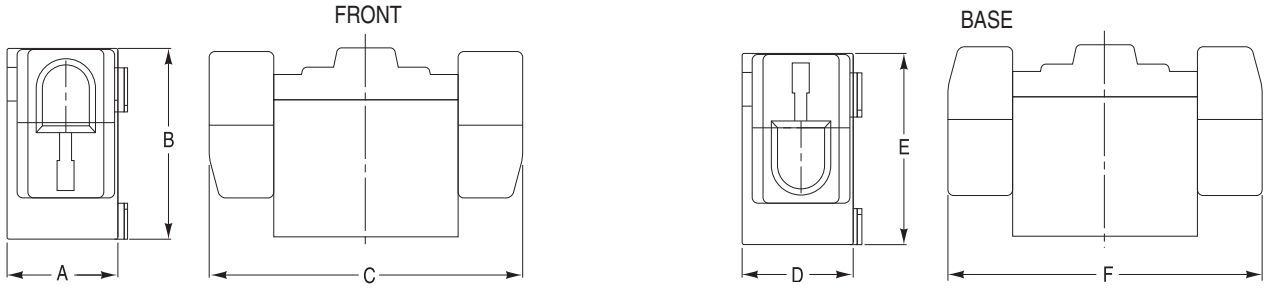


Switch Body 194E-B

[A]	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q
125	91 (3-19/32)	112 (4-3/32)	38 (1-1/2)	36.5 (1-7/16)	3 (1/8)	2 (3/32)	76 (3)	36 (1-13/32)	20 (3/4)	90 (3-17/32)	64 (2-17/32)	10 (13/32)	M10 (3/8)	36 (1-13/32)	6.4 (1/4)
160	91 (3-19/32)	112 (4-3/32)	38 (1-1/2)	36.5 (1-7/16)	3 (1/8)	2 (3/32)	76 (3)	36 (1-13/32)	20 (3/4)	90 (3-17/32)	64 (2-17/32)	10 (13/32)	M10 (3/8)	36 (1-13/32)	6.4 (1/4)
250	98 (3-27/64)	145 (5-23/32)	52.5 (1-22/32)	38.6 (1-1/2)	4 (5/32)	2 (3/32)	80 (3-1/8)	44 (1-23/32)	26 (1-1/64)	100 (3-15/16)	70 (2-3/4)	13 (1/2)	M12 (15/32)	44 (1-23/32)	6.4 (1/4)
315	98 (3-27/64)	145 (5-23/32)	52.5 (1-22/32)	38.6 (1-1/2)	4 (5/32)	2 (3/32)	80 (3-1/8)	44 (1-23/32)	26 (1-1/64)	100 (3-15/16)	70 (2-3/4)	13 (1/2)	M12 (15/32)	52 (2-1/16)	6.4 (1/4)

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

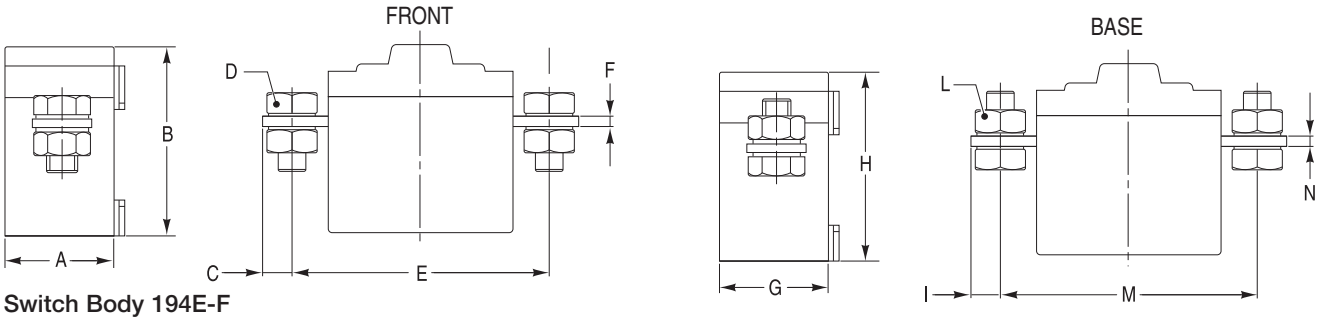
Box Ground and Neutral Terminal



Switch Body 194E-F

[A]	A	B	C	D	E	F
125	37.8 (1-1/2)	64 (2-17/32)	108 (4-1/4)	37.8 (1-1/2)	64 (2-17/32)	108 (4-1/4)
160	37.8 (1-1/2)	64 (2-17/32)	108 (4-1/4)	37.8 (1-1/2)	64 (2-17/32)	108 (4-1/4)
250	52.3 (2-1/16)	71.1 (2-25/32)	126 (4-15/16)	52.3 (2-1/16)	80.6 (3-1/8)	126 (4-15/16)
315	52.3 (2-1/16)	71.1 (2-25/32)	126 (4-15/16)	52.3 (2-1/16)	80.6 (3-1/8)	126 (4-15/16)

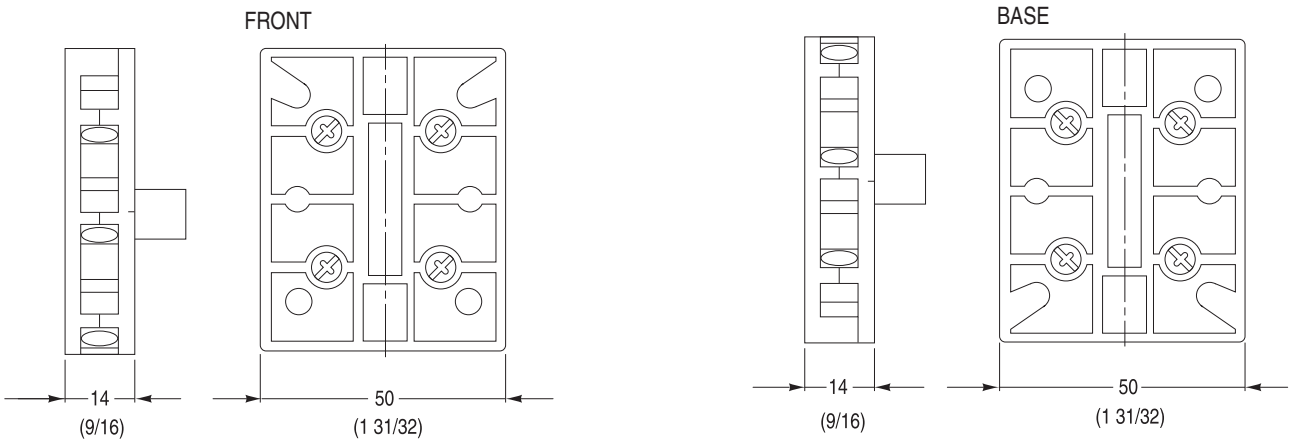
Bolt Ground and Neutral Terminal



Switch Body 194E-F

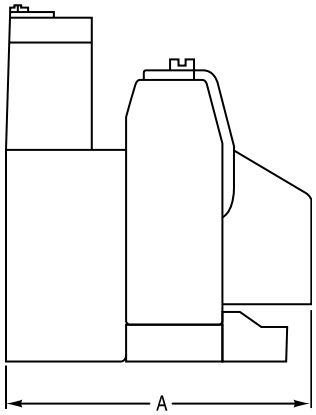
[A]	A	B	C	D	E	F	G	H	I	L	M	N
125	37.8 (1-1/2)	64 (2-17/32)	10 (13/32)	M10 (13/32)	90 (3-17/32)	3 (1/8)	37.8 (1-1/2)	64 (2-17/32)	10 (13/32)	M10 (13/32)	90 (3-17/32)	3 (1/8)
160	37.8 (1-1/2)	64 (2-17/32)	10 (13/32)	M10 (13/32)	90 (3-17/32)	3 (1/8)	37.8 (1-1/2)	64 (2-17/32)	10 (13/32)	M10 (13/32)	90 (3-17/32)	3 (1/8)
250	52.3 (2-1/16)	68 (2-21/32)	13 (1/2)	M12 (15/32)	100 (3-15/16)	4 (5/32)	52.3 (2-1/16)	68 (2-21/32)	13 (1/2)	M12 (15/32)	100 (3-15/16)	4 (5/32)
315	52.3 (2-1/16)	68 (2-21/32)	13 (1/2)	M12 (15/32)	100 (3-15/16)	4 (5/32)	52.3 (2-1/16)	68 (2-21/32)	13 (1/2)	M12 (15/32)	100 (3-15/16)	4 (5/32)

Auxiliary Contacts

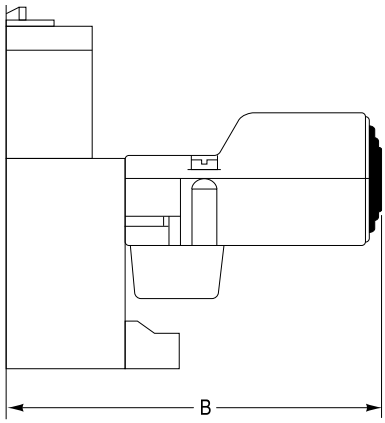


Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Terminal Cover

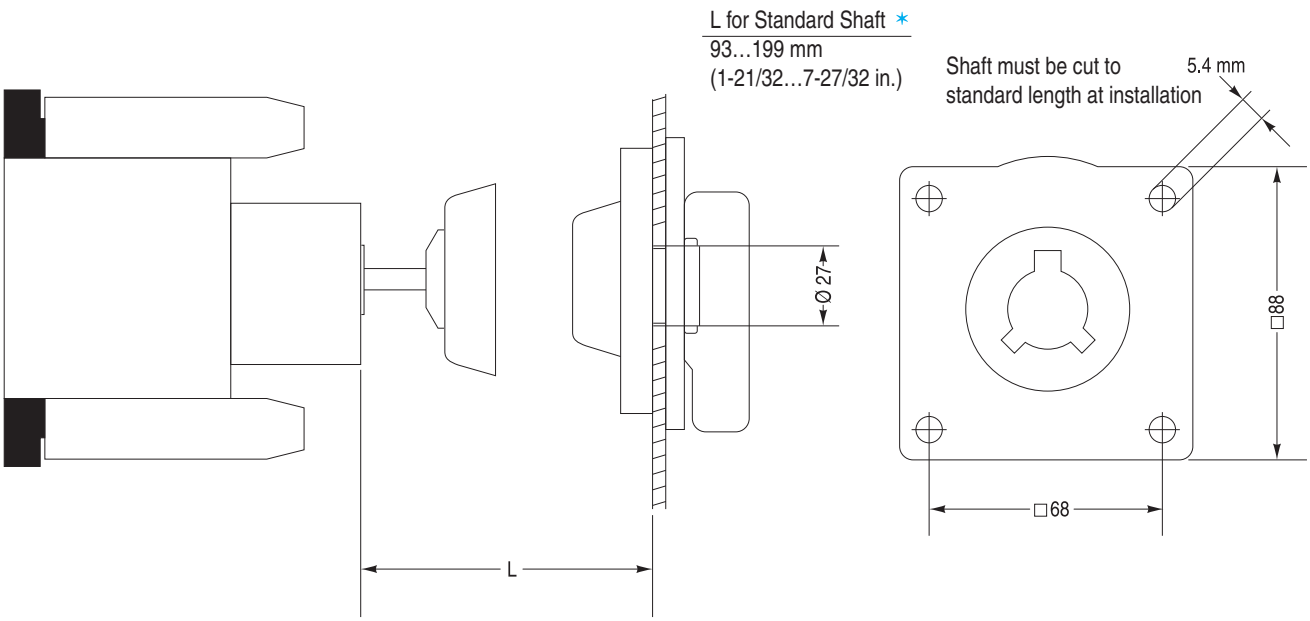


Switch Body 194E-F



[A]	A	B
125	76.2 (3)	95 (3-3/4)
160	76.2 (3)	95 (3-3/4)
250	88 (3-15/32)	109.5 (4-5/16)
315	88 (3-15/32)	109.5 (4-5/16)

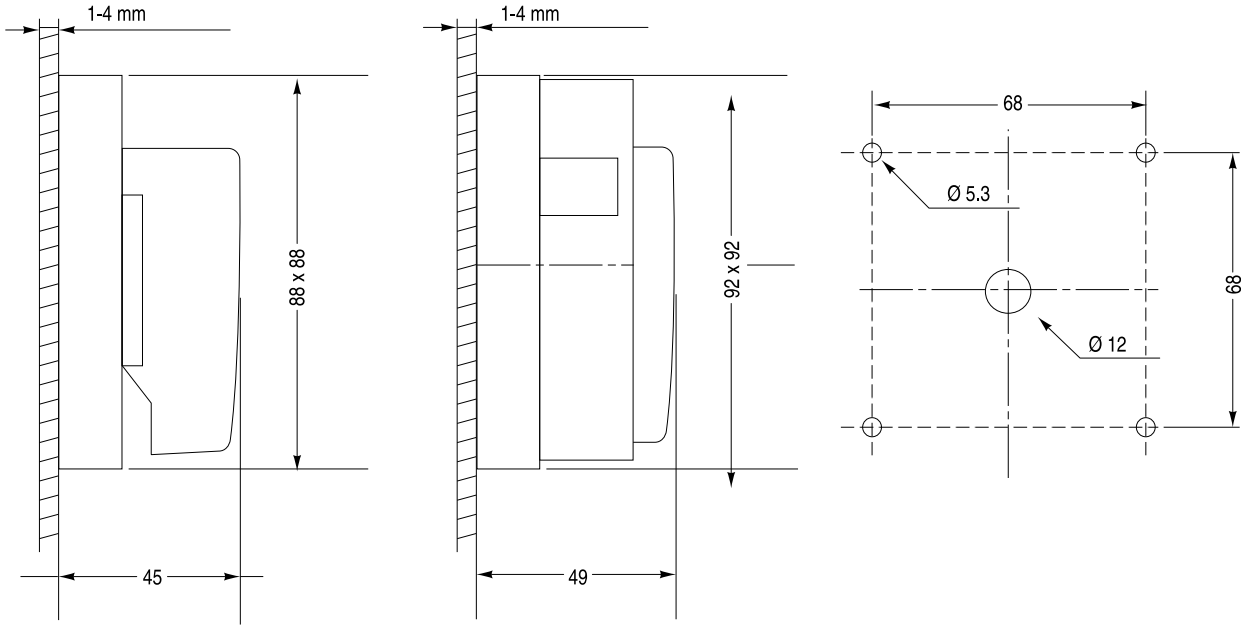
Door Clutches



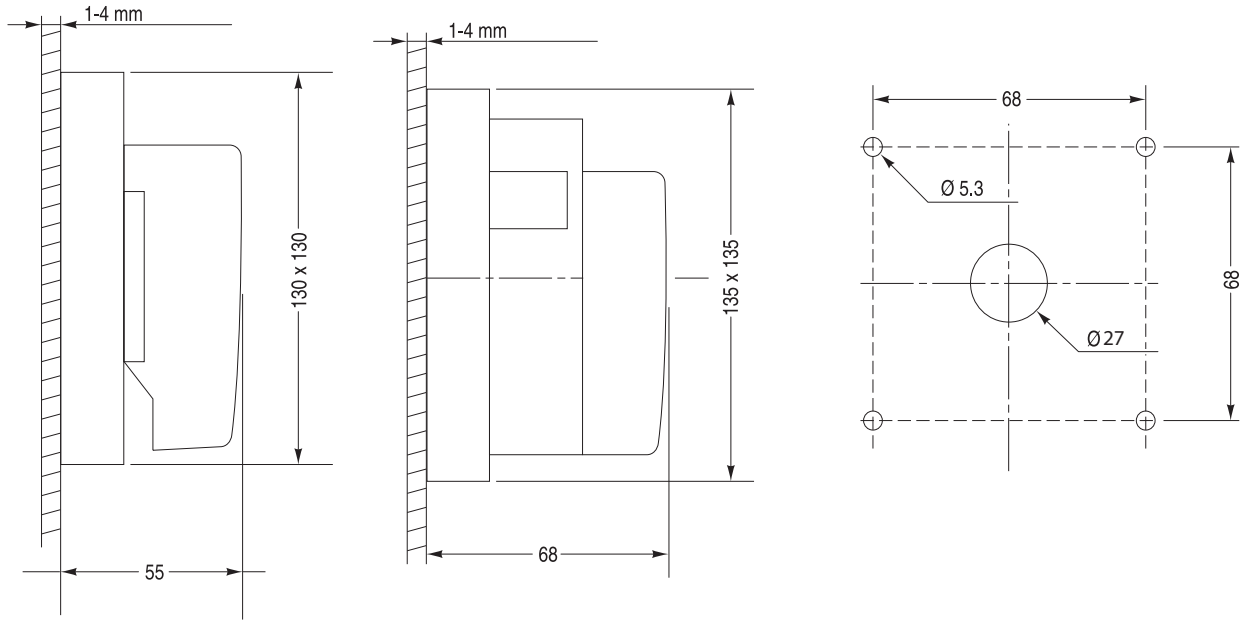
* Use Cat. No. 194E-AB40 shaft extension accessory to extend beyond the standard shaft length.

Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes.

Handles (Type 194E-HE-8A-8I-8G-8N)



Handles (Type 194E-HE-13A-13I-13G-13N)

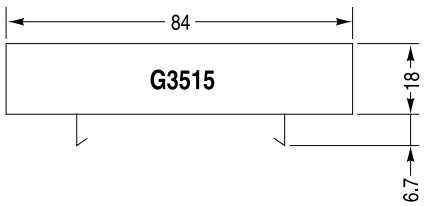


Type A and I

Type G and N

Additional Name Plate

Frame and legend snaps on to handle bezel. Fits size 8 and 13 handles.



Connection Systems

Overview 7-2

Safety Wiring Systems

Safety Wired T-Port, DC Micro 7-6
Safety Wired Distribution Box, DC Micro 7-7
Safety Wired Distribution Box, AC Micro 7-10
Safety Wired Shorting Plug, DC Micro & AC Micro 7-11

Cables

Cordsets & Patchcords, DC Micro Style 7-12
Cordsets & Patchcords, AC Micro Style 7-16
Cordsets & Patchcords, Mini Style 7-18
Cordsets & Patchcords, Mini-Plus Style 7-20
Cordsets & Patchcords, M23 Style 7-22

Connectors

Field Attachable, DC Micro Style, Screw Terminal 7-24
Field Attachable, DC Micro Style, Insulation Connector 7-26
Field Attachable, M23 Style, Solder Connector 7-27
Receptacles, DC & AC Micro Male Style 7-28
Receptacles, M23 Male 7-29

Overview

The Allen-Bradley Guardmaster® Safety Connection Systems are complete wiring solutions dedicated to machine safety. These quick disconnect-based systems consist of safety wired T-Ports and distribution boxes as well as patchcords and shorting plugs. Specifically intended for use with dry-contact safety switches, Safety Connection Systems provide flexible and reliable connections between safety interlock switches, E-stops, cable pull switches and safety relays. And while this system is ideal for use with these components, it is not suitable for use with light curtains, safety mats or pressure sensitive safety edges.

Allen-Bradley Guardmaster Safety Connection Systems are designed to:

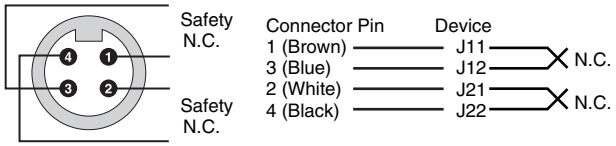
- Reduce installation cost
- Ease system expansion
- Simplify troubleshooting
- Promote system modularity
- Provide for Safety PLC input expansion
- Support systems up to Category 3 (per EN954-1)

Safety Connection Systems layouts are available with or without enunciation capabilities, allowing the user the option of direct feedback for the status of individual switches in the system. Enunciation systems utilize an auxiliary contact as input to tower lights, audible alarms, PLC input cards, etc.

Systems without Enunciation

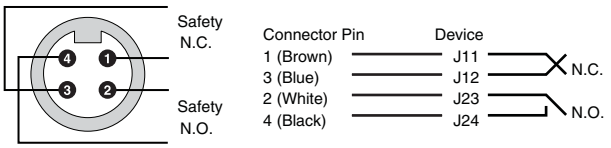
As illustrated in the example layout below, wiring systems for applications not requiring enunciation use a combination of patchcords, shorting plugs, safety wired distribution boxes and T-ports for series wiring of safety circuits. Distribution boxes for such an application are dual channel models with 2 N.C. or 1 N.C. + 1 N.O. contact configurations. See the wiring diagrams below for connector pin assignments.

Dual Channel 2 N.C.



Male Connector (On Switch)

Dual Channel 1 N.C./1 N.O.



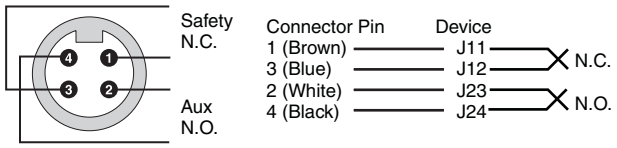
Male Connector (On Switch)

Note: Shorting plugs must be used on all unused ports for the system to operate.

Systems with Enunciation

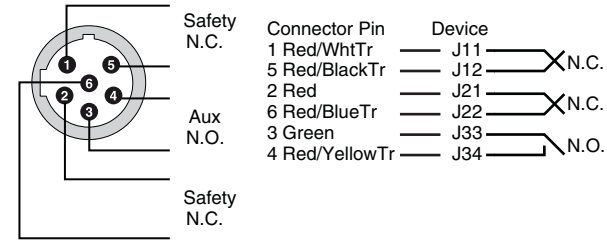
As shown below, system layouts with enunciation require patchcords, shorting plugs and distribution boxes, which allow for series wiring of the safety circuits while providing a separate circuit for enunciation. Distribution boxes are offered for these applications in two contact configurations: dual channel with 2 N.C. or single channel with 1 N.C. Each type also provides a N.O. auxiliary contact that is interfaced with the enunciation device to provide visual or audible alarm indication. In addition, LEDs on the distribution boxes assist in the troubleshooting of this system. See the wiring diagrams below for the associated connector pin configurations.

Single Channel 1 N.C./1 N.O.



Male Connector (On Switch)

Dual Channel 2 N.C./1 N.O.



Male Connector (On Switch)

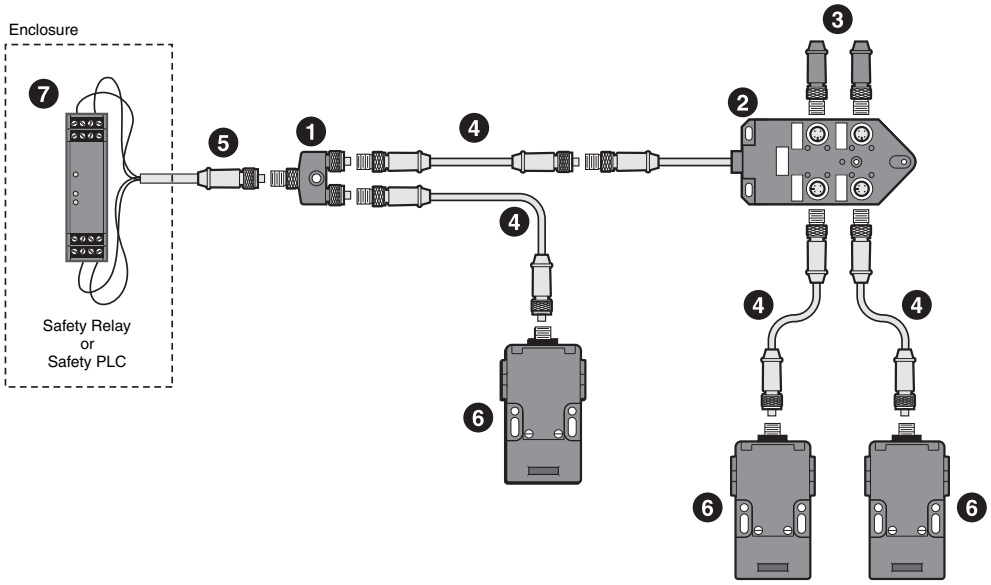
Note: Shorting plugs must be used on all unused ports for the system to operate.

Installation Considerations

Some important notes regarding Safety Connection Systems:

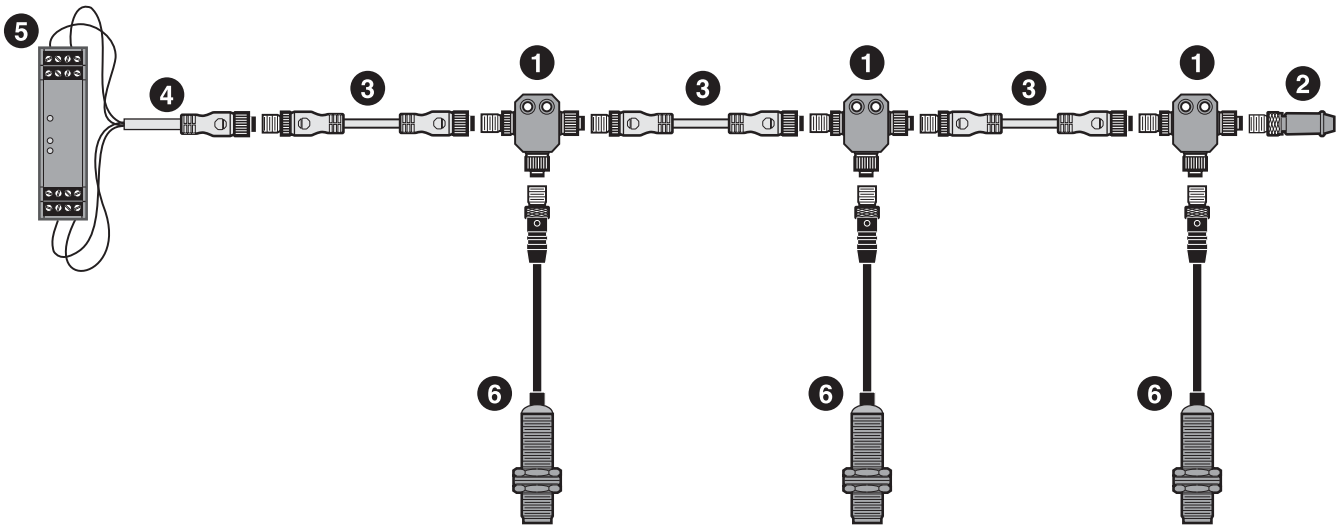
- To help ensure that only authorized personnel can access the connections, safety distribution boxes should be mounted in the 'guarded' area as defined in the risk assessment for the application.
- The safety connection system is designed to simplify the installation of safety devices—it does ***not*** control the safety circuit.
- Since the safety circuits are wired in series, shorting plugs must be installed in all unused distribution box ports in order for the system to operate.

Example Layout without Enunciation



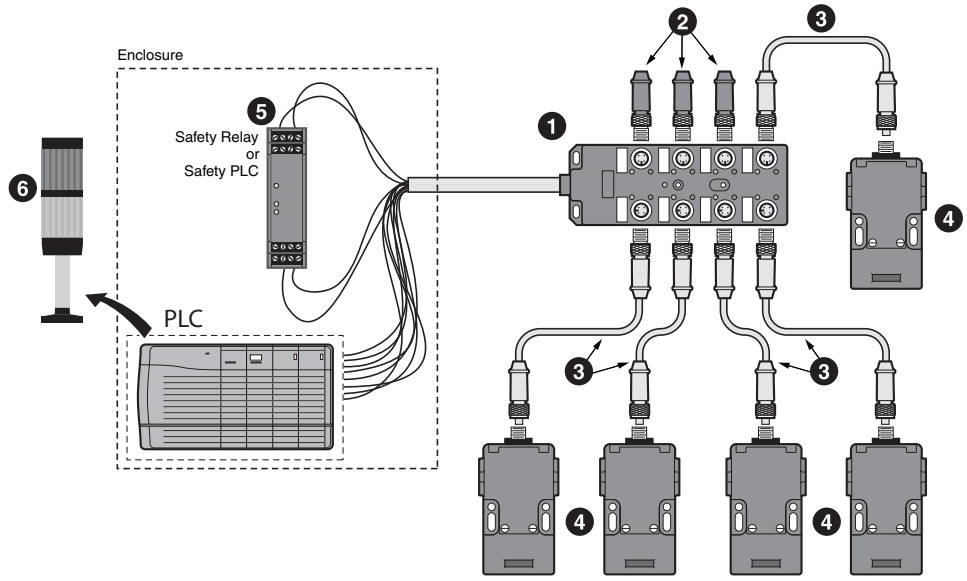
1. Safety-Wired Splitter/T-Port 7-6
2. Safety-Wired Distribution Box 7-7
3. Shorting Plug 7-11
4. Device Patchcord 7-12
5. Device Cordset 7-12
6. Safety Switch with QD 3-1
7. Safety Relay 5-2

SensaGuard Units Wired in Series without Enunciation



1. Safety-Wired Splitter/T-Port 7-6
2. Shorting Plug 7-11
3. Device Patchcord 7-12
4. Device Cordset 7-12
5. Safety Relay 5-2
6. SensaGuard with QD 3-56

Example Layout with Enunciation



1. Safety-Wired Distribution Box 7-7
2. Shorting Plug 7-11
3. Device Patchcord 7-12
4. Safety Switch with QD..... 3-1
5. Safety Relay..... 5-2
6. Tower Light ..... See *Industrial Controls* catalog

Safety Wired T-Port, DC Micro Style

Dual Channel, No Enunciation



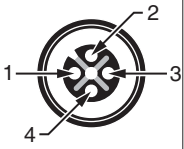
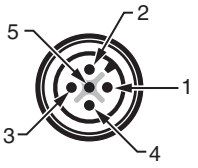
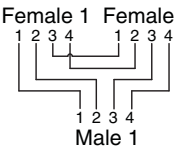
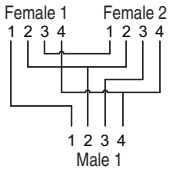
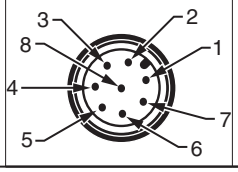
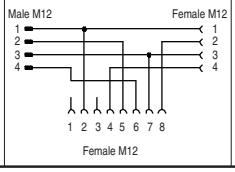
Specifications

Connector Shell Material	Epoxy coated zinc
Contact Material	Brass, gold over nickel plating
O-Ring Material	Fluorelastomer
Enclosure Type Rating	IP67, NEMA 6P
Operating Temperature [C (F)]	-20…105° (-13…221°)

Features

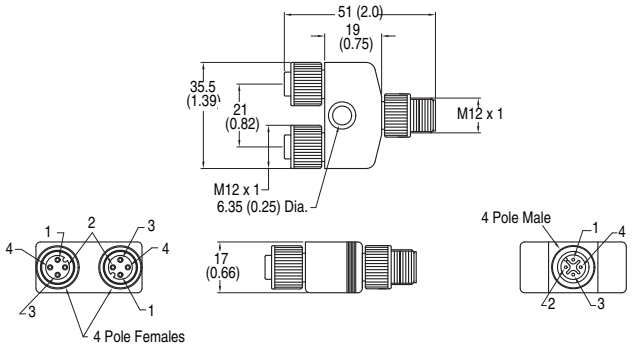
- T-port/splitter designed for use with dual-channel safety devices with 4-pin DC micro connector
- PUR body offers good oil and chemical resistance
- Ratcheting coupling nut for vibration resistance
- For use in Category 2 or 3 systems per EN 954-1
- SensaGuard units may be wired in series maintaining a Cat. 4/SIL 3 rating

Product Selection

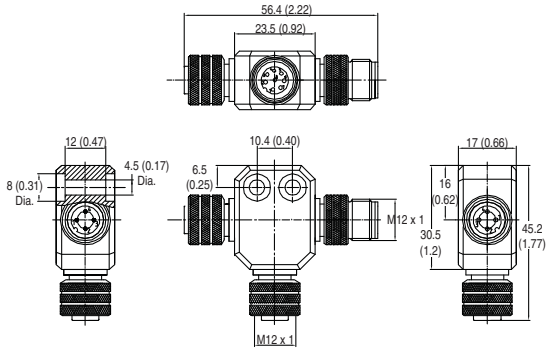
Face View of Female (2)	Rating	Face View of Male (1)	Configuration	Wiring	Dimensions	Housing Material	Connector Insert Material	Cat. No.
	10…30V DC 3 A		2 N.C.		A	Red PUR	PUR	898D-43LY-D4
			1 N.O. & 1 N.C.		A	Red PUR	PUR	898D-43KY-D4
			For use with SensaGuard switches only		B	Black PVC	Polyamide	898D-438Y-D8

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



A



B

Safety Wired Distribution Box, DC Micro Style

Dual-Channel N.C., No Enunciation



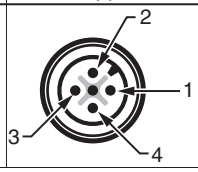
Specifications

Housing Material	Red PBT
Connector Insert Material	PBT
Connector Shell Material	Nickel-plated brass
Contact Material	Gold-plated palladium/nickel
Cable O.D.	9.8 mm (0.39 in.)
Cable Type	Oil-resistant yellow PVC jacket, 22 AWG conductors
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-20…105° (-13…221°)

Features

- Prewired for dual-channel N.C. safety
- 4 or 8 safety wired 4-pin DC micro connectors
- 4-pin male DC micro pigtail main connection
- For use in category 2 or 3 systems per EN 954-1

Product Selection

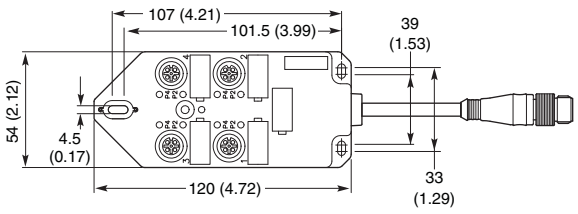
Face View of Female	No. of Ports	Illuminated	Rating	Face View of Male (1)	Cable Length	Cat. No.
	4	No LED	10…30V DC		0.2 m (8 in.)	898D-44LT-DM4
	8					898D-48LT-DM4
Shorting plug for unused ports						898D-41LU-DM
Patchcord, straight to straight DC Micro						889D-F4ACDM-∗

∗ Length in meters (1, 2, 3, 5, 10 standard).

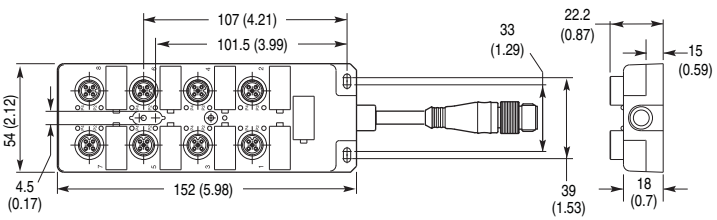
Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.

4-Port

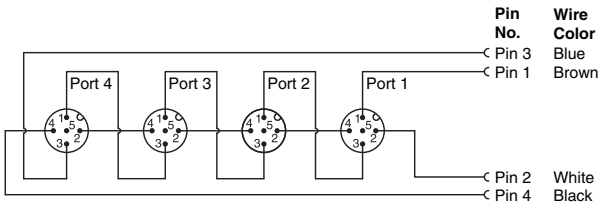


8-Port

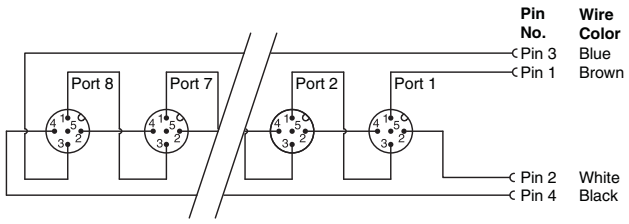


Wiring Diagrams

4-Port



8-Port



Safety Wired Distribution Box, DC Micro Style

Dual-Channel N.C./N.O., No Enunciation



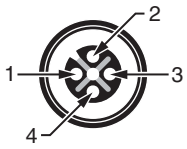
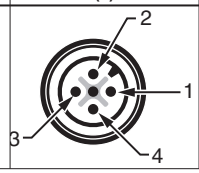
Specifications

Housing Material	Red PBT
Connector Insert Material	PBT
Connector Shell Material	Nickel-plated brass
Contact Material	Gold-plated palladium/nickel
Cable O.D.	9.8 mm (0.39 in.)
Cable Type	Oil-resistant yellow PVC jacket, 22 AWG conductors
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-20…105° (-13…221°)

Features

- Prewired for dual-channel (one N.O./one N.C.) safety
- 4 or 8 safety wired 4-pin DC micro connectors
- 4-pin male DC micro pigtail main connection
- For use in category 2 or 3 systems per EN 954-1

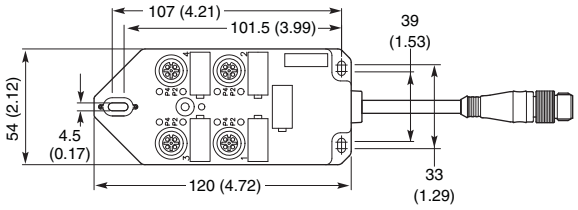
Product Selection

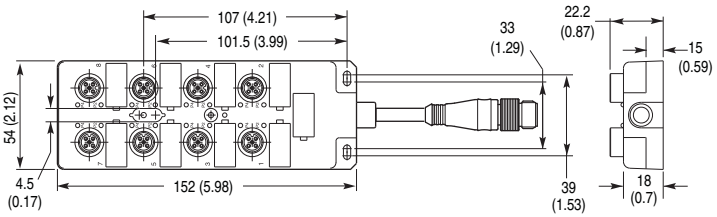
Face View of Female	No. of Ports	Illuminated	Rating	Face View of Male (1)	Cable Length	Cat. No.
	4	No LED	10…30V DC		0.2 m (8 in.)	898D-44KT-DM4
	8					898D-48KT-DM4
Shorting plug for unused ports						898D-41KU-DM
Patchcord, straight to straight DC Micro						889D-F4ACDM-∗

∗ Length in meters (1, 2, 3, 5, 10 standard).

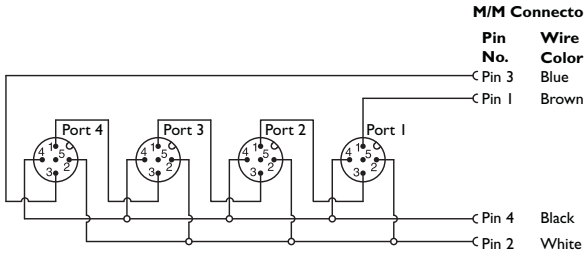
Approximate Dimensions

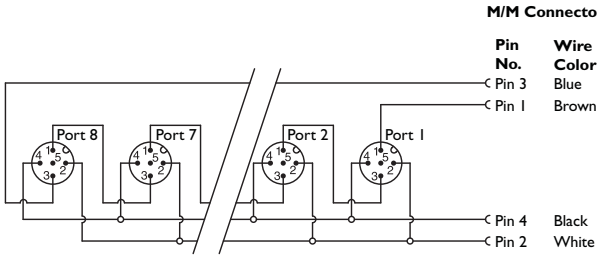
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.





Wiring Diagrams





Safety Wired Distribution Box, DC Micro Style

Single-Channel N.C. plus Individual N.O. Enunciation



Specifications

Housing Material	Red PBT
Connector Insert Material	PBT
Connector Shell Material	Nickel-plated brass
Contact Material	Gold-plated palladium/nickel
Cable O.D.	9.8 mm (0.39 in.)
Cable Type	Oil-resistant yellow PVC jacket, (12) 18 AWG conductors
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-20…105° (-13…221°)

Features

- Prewired for single-channel (N.C.) safety with enunciation
- 8 safety wired 4-pin DC micro connectors
- Individual enunciation output for each port
- For use in category 2 or 3 systems per EN 954-1

Product Selection

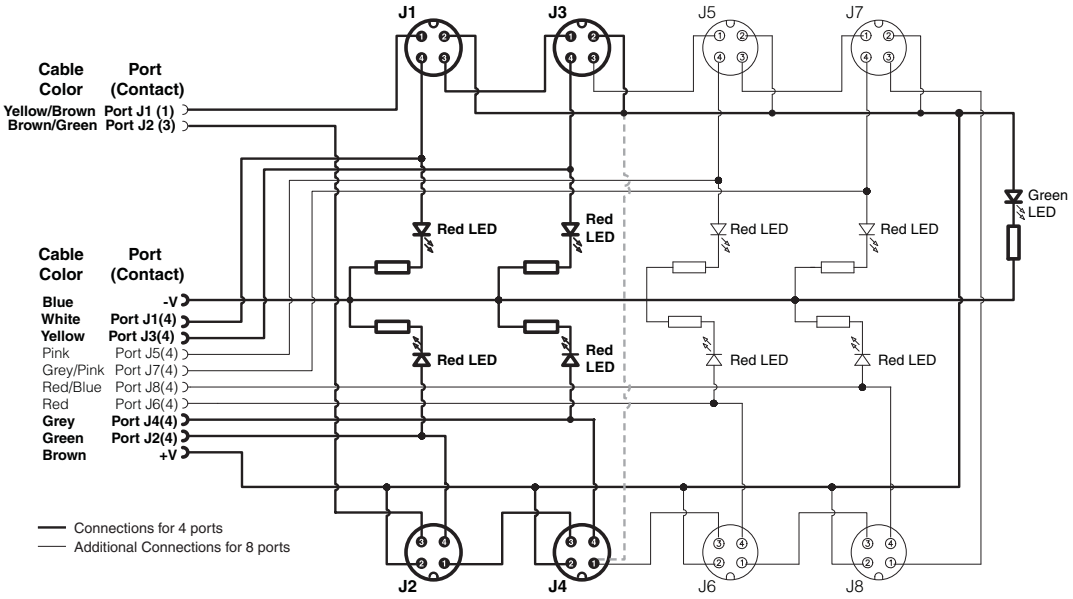
Face View of Female	No. of Ports	Illuminated	Rating	Face View of Male (1)	Cable Length	Cat. No.
	4	LEDs	10…30V DC	Cable	5 m (16.4 ft)	898D-P44JT-A5
					10 m (32.8 ft)	898D-P44JT-A10
	8				5 m (16.4 ft)	898D-P48JT-A5
					10 m (32.8 ft)	898D-P48JT-A10
Shorting plug for unused ports						898D-41KU-DM
Patchcord, straight to straight DC Micro						889D-F4ACDM-∗

∗ Length in meters (1, 2, 3, 5, 10 standard).

Approximate Dimensions

See 8-port dimensions on page 7-7.

Wiring Diagrams



Safety Wired Distribution Box, AC Micro Style

8-Port, Dual-Channel (2 N.C.) plus Individual N.O. Enunciation



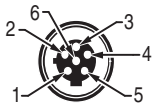
Specifications

Housing Material	Red PBT
Connector Insert Material	PBT
Connector Shell Material	Nickle-plated brass
Contact Material	Gold-plated palladium/nickel
Cable O.D.	9.8 mm (0.39 in.) OD
Cable Type	Oil-resistant yellow PVC jacket, (6) 19 AWG conductors and (8) 22 AWG conductors
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-20…105° (-13…221°)

Features

- Prewired for dual-channel N.C. safety plus individual N.O. enunciation
- Eight 6-pin AC micro connectors
- 14-conductor main cable
- Individual enunciation output for each port
- For use in category 2 or 3 systems per EN 954-1

Product Selection

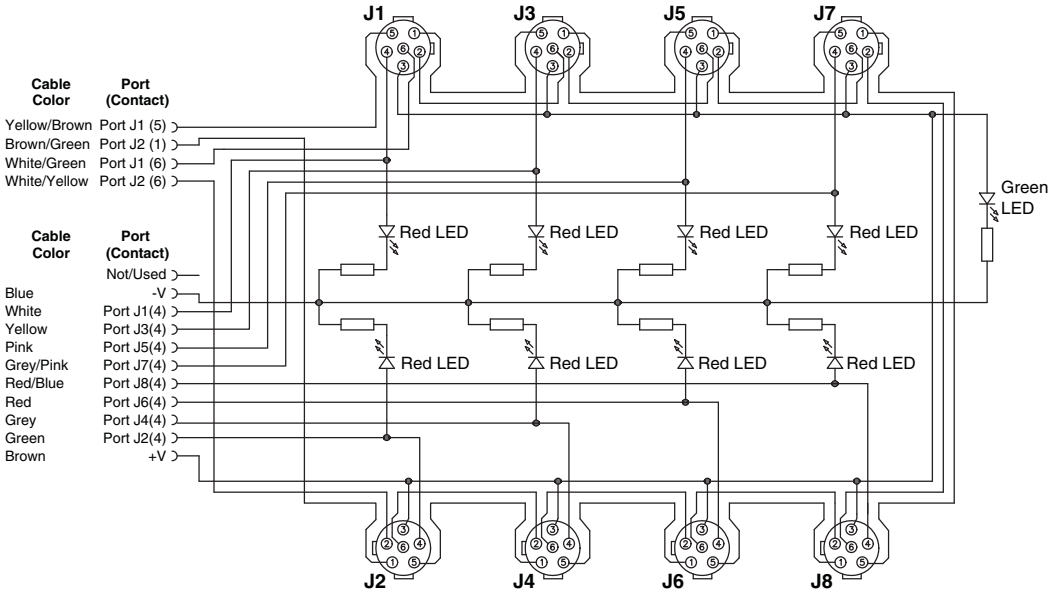
Face View of Female	No. of Ports	Illuminated	Rating	Face View of Male (1)	Cable Length	Cat. No.
	8	LEDs	10…30V DC	Cable	5 m (16.4 ft)	898R-P68MT-A5
					10 m (32.8 ft)	898R-P68MT-A10
Shorting plug for unused ports						898R-61MU-RM
Patchcord, straight to straight DC Micro						889R-F6ECRM-∗

∗ Length in meters (1, 2, 3, 5, 10 standard).

Approximate Dimensions

See 8-port dimensions on page 7-7.

Wiring Diagrams





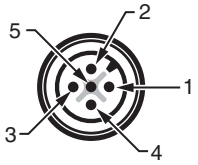
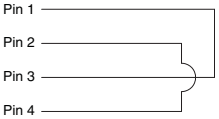
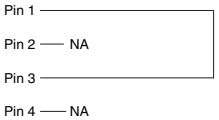
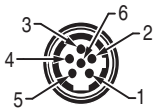
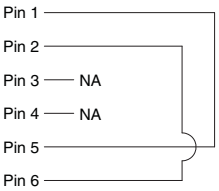
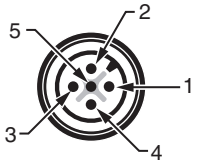
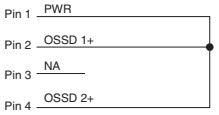
Specifications

Connector Insert Material	PUR
Connector Shell Material	RED PVC
Contact Material	Brass, gold over nickel plating
O-Ring Material	Fluorelastomer
Enclosure Type Rating	IP67, NEMA 6P
Operating Temperature [C (F)]	-20…105° (-13…221°)

Features

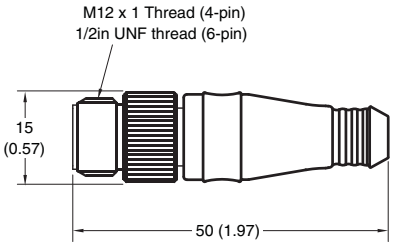
- Shorting plug designed for use with safety-wired distribution boxes
- PVC body offers good oil and chemical resistance
- Ratcheting coupling nut on 4-pin models for vibration resistance

Product Selection

Face View of Male	Rating	Configuration	Wiring	Coupling Nut Material	Cat. No.
	10…30V DC 4 A	2 N.C.		Epoxy-coated zinc	898D-41LU-DM
		1 N.O. & 1 N.C.		Epoxy-coated zinc	898D-41KU-DM
		2 N.C. & 1 N.O.		Nickel-plated brass	898R-61MU-RM
		For use with SensaGuard compatible T-Ports only		Nickel-plated brass	898D-418U-DM

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Cordsets & Patchcords, DC Micro Style

18 and 22 AWG, Yellow, Black, or Blue PVC



Features

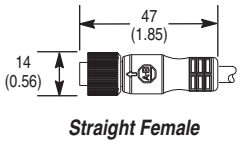
- Ratcheting coupling nut
- Subtle black or highly visible yellow PVC jacket offers good oil and chemical resistance
- Blue jacket models for intrinsically safe applications

Specifications

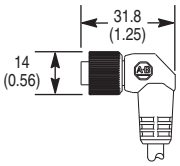
Certifications	UL Recognized and CSA Certified
Mechanical	
Coupling Nut Material	Epoxy-coated zinc
Connector Shell Material	Molded oil resistant PVC or PUR
Contact Material	Gold over nickel-plated brass
Cable Type	Oil resistant yellow PVC jacket, 20 AWG stranded copper, 300V, UL Recognized and CSA Certified
Home Run Connection	10 x diameter
Cable Diameter	4/c = 5 mm (0.21 in.); 5/c = 6.5 mm (0.25 in.)
Electrical	
Cable Rating	LED models: UL AWM style 2661 VW-1 105C 300V, CSA AWM A/B I/II 80C 300V FT1, UV oil and water resistant
Assembly Rating	250V, 4 A
Environmental	
Enclosure Type Rating	IP67 and IP69K, NEMA 6P
Operating Temperature [C (F)]	-20…+105° (-4…+221°)

Approximate Dimensions

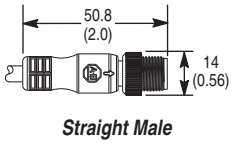
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



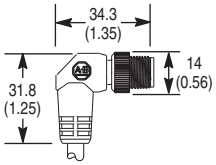
Straight Female



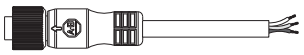
Right Angle Female



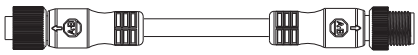
Straight Male



Right Angle Male

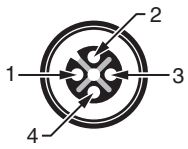
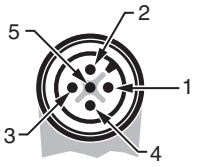


Example of Cordset



Example of Patchcord

Pinout and Color Code

Color Code	Face View Pinout			
	4-Pin		5-Pin	
				
A	1 Brown 2 White 3 Blue	4 Black 5 NA	1 Brown 2 White 3 Blue	4 Black 5 Grey

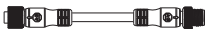
Product Selection

Cordsets



Pin Count	Color Code	Jacket Color	Wire Size	Cat. No.			
				Straight Female	Right Angle Female	Straight Male	Right Angle Male
4-Pin	A	Yellow	22 AWG	889D-F4AC-2∗	889D-R4AC-2∗	889D-M4AC-2∗	889D-E4AC-2∗
		Yellow	18 AWG	889D-F4AE-2∗	889D-R4AE-2∗	889D-M4AE-2∗	889D-E4AE-2∗
		Black	22 AWG	889D-F4BC-2∗	889D-R4BC-2∗	889D-M4BC-2∗	889D-E4BC-2∗
		Blue		889D-F4LC-2∗	889D-R4LC-2∗	889D-M4LC-2∗	889D-E4LC-2∗
5-Pin		Yellow	22 AWG	889D-F5AC-2∗	**889D-R5AC-2∗**	889D-M5AC-2∗	889D-E5AC-2∗
		Black		889D-F5BC-2∗	889D-R5BC-2∗	889D-M5BC-2∗	889D-E5BC-2∗

Patchcords



Pin Count	Color Code	Jacket Color	Wire Size	Cat. No.			
				Straight Female Straight Male	Straight Female Right Angle Male	Right Angle Female Straight Male	Right Angle Female Right Angle Male
4-Pin	A	Yellow	22 AWG	889D-F4ACDM-2❄	889D-F4ACDE-2❄	889D-R4ACDM-2❄	889D-R4ACDE-2❄
		Yellow	18 AWG	889D-F4AEDM-2❄	889D-F4AEDE-2❄	889D-R4AEDM-2❄	889D-R4AEDE-2❄
		Black	22 AWG	889D-F4BCDM-2❄	889D-F4BCDE-2❄	889D-R4BCDM-2❄	889D-R4BCDE-2❄
		Blue	22 AWG	889D-F4LCDM-2❄	889D-F4LCDE-2❄	889D-R4LCDM-2❄	889D-R4LCDE-2❄
5-Pin		Yellow	22 AWG	889D-F5ACDM-2❄	889D-F5ACDE-2❄	889D-R5ACDM-2❄	889D-R5ACDE-2❄
		Yellow	22 AWG	889D-F5BCDM-2❄	889D-F5BCDE-2❄	889D-R5BCDM-2❄	889D-R5BCDE-2❄

∗ Replace 2 (2 m) with 5 (5 m) or 10 (10 m) for standard cable lengths.
❄ Replace 2 (2 m) with 0M3 (1 ft), 1 (1 m), 5 (5 m) or 10 (10 m) for standard lengths.

Note: Stainless steel connectors may be ordered by adding an "S" to the cat. no. (e.g. 889D**S**-F4AC-∗).

Cordsets & Patchcords, DC Micro Style

18 and 22 AWG, PUR, TPE, or TPR



Features

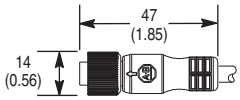
- PUR jacket provides good oil and chemical resistance
- TPE jacket material for good oil, chemical, and weld slag resistance
- 8-pin/7-wire configuration for Sipha safety switches and other applications
- Ratcheting coupling nuts for vibration resistance

Specifications

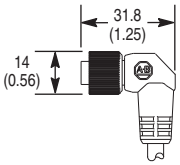
Certifications	UL Recognized and CSA Certified
Mechanical	
Coupling Nut Material	Epoxy-coated zinc
Connector Shell Material	Molded oil-resistant PVC or PUR
Contact Material	Gold over nickel-plated brass
Cable Type	Oil-resistant PVC jacket, 18 & 22 AWG or 24 AWG conductors, 300V; UL Recognized and CSA Certified
Cable Diameter	4/c (PUR); 5 mm (0.21 in.); 4/c (18 AWG TPE); 7 mm (0.28 in.); 5/c 6.5 mm (0.25 in.); 7/c 7.4 mm (0.29 in.); 8/c 7.4 mm (0.29 in.)
Electrical	
Cable Rating	UL AWM style 2661 VW-1 105C 300V, CSA AWM A/B I/II 80C 300V FT1, UV oil and water resistant
Assembly Rating	250V, 4 A
Environmental	
Enclosure Type Rating	IP67, NEMA 6P, 1200 psi (8270 kPa) washdown
Operating Temperature [C (F)]	PUR: -20…+80° (-4…+176°); TPE: -20…+105° (-4…+221°); TPR: -25…+125° (-13…+256°)

Approximate Dimensions

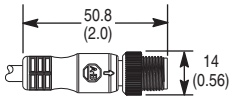
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



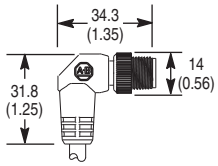
Straight Female



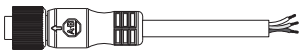
Right Angle Female



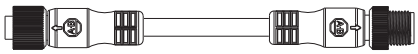
Straight Male



Right Angle Male

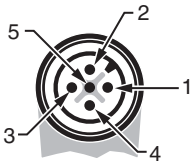
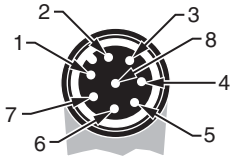
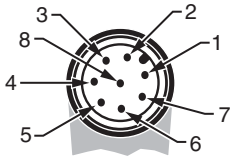


Example of Cordset



Example of Patchcord

Pinout and Color Code

Color Code	Face View Pinout			
	4-Pin	5-Pin	8-Pin	
				
A	1 Brown 2 White 3 Blue 4 Black 5 NA	1 Brown 2 White 3 Blue 4 Black 5 Grey	1 Red 2 Blue 3 Green 4 Yellow	5 Black 6 White 7 N.C. 8 Grey
B	—	—	1 White 2 Brown 3 Green 4 Yellow	5 Grey 6 Pink 7 Blue 8 Red

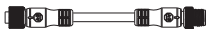
Product Selection

Cordsets



Pin Count	Cable Type	Wire Size	Assembly Rating	Color Code	Cat. No.			
					Straight Female	Right Angle Female	Straight Male	Right Angle Male
4-Pin	TPE	18 AWG	18 AWG, 250V, 4 A	A	889D-F4HJ-2∗	889D-R4HJ-2∗	889D-M4HJ-2∗	889D-E4HJ-2∗
		22 AWG		A	889D-F4HL-2∗	889D-R4HL-2∗	889D-M4HL-2∗	889D-E4HL-2∗
	PUR	22 AWG	22 AWG, 250V, 4 A	A	889D-F4UC-2∗	889D-R4UC-2∗	889D-M4UC-2∗	889D-E4UC-2∗
5-Pin					889D-F5UC-2∗	889D-R5UC-2∗	889D-M5UC-2∗	889D-E5UC-2∗
8-Pin	TPR	24 AWG	30V AC/36V DC 1.5 A	A	889D-F8AC-2∗	—	—	—
	PUR			B	889D-F8AB-2∗	889D-R8AB-2∗	889D-M8AB-2∗	—

Patchcords



Pin Count	Cable Type	Wire Size	Assembly Rating	Cat. No.			
				Straight Female Straight Male	Straight Female Right Angle Male	Right Angle Female Straight Male	Right Angle Female Right Angle Male
4-Pin	PUR	22 AWG	22 AWG, 250V, 4 A	889D-F4UCDM-2❄	889D-F4UCDE-2❄	889D-R4UCDM-2❄	889D-R4UCDE-2❄
5-Pin		22 AWG	22 AWG, 250V, 4 A	889D-F5UCDM-2❄	889D-F5UCDE-2❄	889D-R5UCDM-2❄	889D-R5UCDE-2❄
8-Pin		24 AWG	30V AC/36V DC 1.5 A	889D-F8ABDM-2❄	—	—	—

∗ Replace 2 (2 m) with 5 (5 m) or 10 (10 m) for standard cable lengths.
❄ Replace 2 (2 m) with 0M3 (1 ft), 1 (1 m), 5 (5 m) or 10 (10 m) for standard lengths.

Note: Stainless steel connectors may be ordered by adding an "S" to the cat. no. (e.g. 889D**S**-F4UCDM-∗).

Cordsets & Patchcords, AC Micro Style

22 AWG, PVC



Features

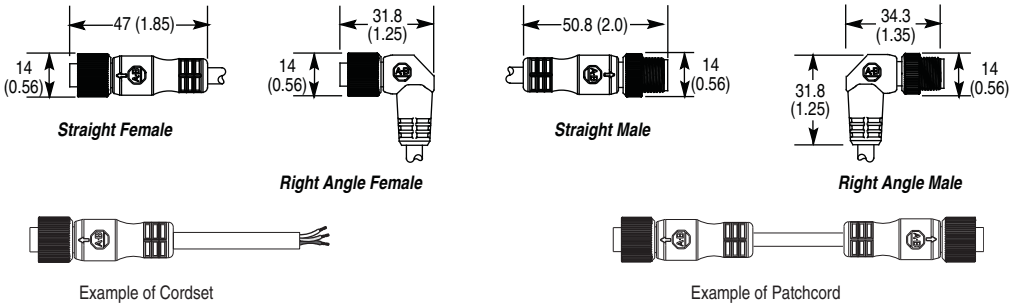
- Highly visible yellow PVC jacket offers good oil and chemical resistance
- Heavy-duty re-inforcing braiding can be used as a grounded shield to reduce noise
- Ratcheting coupling nut for vibration resistance

Specifications

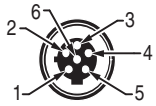
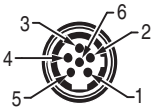
Certifications	UL Recognized and CSA Certified
Mechanical	
Coupling Nut Material	Epoxy-coated zinc
Connector Material	Molded oil-resistant polyurethane
Contact Material	Gold over nickel-plated brass
Cable Type	Oil-resistant yellow PVC jacket, 22 AWG conductors, 300V, UL Recognized and CSA Certified
Home Run Connection	10x diameter
Cable Diameter	6/c (22 AWG) = 6.7 (0.26)
Braiding	Tinned copper braid
Cable Rating	UL AWM style 2661 VW-1 105C 300V, CSA AWM A/B I/II 80C 300V FT1, UV oil and water resistant
Assembly Rating	Braided 22 AWG, 250V, 4 A
Environmental	
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-20…+105° (-4…+221°)

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Pinout and Color Code

Color Code	Face View Pinout 6-Pin	
		
A	1 Red/White Tr. 2 Red 3 Green	4 Red/Yellow Tr. 5 Red/Black Tr. 6 Red/Blue Tr.

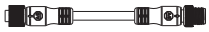
Product Selection

Cordsets



Pin Count	Wire Size	Assembly Rating	Color Code	Cat. No.			
				Straight Female	Right Angle Female	Straight Male	Right Angle Male
6-Pin	Braided 22 AWG	Braided 22 AWG, 250V, 4 A	A	889R-F6ECA-2∗	889R-R6ECA-2∗	889R-M6ECA-2∗	889R-E6ECA-2∗

Patchcords



Pin Count	Wire Size	Assembly Rating	Color Code	Cat. No.			
				Straight Female to Straight Male	Straight Female to Right Angle Male	Right Angle Female to Straight Male	Right Angle Female to Right Angle Male
6-Pin	Braided 22 AWG	Braided 22 AWG, 250V, 4 A	A	889R-F6ECRM-2❄	889R-F6ECRE-2❄	889R-R6ECRM-2❄	889R-R6ECRE-2❄

∗ Replace 2 (2 m) with 5 (5 m) or 10 (10 m) for standard cable lengths.
❄ Replace 2 (2 m) with 0M3 (1 ft), 1 (1 m), 5 (5 m) or 10 (10 m) for standard lengths.

Cordsets & Patchcords, Mini Style

18 AWG, PVC



Features

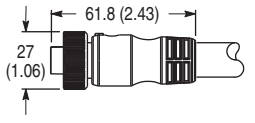
- General purpose 18 AWG cable
- Highly visible yellow PVC jacket offers good oil and chemical resistance
- 2-, 3-, 4-, 5-, and 6-pin configurations
- Ratcheting coupling nut for vibration resistance

Specifications

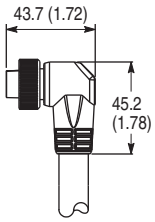
Certifications	UL Recognized and CSA Certified
Mechanical	
Coupling Nut Material	Epoxy-coated zinc
Connector Material	Molded oil-resistant PVC
Contact Material	Gold over nickel-plated brass
Cable Type	Oil-resistant yellow PVC jacket, 18 AWG stranded copper, 300V; UL Recognized and CSA Certified
Home Run Connection	10x diameter
Cable Diameter	4/c = 7 mm (0.27 in.) 5/c = 8 mm (0.31 in.)
Electrical	
Cable Rating	UL AWM style 2661 VW-1 105C 300V, CSA AWM A/B I/II 80C 300V FT1, UV oil and water resistant
Assembly Rating	4-pin = 300V, 7 A 5-pin = 300V, 5.6 A
Environmental	
Enclosure Type Rating	NEMA 4, 6P, 12, 13; IP67 and IP69K; 1200 psi washdown
Operating Temperature [C (F)]	-20…105° (-4…221°)

Approximate Dimensions

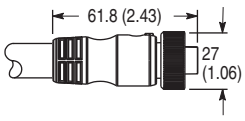
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



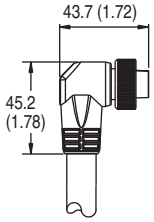
Straight
Female



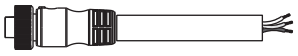
Right Angle Female



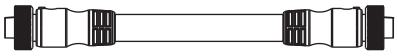
Straight Male



Right Angle Male

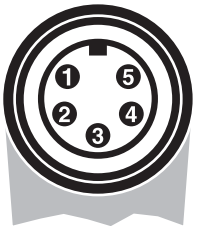


Example of Cordset



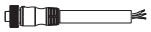
Example of Patchcord

Pinout and Color Code

Color Code	Face View Pinout			
	4-Pin		5-Pin	
				
C (IEC)	1 Black 2 Blue	3 Brown 4 White	1 Black 2 Blue 3 Grey	4 Brown 5 White

Product Selection

Cordsets



Pin Count	Assembly Rating	Color Code	Cat. No.			
			Straight Female	Right Angle Female	Straight Male	Right Angle Male
4-Pin	300V, 7 A	C	889N-F4AE-6F∗	889N-R4AE-6F∗	889N-U4AE-6F∗	889N-V4AE-6F∗
5-Pin	300V, 5.6 A		889N-F5AE-6F∗	889N-R5AE-6F∗	889D-M5UC-2‡	889N-V5AE-6F∗

Patchcords



Pin Count	Assembly Rating	Cat. No.			
		Straight Female Straight Male	Straight Female Right Angle Male	Right Angle Female Straight Male	Right Angle Female Right Angle Male
4-Pin	300V, 7 A	889N-F4AENU-6F❄	889N-F4AENV-6F❄	889N-R4AENU-6F❄	889N-R4AENV-6F❄
5-Pin	300V, 5.6 A	889N-F5AENU-6F❄	889N-F5AENV-6F❄	889N-R5AENU-6F❄	889N-R5AENV-6F❄

∗ Replace 6 (6 ft) with 12 (12 ft), or 20 (20 ft) for standard cable lengths.
‡ Replace 2 (2 m) with 5 (5 m) or 10 (10 m) for standard cable lengths.
❄ Replace 6 (6 ft) with 3 (3 ft), 12 (12 ft), or 20 (20 ft) for standard cable lengths.

Note: Stainless steel connectors may be ordered by adding an "S" to the cat. no. (e.g. 889N**S**-F3AEC-∗F).

Cordsets and Patchcords, Mini-Plus Style

18 AWG



Features

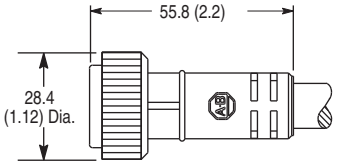
- Highly visible yellow PVC jacket offers good oil and chemical resistance

Specifications

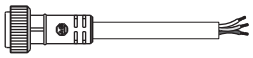
Certifications	UL Recognized and CSA Certified
Mechanical	
Coupling Nut Material	Epoxy-coated zinc, 18 AWG
Connector Material	Molded oil-resistant PVC
Contact Material	Gold over nickel-plated brass
Cable Type	Oil-resistant yellow PVC jacket, 18 AWG stranded copper, 300V; UL Recognized and CSA Certified, STOOW
Cable Diameter	7/c = 14 mm (0.55 in.) 8/c = 15 mm (0.59 in.)
Electrical	
Cable Rating	18 AWG: UL AWM style 2517 or 2661 105C 300V, CSA AWM A/B I/II 105C 300V FT1
Assembly Rating	(5) 18 AWG/(2) 20 AWG, 300V, 3 A
Environmental	
Enclosure Type Rating	NEMA 4, 6P, 12, 13; IP67; 1200 psi washdown
Operating Temperature [C (F)]	-40…+105° (-40…+221°)

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Straight Female



Example of Cordset

Pinout and Color Code

Color Code	Face View Pinout			
	7-Pin		8-Pin	
				
B	1 Black 2 White 3 Blue 4 Brown	5 Grey❄ 6 Yellow❄ 7 Green	1 Red 2 White 3 Blue 4 Brown	5 Grey 6 Yellow 7 Green 8 Pink

❄ 20 AWG conductors

Product Selection

Cordsets

Pin Count	Wire Size	Assembly Rating	Color Code	Cat. No.
				Straight Female
7-Pin	(5) 18 AWG (2) 20 AWG	(5) 18 AWG/(2) 20 AWG, 300V, 3 A	B	889N-F7AG-2∗
8-Pin	18 AWG			889N-F8AE-2∗

∗ Replace 2 (2 m) with 5 (5 m), 10 (10 m), 20 (20 m), or 30 (30 m) for standard cable lengths.

Cordsets & Patchcords, M23 Style

18 or 18/22 AWG, Yellow PVC



Features

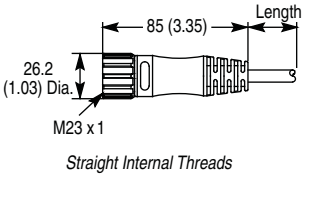
- 12-pin configuration for SafeShield light curtains and other applications
- Highly visible yellow PVC jacket offers good oil and chemical resistance

Specifications

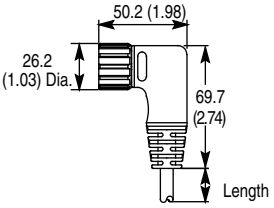
Certifications	UL Recognized and CSA Certified
Mechanical	
Coupling Nut Material	Nickel-plated brass
Connector Material	Molded oil-resistant PUR
Contact Material	Gold over nickel-plated brass
Cable Type	Oil-resistant yellow PVC jacket, 18 AWG conductors, 60V, UL Recognized and CSA Certified
Home Run Connection	10x diameter
Cable Diameter	10 mm (0.41 in.)
Electrical	
Cable Rating	300V
Assembly Rating	9- & 12-pin: 300V, 4 A; 11-pin: 63V, 6 A; 19-pin: 63V, 12 A
Environmental	
Enclosure Type Rating	IP67, NEMA 6P, 1200 psi (8270 kPa) washdown
Operating Temperature [C (F)]	-20…+80° (-4…+176°)

Approximate Dimensions

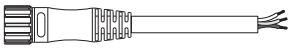
Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Straight Internal Threads



Right Angle Internal Threads



Example of Cordset



Example of Patchcord

Pinout and Color Code

Color Code	Face View Pinout 9-, 11-, or 12-Pin		
A	1 Brown 2 NA 3 Blue 4 White	5 NA 6 Green 7 Yellow 8 Grey	9 Pink 10 Red 11 NA 12 Green/Yellow
B	1 Brown 2 Blue 3 Grey 4 Pink	5 Red 6 Yellow 7 White 8 Red/Blue	9 Black 10 Violet 11 Grey/Pink 12 Green

Product Selection

Cordsets



No. of Pins	Color Code	Jacket Color	Wire Size	Cat. No. Straight Female	Cat. No. Right Angle Female
9-Pin	A	Yellow	18 AWG	889M-FX9AE-2∗	889M-RX9AE-2∗
12-Pin	B	Yellow	18 AWG	**889M-F12AH-2∗**	889M-R12AH-2∗

Patchcords



Pin Count	Jacket Color	Wire Size	Cat. No. Straight Female Straight Male
12-Pin	Yellow	18 AWG	889M-F12AHMU-2❄

∗ Replace 2 (2 m) with 5 (5 m) or 10 (10 m) for standard cable lengths.
❄ Replace 2 (2 m) with 0M3 (1 ft), 0M6 (0.6 m), 1 (1 m), or 3 (3 m) for standard cable lengths.

Field Attachables, DC Micro Style

Screw Terminal Connector



Features

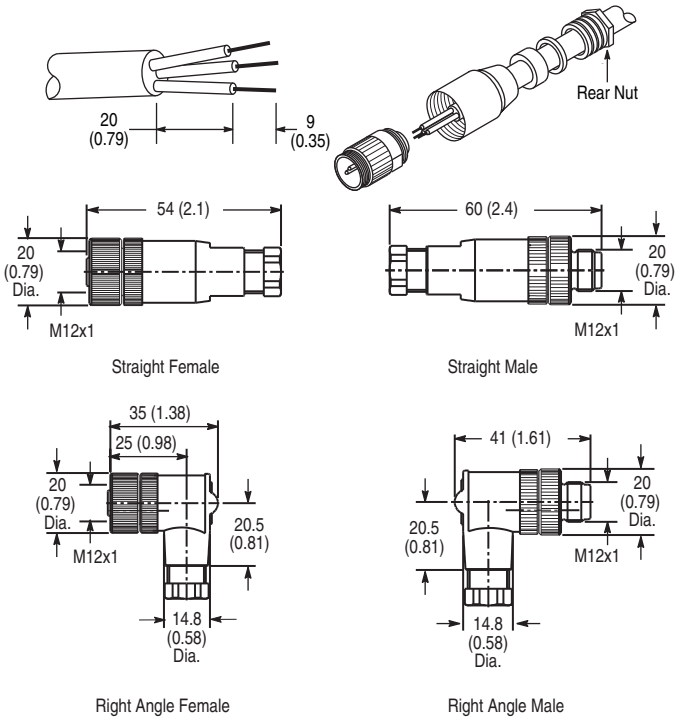
- Field installable
- 4- or 5-pin DC micro style
- Single cable or dual cable models
- Screw terminals provide simple and secure installation
- Allows easy modification of existing cable installations
- Embedded thermistor models designed for use with ArmorPoint thermocoupling input modules provide cold junction compensation capability

Specifications

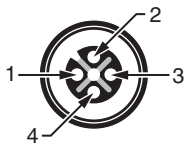
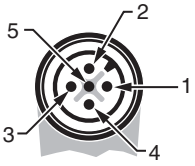
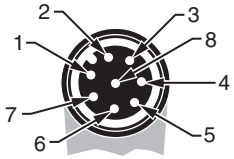
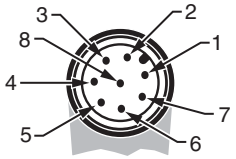
Mechanical	
Coupling Nut Material	Nickel-plated brass
Connector Shell Material	PBT, except embedded thermistor models: Nylon
Contact Material	Gold plated palladium nickel
Wire Rating	18 AWG (0.75 mm²)
Electrical	
Assembly Rating	4- or 5-pin: 250V, 4 A; 8-pin: 60V, 2 A
Environmental	
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-40…88° (-40…185°)

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Pinout and Color Code

Face View Pinout			
4-Pin	5-Pin	8-Pin	
			
Female	Male	Female	Male

Product Selection

Single-Cable Model Terminal Chambers

Pin Count	Cable Diameter [mm (in.)]	Assembly Rating	Thread Size	Cat. No.			
				Straight Female	Right Angle Female	Straight Male	Right Angle Male
4-Pin	4.0…6.0 (0.16…0.24)	250V, 4 A	PG 7	871A-TS4-D	**871A-TR4-D**	871A-TS4-DM	**871A-TR4-DM**
	6.0…8.0 (0.24…0.32)		PG 9	871A-TS4-D1	871A-TR4-D1	871A-TS4-DM1	871A-TR4-DM1
5-Pin	4.0…6.0 (0.16…0.24)		PG 7	871A-TS5-D	871A-TR5-D	871A-TS5-DM	871A-TR5-DM
	—		PG 9	871A-TS5-D1	871A-TR5-D1	871A-TS5-DM1	871A-TR5-DM1
8-Pin	6.0…8.0 (0.24…0.32)	60V, 2 A	PG 9	871A-TS8-D1	—	871A-TS8-DM1	—

Dual-Cable Model Terminal Chambers

Pin Count	Cable Diameter [mm (in.)]	Assembly Rating	Thread Size	Cat. No.	
				Straight Male	Right Angle Male
4-Pin	Two cables 2.1…3.0 (0.08…0.12) or 3.5…5.2 (0.14…0.21)	250V, 4 A	PG 9	**871A-VS4-DM**	871A-VR4-DM
5-Pin				871A-VS5-DM	871A-VR5-DM

Note: Stainless steel coupling nuts are available, add an "S" to the cat. no. (e.g. 871A**S**-TS4-DM).

Field Attachables, DC Micro Style

Insulation Displacement Connector



Features

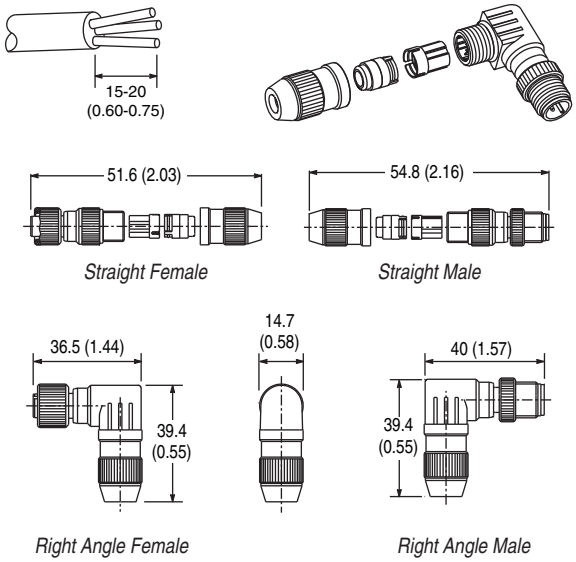
- Field installable with no hand tools required
- 4-pin DC micro style
- Straight or right angle, male or female
- Allows easy modification of existing cable installations
- Insulation displacement technology for secure and reliable installation

Specifications

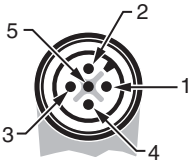
Coupling Nut Material	Zinc die-cast
Connector Shell Material	Zinc die-cast or polyamide
Connector Material	Hytrel
Contact Material	Gold-plated palladium nickel
Enclosure Type Rating	IP67
Operating Temperature [C (F)]	-25…85° (-13…185°)
Installation Temperature [C (F)]	-5…50° (23…185°)
IDC Installations	10 max.
Cable Diameter [mm (in.)]	4.0…5.1 (0.16…0.20)
Wire Size	1.2…1.6 (0.047…0.063) 26…22 AWG

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Product Selection

Connector Style	Cable Diameter [mm (in.)]	Wire Rating	Face View		Cat. No.	
			Female	Male	Female	Male
Straight Male	4.0…5.1 (0.16…0.20)	32V, 4 A			889D-F4DC-H	889D-M4DC-H
Right Angle Male					889D-R4DC-H	889D-E4DC-H

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Specifications

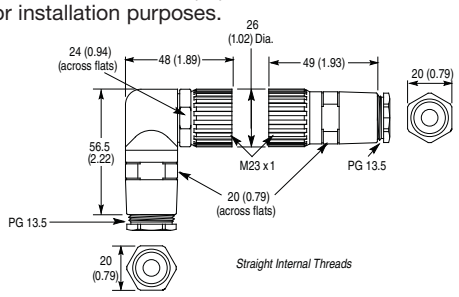
Coupling Nut Material	Nickel-plated brass
Connector Shell Material	Nickel-plated brass
Contact Material	Gold-plated palladium/nickel
Wire Rating	18 AWG (1.0 mm²), max.
Enclosure Type Rating	IP65
Operating Temperature [C (F)]	-20…+105° (-4…221°)

Features

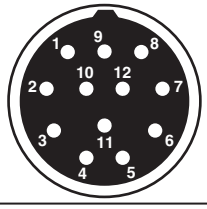
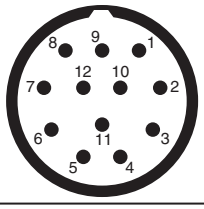
- Straight or right angle, male or female
- 12-pin M23 style for standard connectivity
- Allows modification of existing cable installations and field creation of special cable lengths
- Solder connector for secure and reliable installation

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Product Selection

Connector Style	Cable Diameter [mm (in.)]	Face View			Cat. No.	
		Wire Rating	Female	Male	Female	Male
Straight Male	10…14 (0.39…0.55)	60V 4 A			889M-F12AH-T	889M-M12AH-T
Right Angle Male					889M-R12AH-T	889M-E12AH-T

Receptacles, DC Micro Male

4-Pin, 5-Pin or 8-Pin and AC Micro Male, 6-Pin



Specifications

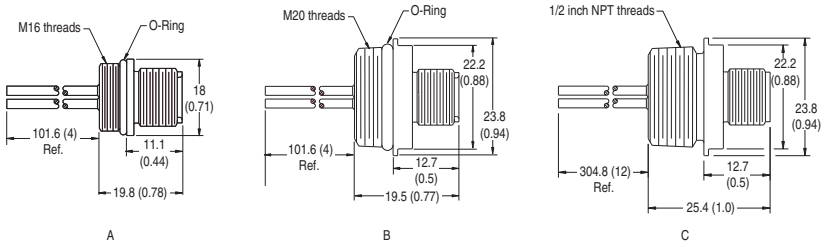
Connector Shell Material	Nickel-plated brass
Connector Insert Material	Nylon
Contact Type	Machined brass with gold over nickel plating
Wire Insulation	Oil resistant PVC, 22 AWG stranded copper, 300V
Operating Temperature [C (F)]	-20…+105° (-4…+221°)

Features

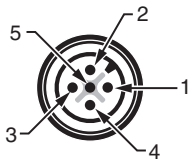
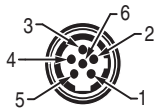
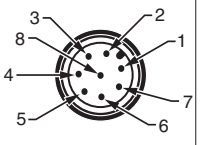
- Male bulkhead receptacles
- 4-, 5- or 8-pin DC micro configuration
- M16, M20 or 1/2 inch-14 NPT mounting threads

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Product Selection

Face View of Male	Wire Color	Wire Rating	Length [m (ft)]	Panel Mount Thread Size	Drawing	Cat. No.
	1 Brown 2 White 3 Blue 4 Black	22 AWG 300V 3 A	0.1 (0.3)	M16 x 1	A	888D-M4AC9-4N
				M20 x 1.5	B	888D-M4AC8-4N
			0.3 (1)	1/2 inch-14 NPT	C	888D-M4AC1-0M3
	1 Brown 2 White 3 Blue 4 Black 5 Grey		0.1 (0.3)	M16 x 1	A	888D-M5AC9-4N
				M20 x 1.5	B	888D-M5AC8-4N
			0.3 (1)	1/2 inch-14 NPT	C	888D-M5AC1-0M3
	1 Red/White Tr 2 Red 3 Green 4 Red/Yellow Tr 5 Red/Black Tr 6 Red/Blue Tr	22 AWG 300V 3 A	0.1 (0.3)	M16 x 1	A	888R-M6AC9-4N
				M20 x 1.5	B	888R-M6AC8-4N
			0.3 (1)	1/2 inch-14 NPT	C	888R-M6AC1-0M3
	1 White 2 Brown 3 Green 4 Yellow 5 Grey 6 Pink 7 Blue 8 Red	24 AWG 36V DC/30V AC 1.5 A	0.1 (0.3)	M16 x 1	A	888D-M8AC9-4N
				M20 x 1.5	B	888D-M8AC8-4N



Specifications

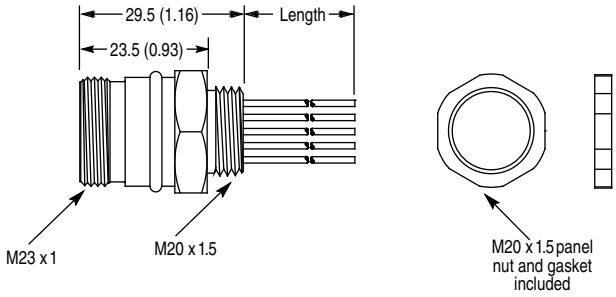
Connector Shell Material	Nickel-plated brass
Connector Insert Material	Nylon
Contact Material	Machined brass with gold over nickel plating
Wire Size	Oil resistant PVC, 18 AWG stranded copper, 300V
Certifications	Cable: UL Recognized and CSA Certified
Enclosure Type Rating	IP67, NEMA 6P, 1200 psi (8270 kPa) washdown
Operating Temperature [C (F)]	-20…+105° (-4…+221°)

Features

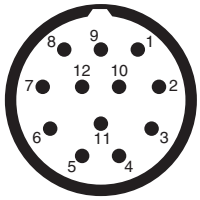
- 18 AWG conductors for ease of wiring
- 12-pin configuration provides standard connectivity
- M20 x 1.5 threads for convenient mounting to safety switches
- Mounting nut and rubber sealing washer included

Approximate Dimensions

Dimensions are shown in mm (in.). Dimensions are not intended to be used for installation purposes.



Product Selection

Face View of Male	Cable			Panel Mount Thread Size	Cat. No.
	Wire Color	Wire Rating	Length [m (ft)]		
	1 Brown 2 Blue 3 Grey 4 Pink 5 Red 6 Yellow 7 White 8 Red/Blue 9 Black 10 Violet 11 Grey/Pink 12 Green	18 AWG 60V 4 A	0.15 (0.5)	M20 x 1.5	888M-M12AE-0F5
	1 Brown 2 NA 3 Blue 4 White 5 NA 6 Green 7 Yellow 8 Grey 9 Pink 10 Red 11 NA 12 Green/Yellow				888M-M12X9AE-0F5

Notes

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Applied Safety Solutions

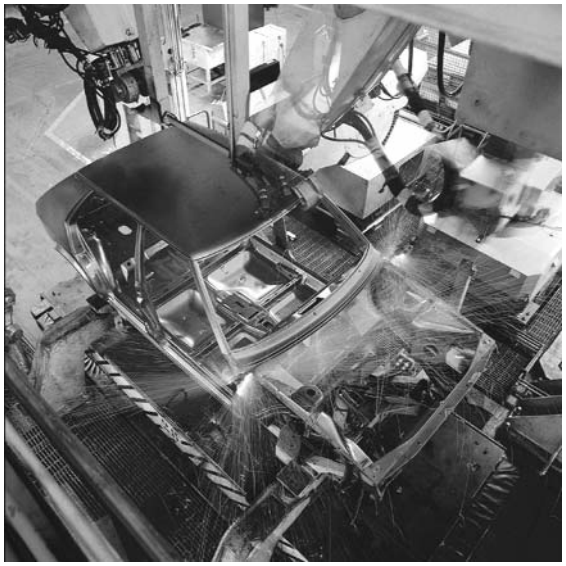
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Overview 8-3

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StamPro™ 8-7

Machine Safety Services

Overview



Risk assessments, risk reduction planning and project services allow companies to plan and implement safety programs for machine safeguarding applications to help reduce costs, improve compliance and enhance plant floor safety.

System Description

Rockwell Automation's Machine Safety Services include consulting, system integration and long-term support services for machines that must meet standards set forth by OSHA and ANSI in the United States. These services complement Rockwell Automation's expertise in metal forming and automation projects, including over 15 years of experience in automating mechanical and hydraulic stamping presses.

Rockwell Automation's Machine Safety Services include:

- Standards Training
  - Customer training on current standards and industry accepted interpretations
  - Standards updates as necessary
- Risk Assessment and Risk Reduction Planning
  - Coach/train client through procedures of risk assessment
  - Provide assistance with interpretation of standards and documentation of assessments
  - Facilitate an iterative process of mitigating each identified hazard by redesign or additional measures
- Technical Specification Development
  - Assist with the development of a machine safety standard that addresses safety solutions for an entire company, facility or machine
- Conformity Audits
  - Machine audits to verify and document compliance; a complete step-by-step assessment determines which standards are applicable and whether or not they have been satisfied
- Stop Time Measurements and Safety Distance Calculations
  - Help assess compliancy of light curtain and area guarding device installations
  - Help determine ergonomic and operational advantages of safeguarding options
- Safety Circuit Design
  - Including limited and sequential shutdown and applications
- Probability of Failure on Demand Calculations
  - Assist with obtaining a desired Safety Integrity Level (SIL) based on IEC 61508

The implementation of a comprehensive machine safety program will involve many disciplines. Rockwell Automation has the entire spectrum covered. From the design and integration of safety critical circuits using the most advanced controls to the implementation of hard guarding. Rockwell Automation has the experience necessary to fulfill all your needs.

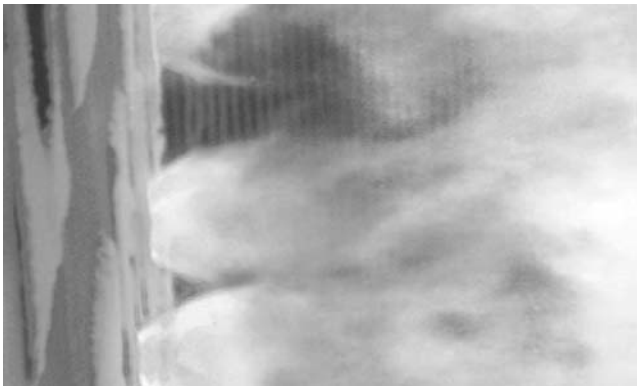
Typical machine system integration services can include:

- System Integration Services
- Project management
  - System architecture design
  - Panel design
  - Material procurement
  - RA products
  - Third party products (including hard guarding solutions)
  - Assembly
  - Software development
  - Hardware/software integration testing
  - Factory acceptance
  - Start-up assistance

Rockwell Automation's support and follow through are available at every stage and can include:

- On-Site Training
- Maintenance and operator training for our installed machine safety solutions
- Preventive Maintenance Programs
- Verify installed safety systems are operating within defined parameters
- Field Service
- Field work to be done on a contractual or as needed basis





System Description

Rockwell Automation burner management systems are engineered to provide igniter (pilot) and main flame detection, as well as control and monitoring of burner start-up and shutdown sequences including master fuel trip and purge.

The systems can help you:

- Protect against damage to your combustion process equipment and surrounding areas due to explosion or other undesirable event
- Qualify for lower insurance premiums resulting from compliance with applicable industry standards such as NFPA, IRI and FM
- Reduce installation times because our systems are fully assembled, programmed, thoroughly tested, and designed for immediate field installation
- Simplify unit operation through alarm management and operator displays
- Reduce start-up time with advanced diagnostics and operator help messages
- Reduce critical troubleshooting time through the use of pinpoint diagnostic messaging
- Enhance communication and reporting capabilities to other systems in your facility

Our BurnerMaster™ concept of burner management systems are designed for single burner applications for boilers, process heaters, furnaces, kilns and natural gas.

In addition to our family of burner management systems, Rockwell Automation offers related systems for control of combustion related processing including:

- Combustion temperature/pressure control
- Coal handling
- Ash handling and emission control systems
- Soot blowing
- Demineralizer control



Keep your combustion process safe and minimize fuel usage on the same platform!

Overview

Rockwell Automation offers various systems, bundled packages, and kits for meeting the safety-related control standards for the clutch/brake of mechanical stamping presses. These solutions are designed to meet the safety requirements of ANSI B11.1, OSHA 1910.217, CAN/CSA Z142-M90, IEC-61508, EN-954 and EN-692.

The 6556 Clutch/Brake kits are bundled packages consisting of redundant PLC components with application software, wiring diagrams, relays and documentation. Each solution is designed with independent redundant programmable controllers with additional electromechanical components and the application software to provide the necessary monitoring, self testing, security, and verification that make up a control-reliable design.

The PLC-5/x6 based kits come with the clutch/brake software secured in program file #16, and the user can add other logic to other files. The PLC-5-based kits are designed for large presses with extensive automation.

The MicroLogix™ kits are pre-programmed with the ladder program locked in flash memory. Certain features in the fixed kits are configurable. The MicroLogix-based Compact PressMaster™ kit, for example, has a variety of standard features to control ancillary functions such as lube and programmable limit switch that can be configured through pre-programmed PanelView screens. The fixed kits are easy to use, require no programming, and are designed for small to medium-size presses retrofitted by the user.

The StamPro™ system is a complete, ready-to-install, Logix-based press control system that comes with controllers and hardware for controlling a stamping press. Ancillary control functions, which can be purchased from Rockwell Automation or supplied by the user, are integrated into the system hardware and software designs. The StamPro system is designed for end users, OEMs and integrators. The system can be purchased either with pre-programmed optional functions or can be programmed by the user.

Some press functions which can be integrated with our solutions include:

- **Clutch/Brake.** The Allen-Bradley controller designed system that controls the dual-valve clutch/brake mechanism as found on all mechanical stamping presses. This system includes dual redundant controllers with application software for monitoring and self-testing to achieve safety regulation compliance.
- **Programmable Limit Switch (PLS).** Ladder Logic for switching outputs according to crankshaft position. The PLS is often used to integrate and synchronize other press auxiliary functions such as feeders, grippers, blow-off and ejector valves. This feature requires a resolver position input for accuracy. The PLS is usually pre-programmed and configured by the user for each job or die.
- **Die Monitoring.** Logic that monitors a variety of in-die sensors to determine misalignment, double blanks, misfeeds, part positioning, plus other critical conditions. The die monitor function requires a resolver input and is generally pre-programmed and configured for each job or tool.

Modes of Operation

The following table lists the modes of operation for each Rockwell Automation press control solution.

Press Modes of Operation	MicroLogix™ Clutch Brake	Clutch Pro™	Compact Press Master™	StamPro™ System
Off	X	X	X	X
Inch	X	X	X	X
Micro Inch			X	X
Single	X	X	X	X
Continuous	X	X	X	X
Remote & Auto Single				X

Contact your local Rockwell Automation sales office or Allen-Bradley distributor for pricing and order information.

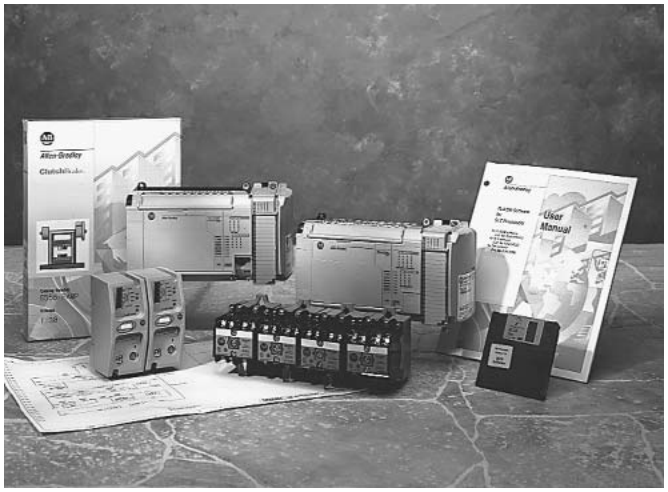
Press Features/Functions

The table below summarizes the various press control functions available for each press control solution.

(S = Standard, O = Optional, P = User Programmable, Blank table cell = Function not available).

Press Control Features	MicroLogix™ Clutch Brake	Clutch Pro™	Compact Press Master™	StamPro™ System
Clutch/Brake Control	S	S	S	S
Operator Interface	O	O	S/P	S/P
E-Stop & MCR Relays	S	S	S	S
Run Sta. Monitored	4	4	4	4+
Main Motor Control		S		S/P
RCLS Position Capable	S	S	S	S/P
Resolver Capable	O	O	O	O/P
Brake Time Monitor	S	S	S	S
Var. Speed Top Stop	S	S	S	S/P
Production Counters		S		S/P
Prog. Limit Switch			O	O/P
Die Protection Mon.			O	O/P
Recipe Storage			S/30	S/99
Var. Speed Comp.		S	S	S
Lubrication Control			S	S/P
Tonnage Monitoring			O	O/P
Auto Counterbalance			O	O/P
Shut Height Adjust			S	S/P
Var. Speed Drive Interf.			O	O/P
Servo Feed Interface			O	O/P
Robot Interface			O	O/P
Coil Feed Interface			O	O/P
Die Cushion Control			O	O/P
Die Clamp Control			O	O/P
Bolster/Die Cart Cntl.			O	O/P
Aux. Automation Intrf.			O	O/P
Prod. Monitoring/OEE			S	S/P
Hydric. Overload Cntl.			O	O/P
Light Curtain Interface			S	S
Disconnect/Starters			O	O
Open Net. Interface Capable‡	S	S	S	S
User Prog. Capable		S		S
Enclosure Assembled	O	O	O	O
Complete System	O	O	O	O

‡ Ethernet, DeviceNet, Controlnet, RS-232



Description

A MicroLogix™ 1500 processor-based Clutch/Brake Package is a bundle of hardware, software, and documentation that controls the basic clutch/brake mechanisms on mechanical stamping presses. This package requires no user programming. It can be interfaced with other controllers such as the ControlLogix system.

The package uses redundant MicroLogix 1500 processors with application software for self testing and verification to help meet the safety requirements of ANSI B11.1, OSHA 1910.217 and CAN/CSA Z142-M90 press safety regulations for mechanical stamping presses. Each MicroLogix 1500 processor has the basic clutch/brake functionality as well as the basic diagnostics to interface to several display options making it an easy-to-use cost-effective solution for small presses. Since you don't need programmable controller experience; you can just wire and mount the equipment.

For other press functions such as programmable limit switch, automation control, die protection monitoring and resolver based, consider using the Compact PressMaster system. If you require more automation flexibility or need a custom system, consider using the StamPro system.

Control Features

- Four sets of Run buttons monitored
- One set of Inch buttons monitored
- AC and DC versions
- Hard wired cross-checking
- Open communication for diagnostics

Modes of operation:
  – Off
  – Inch
  – Single
  – Continuous (Armed)
- Brake monitoring
- Top stop overrun and anti-repeat protection

System Requirements

- Rotary Cam Limit Switch or Allen-Bradley Encoder
- Motion detection device
- Self-checking valve

Ordering Information

The purchase of one kit includes the license to use this control on one stamping press.

- Contact your local Rockwell Automation Sales office or Allen-Bradley distributor.
- Email inquiries to: metalforming@ra.Rockwell.com
- FAX inquiries to: 440-646-4843
  Attention: Metalforming Group

The **HMI** option, which must be ordered in addition to the basic Clutch/Brake package, includes installed software, communication modules, and necessary cables.

New—Enhanced Options for MicroLogix Clutch/Brake Controllers

Option Description	Option Number
HMI Option — Includes PanelView™ Plus 400, network hardware for Ethernet/IP and software for diagnostics, brake monitor setup, and encoder configuration.	PV400
Encoder, scanner module, and software to create a dual encoder feedback system for press position.	PF1
One operator run station on T-stand with run, top stop, and E-stop pushbuttons	RS1

Press Control Systems

PressMaster™

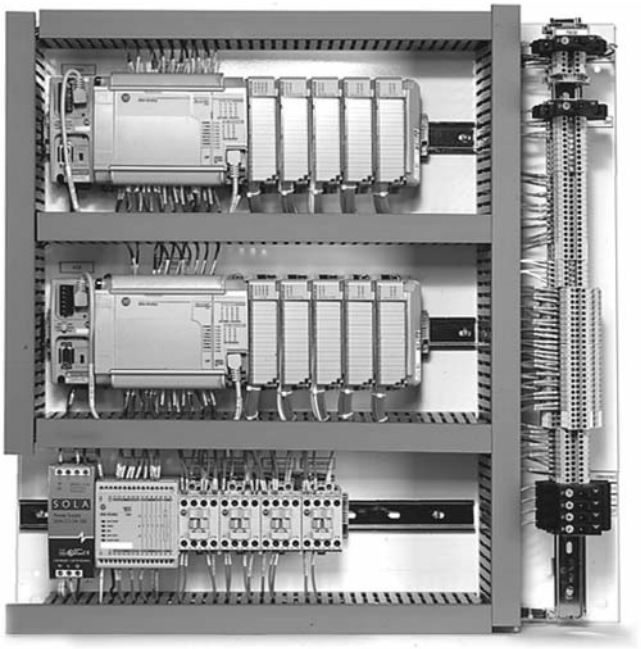
Help reduce operating costs and downtime with flexible press controls.

The Rockwell Automation Compact PressMaster™ System is a cost competitive, programmable controller-based system used for the control and monitoring of mechanical stamping presses. Help reduce cost and risk by purchasing a complete system, pre-wired and tested, ready for installation. The system is designed to modernize your press controls, increase control system reliability, and help reduce downtime by providing comprehensive operator diagnostics. Compact PressMaster provides press users, rebuilders, and OEMs a low cost PLC based control system to remain competitive and reduce risk.

System Description

The Compact PressMaster System is an expandible press control system based on standard Rockwell Automation components available locally and supported worldwide. Compact PressMaster Systems provide press control, operator interface with comprehensive diagnostics, expandability, and motor controls in a single integrated package. The system is provided, ready to install, with a complete set of documentation.

The Compact PressMaster System is based on the standard Bulletin 6556 clutch/brake control with dual processors and software designed by Rockwell Automation to help customers comply with ANSI B11.1, OSHA 1910.217, CSAZ142-2002, and EN 954. An Allen-Bradley PanelView operator interface is included to complete the system and provide maximum reliability.



Standard Features

Standard features include:

- Safety interlocks and light curtain interface
- Clutch/brake safety control with inch, single stroke, continuous, modes of operation
- Main motor control
- Lubrication control
- Slide adjust control
- Operator fault and prompt messages, alarm status operator screen
- One industrial absolute encoder
- Brake time monitoring and 90° stop test
- Interface for four run stations with anti-tiedown protection
- Press stroking anti-repeat and top stop overrun protection
- Clutch/brake and counterbalance air pressure monitoring
- User immediate and top stop control interlocks
- Production counters
- Variable speed compensation

Optional features available:

- Automatic slide adjust
- Sixteen channels of die protection
- Eight programmable limit switch outputs
- Hydraulic overload control
- Light curtains with muting
- OEM packages
- Automatic counterbalance control
- 6-inch color operator display terminal

Results

A Compact PressMaster System helps provide:

- Reduced downtime through advanced diagnostic messages, helpful operator prompts, and on-line control system troubleshooting.
- Improved system reliability through the use of standard Rockwell Automation industrial control hardware and software.
- Increased operational flexibility and expandability, while reducing costs and risk.
- Compliance with ANSI, OSHA, and CSA regulations.
- A press control that can grow with your stamping operations.

Ordering Information

- Contact your local Rockwell Automation sales office or Allen-Bradley distributor.
- Email inquiries to: metalforming@ra.Rockwell.com
- FAX inquiries to: 440-646-4843
  Attention: Metalforming Group

Help reduce operating costs and downtime with flexible programmable press controls.

The Rockwell Automation StamPro™ System is an advanced programmable controller-based system used for the control and monitoring of mechanical and hydraulic stamping presses. The StamPro control system is for customers who want to help reduce cost and risk by purchasing a complete pre-engineered system, ready for installation.

System Description

The StamPro System is a flexible, pre-engineered press control system based on standard Rockwell Automation components available locally and supported worldwide. StamPro Systems provide press control, operator interface, and magnetics in an integrated package with a complete set of documentation. The use of field-proven hardware and software helps users minimize cost and risk, while also helping to comply with the necessary ANSI, OSHA and CSA standards.

System Architecture

The StamPro System uses the Allen-Bradley Logix family of processors. The safety kernel, executed in dual Logix processors, is based on the standard Bulletin 6556 clutch/brake control with dual processors and software designed by Rockwell Automation to help customers comply with ANSI B11.1/B11.2, OSHA 1910.217, CSAZ142-2002, and EN 954.

This safety kernel is coupled with optional application software that provides all other press automation control, monitoring, information and network requirements. The Logix programming environment allows the user to add their own additional custom software into the same processors where the safety kernel resides, to help minimize control hardware costs. The standard operator interface is a pre-programmed color PanelView™ Plus 1000. The system is available in a freestanding console or an upright enclosure with a press mounted operator station.

Features

The StamPro System is modular, which allows each system to be configured to the requirements of each specific application and easily accommodates control expansion for future needs.

Standard features include:

- Stop time monitoring for hands in die
- Safety Interlocks and Light Curtain interface
- Main Motor/Pump control
- Lubrication control
- Manual Slide Adjust/ Ram Profile Control
- A 10-in. color operator interface terminal with Alarm Status/History and Fault/Prompt
- Clutch/Brake Safety Control
- Interface for four run stations with anti-tiedown protection

Optional features include:

- Fully assembled and mounted in a NEMA 12 rated industrial enclosure with one set of operator run palm-buttons
- Automatic Slide Adjust Control
- Die Protection Monitoring
- Programmable Limit Switch
- Tonnage Monitoring
- Die Clamp Control
- Die Cushion Control
- Bolster Control
- Light Curtain with muting
- Hydraulic Overload Control
- Recipe Management
- Automatic Die Change
- Automatic Counterbalance Air Pressure Control

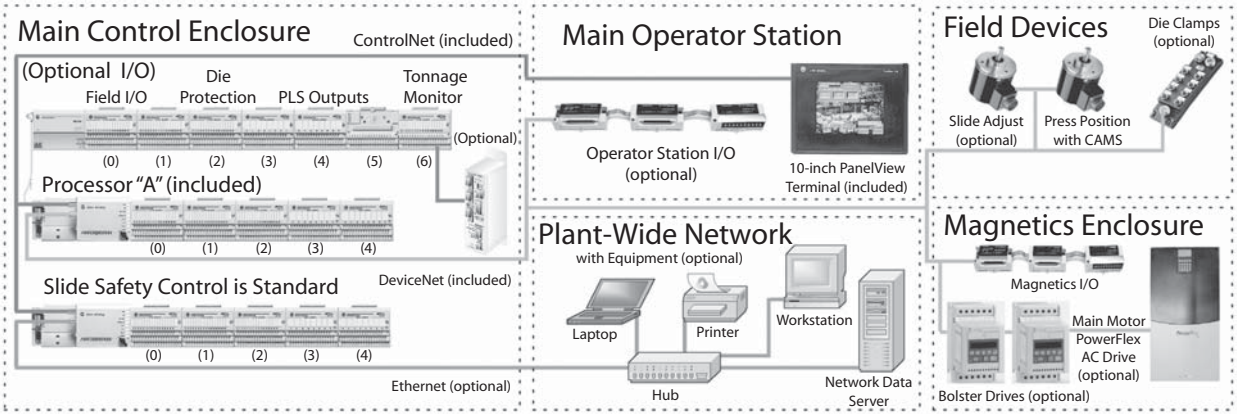
Results

A StamPro System will help provide:

- Reduced downtime through comprehensive operator diagnostic messages, on-line control system troubleshooting and replaceable modular components available worldwide.
- Increased flexibility through open integration of press control functions and industry-standard connectivity to other equipment including coil feeds, computers, drives, robots and servo transfer feeds.
- Improved quality through recipe-based control of process parameters such as shut height, counterbalance air pressure, motor speed, die protection and programmable limit switch.
- Reduced costs through the use of standard Rockwell Automation industrial control hardware, field-proven application software, and a comprehensive documentation package.

Ordering Information

- Contact your local Rockwell Automation Sales office or Allen-Bradley distributor.
- Email inquiries to: metalforming@ra.rockwell.com
- FAX inquiries to: 440-646-4843
  Attention: Metalforming Group



Notes

Visit our website: www.ab.com/catalogs
Publication S117-CA001A-EN-P

Other Safety Related Products

Explosion Proof

Ex Range 9-2

Intrinsically Safe Galvanic Isolators

Overview 9-4
Isolators 9-5
Accessories 9-7

Pneumatic

Lifeline™ 4 and Rotacam™ 9-10

Ex Range



Description

The Guardmaster Ex Range of safety switches are specifically designed for potentially explosive atmospheres. They retain the safety features and operating principles of the conventional Guardmaster switches. They incorporate a sealed flameproof contact block, making them suitable for use in European Zone 1 and Zone 2 environments. In the US and Canada, these products can be used in areas classified as Class 1, Division 2 in Groups A (acetylene), B (hydrogen), C (ethylene) and D (propane). All the Guardmaster Ex switches conform to the exacting standards required by the European harmonized standards. The contact block in these switches has the following approvals: 112G EExd IIC T6 or T5 and 11 2D T80°C IP66.

EEx equipment conforms to types of protection standardised by CENELEC (European standards), EN50014 and EN50018 respectively and BS5501 parts 1-V.

The d suffix indicates that the contact block in the switch is a flameproof enclosure and is designed to ensure that if an internal explosion occurs it will be contained with the enclosure. The designation II indicates use in surface industries and c refers to the group of gases for which the switches are suitable. The designation T represents the surface temperature classification of the switch. These switches have been tested with an ambient temperature of 60°C as opposed to the normal test limit of only 40°C, allowing them to be used in gases having a low flash point.

It should be noted that these groups refer to the explosion-proof qualities of the switches and not corrosion-resistance characteristics. Special precautions may be required to protect the vulnerable parts such as PVC-covered cables against attack by certain corrosive elements and physical damage.

Features

- For use in potentially explosive atmospheres
- Positive mode action, flameproof contact block
- Suitable for use in European Zone 1 and 2 environments
- US and Canada: Class 1, Division 2 in Groups A, B, C and D

Specifications

All switches excluding Ferrogard GS2	
Contact Block Electrical Specifications	
Certifications	112G EExd 11C T6 or T5 112D T80°C IP 66 under ATEX
Safety Contacts	1 N.C. & 1 N.O. or 2 N.C.
Enclosure Protection	IP66
Rated Voltage	250V AC and 250V DC
Rated Current	5 A AC and 0.25 A DC
AC Ratings, Resistive	6 A @ 250V, 6 A @ 125V
AC Ratings, Inductive	2.5 A @ 250V, 3 A @ 125V
DC Ratings, Resistive	0.25 A @ 250V, 0.5 A @ 125V, 1 A @ 75V, 7 A @ 30V
DC Ratings, Inductive	0.1 A @ 250V, 0.2 A @ 125V, 1 A @ 75V, 5 A @ 30V
Contact Block Technical Specifications	
Operating Force	1.6 N - 0.4/ - 0.2 N
Release Force	0.4 N
Pre-travel	0.8 mm (0.03 in.)
Over Travel	0.6 mm (0.02 in.)
Return Travel	1.1 mm (0.04 in.)
Differential Travel	0.5 mm (0.19 in.)
Release Travel	0.2 mm (0.007 in.)
Positive Break Travel	0.4 mm (0.01 in.)
Repeatability	+0.01 mm (0.0003 in.)
Switching Speed, Min.	1 mm (0.039 in.)
Switching Frequency, Max.	3000 operations/hour
Mechanical Life	2,000,000 operations
Electrical Life	Dependent on loading
Operating Temperature [C (F)]	-25…70° (-10…284°)
Electrical Connection	Potted in leads. Flexible 4 x 0.75 mm^2, 2 m long
Ferrogard GS2	
Certifications	EExd IIC T6 Baseefa. Not suitable for Group 1 gases
Safety Contacts	1 N.C.
Enclosure Protection	IP67 (NEMA 6P)
Rated Voltage	250V AC
Rated Current	2 A
Rated VA	100V A max @ 50V 200V A max @ 110V 500V A max @ 250V
Operating Distance, Make [mm (in.)]	15 (0.59)
Operating Distance, Break [mm (in.)]	26 (1.02)
Closing Time	3.0 ms
Drop-Out Time	2.1 ms
Bounce Time	0.7 ms
Shock	<50 g
Vibration	15 g, 20…1000 Hz
Contact Resistance, Initial	0.07 Ω (excluding cable)
Mechanical Life	100,000,000 operations
Electrical Life	5,000,000 operations
Operating Temperature [C (F)]	-10…40° (14…104°)
Housing Material	Brass or Stainless Steel
Cable Length	3 m (9.8 ft), 5 m (32.8 ft), or 10 m (32.8 ft)
Cable Type	Termorad

Product Selection

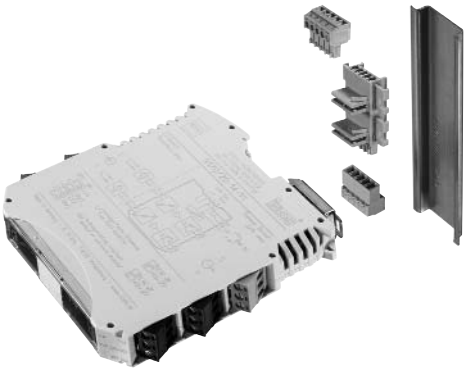
Switch	Description	Type	Safety Contacts	Cable Length	Cat. No.
	Ex Trojan 5. Explosion proof tongue operated safety interlock switch.	Trojan 5-EX	2 N.C.	2 m (6.5 ft)	440K-H11145
				6 m (19.7 ft)	440K-H11160
				15 m (39.2 ft)	440K-H11161
	Ex Ferrogard GS2. Explosion proof magnetically actuated, noncontact safety interlock switches.	GS2-Ex (stainless steel)	1 N.C.	3 m (9.8 ft)	440N-H02047
		Ferrogard GS2-EX (stainless steel)		10 m (32.8 ft)	440N-H02087
	Ex Lifeline 4. Explosion proof, cable and push button actuated Emergency Stop switch.	Lifeline 4-EX	1 N.C. & 1 N.O.	2 m (6.5 ft)	440E-H13046
			2 N.C.		440E-H13069
	Ex Rotacam. Explosion proof, hinge actuated safety interlock switch.	Rotocam-HS-2-EX	1 N.C. & 1 N.O.		440H-H03077

Intrinsically Safe Galvanic Isolators

Overview



Intrinsically Safe Galvanic Isolators



Accessories

Description

For applications involving sensor use in hazardous locations, Rockwell Automation offers a line of Intrinsic Galvanic Isolators, which offer economical solutions for instrumentation and control systems in hazardous locations as defined by NEC article 500 and CEC Part I, Section 18.

Intrinsically Safe or Galvanic Isolators are active protective interface assemblies that limit the amount of energy allowed to enter a hazardous area under fault conditions. Sometimes called Transformer Isolated Barriers, they separate intrinsically safe wiring from non–intrinsically safe wiring through the use of the same isolation coils found in power transformers as defined in FM Class No. 3610 and CSA 22.2 No. 157.

Galvanic isolators, unlike zener diode barriers, do not require grounding—therefore they may reduce ground loop problems as well as installation and maintenance costs. The solid state output version isolators can be located in a Division 2 area. The slim ¾ inch wide housing on DC models also conserves valuable mounting space, while providing 1500 Volt isolation between hazardous area and nonhazardous area terminals and 500 Volt isolation between input/output and external power terminals. DIP switches provide convenient programming of output and diagnostic functions while multiple LEDs provide visual indication of module and circuit status.

Rockwell Automation's zener diode barriers and galvanic isolators are DIN-rail mountable and designed primarily for use with intrinsically safe proximity sensors and photoelectrics. All of Rockwell Automation's barriers and isolators are FM and CENELEC approved, CSA certified and CE marked for all applicable directives.

Intrinsically Safe Galvanic Isolators



Features

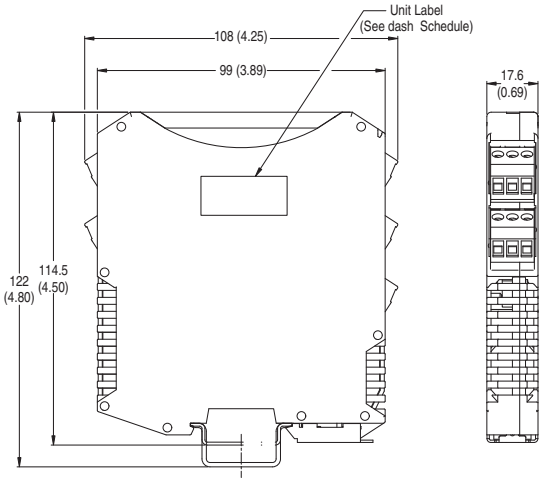
- DIN rail mounting with power bus option
- Removable field connection terminals
- Single- and two-input versions
- Variety of output types
- Approvals to worldwide standards
- SIL 2 and 3 rated
- Intrinsically safe connections for Class I, II, III, Div 1; Groups A-G (EExIa), IIC/IIB

Specifications

Certifications	FM,CSA, UL, CENELEC (PTB) approved and CE marked for all applicable directives
Number of Inputs	2
Switching Current @ Voltage, Max.	8V @ 8.2 mA (to EN 60947-5-6 NAMUR)
Input Current	On > 2.1 mA; Off < 1.2 mA
Input Resistance	1000 Ω
Switching Frequency (Hz)	< 15 Hz
Switch Delay	On to Off: 15 ms; Off to On: 15 ms
Status Indicators	Green = Power; Yellow = Output Closed; Red = Wire Break/Short
Operating Temperature [C (F)]	-20…+65° (-4…+149°)
Relative Humidity	<95% RH
Housing Material	Polyamide 6GF
Enclosure Type Rating	IP 30
Mounting	35 mm DIN rail
Conductor Size, Max.	0.2…2.5 mm² (24-14 AWG)
Weight [g (lbs)]	160 (0.35)

Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.



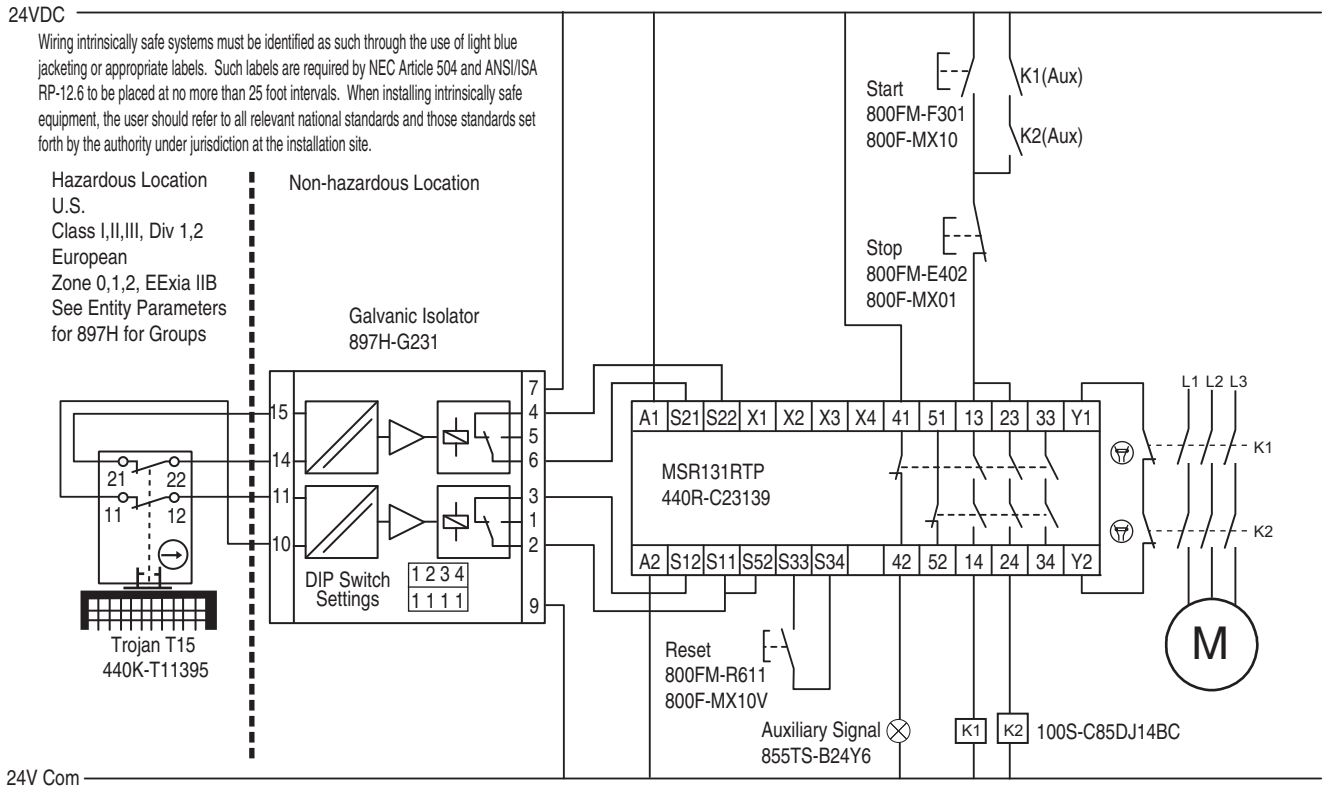
Product Selection

Power Supply	Input Type	Output Type/ Output Rating/ Response Time	Classifi-cation	FM Entity Parameters					ATEC Certified Stahl Cat. No.	Cat. No.
				Voltage, Max.	Current, Max.	Power, Max.	Max. Permiss. External Capacity	Max. Permiss. External Inductance		
120…230V AC	(2) NAMUR Sensors or Dry-Contacts	SPDT Relay/ 250V AC @ 4 A/ 10 ms	A, B, E	10.6V	24 mA	64 mW	2.32 µF	63 mH	9170/20-12-21s	897H-G232
			D, F, G				16.2 µF	230 mH		
24V DC		SPDT Relay/ 250V AC @ 4 A/ 10 ms	A, B, E				2.32 µF	63 mH	9170/20-12-11s	897H-G231
			D, F, G				16.2 µF	230 mH		
24V DC		Transistor, Open Collector/ 35V DC @ 50 mA/ 30 µs	A, B, E				2.32 µF	63 mH	9170/20-14-11s	897H-G211
			D, F, G				16.2 µF	230 mH		

Note: Safety parameters stated above are per input.

Intrinsically Safe Galvanic Isolators

Safeguarding Applications



Circuit Status

Circuit shown with the safety gate closed. The motor is ready for starting.

Operating Principle

The galvanic isolator limits energy to the interlock switch, which is considered a simple apparatus in the hazardous location. The MSR131RTP safety relay checks the outputs of the galvanic isolator upon power-up and each time the gate/e-stop is actuated. The Minotaur safety relay also monitors the status of the safety contactors (or safety control relays).

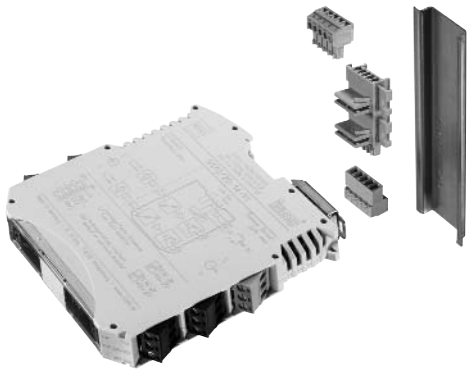
STARTING: Press and release the Reset button to energize the safety outputs (13/14 and 23/24) of the MSR131RTP. Press the Start button to start the motor.
STOPPING: Opening the safety gate or pressing the stop button will stop the motor. If the gate is opened, the gate must be reclosed and the reset button then pressed to energize the outputs of the MSR131RTP.

Fault Detection

The DIP switch setting of the galvanic isolator allows for open and short circuit detection of the tongue interlock switch, as well as opening the gate. The tongue interlock switch should be wired to both inputs (terminals 7 and 8) of the galvanic isolator to drive both outputs (1/5 and 2/3) of the galvanic isolator. A single fault will not cause a loss of safety function. If one output of the galvanic isolator fails in the closed state, the Minotaur safety relay will detect opening of the 2nd output and turn the motor off. The motor will remain off until the fault is corrected or power is cycled. If either contactor K1 or K2 sticks ON - the motor will stop on command due to the other contactor, but the Minotaur safety relay cannot be reset (thus the fault is revealed to the operator). The manual Reset button will prevent the motor from starting in the event of a shorted Start switch.
A single fault detected on the Minotaur safety input circuits will result in the lock-out of the system to a safe state (OFF) at the next operation of the safety gate or e-stop device.

Ratings

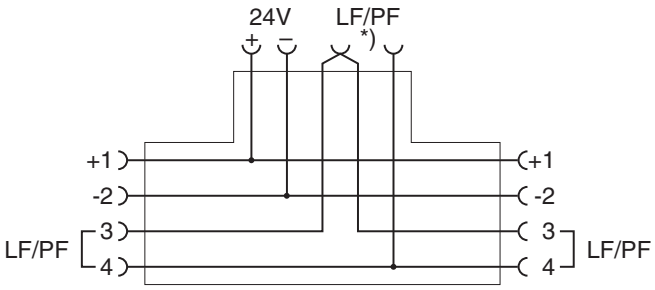
This circuit meets the safety performance requirements of Category 3 of EN954-1:1996. This circuit executes a Category 0 stop.



Description

Rockwell Automation Galvanic Isolators can be daisy chained together via power bus connectors. The snap-on connectors save time and simplify wiring for power distribution and error identification on a series of modules. Each end on a string of bussed isolators is terminated with a screw terminal connector. The line fault and power supply failure line are bridged on these connectors to close the current.

Typical Wiring Diagrams



Approximate Dimensions [mm (in.)]

Dimensions are not intended to be used for installation purposes.

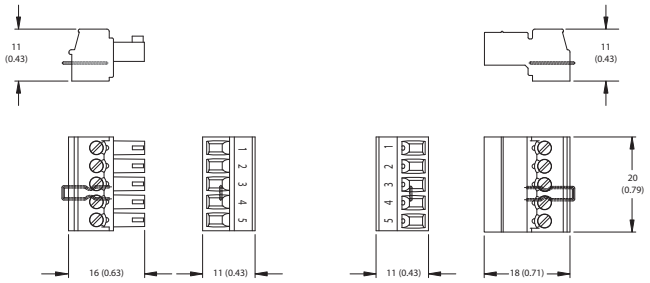


Figure 1: Power Bus Screw Terminal Connector

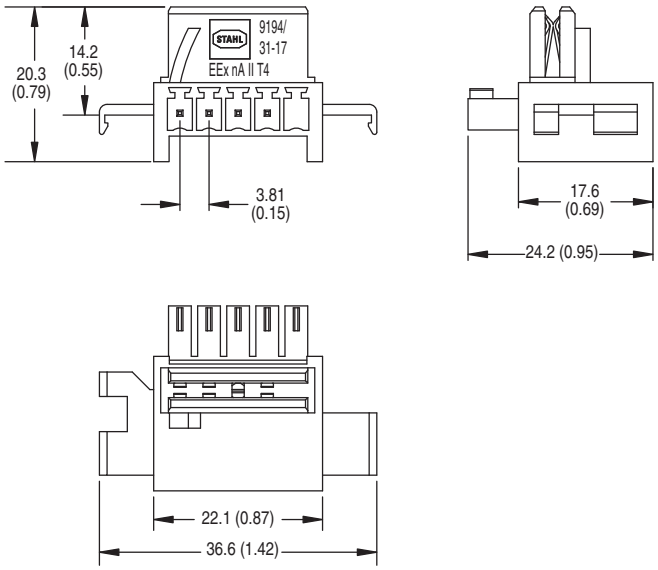


Figure 2: Power Bus T-Connector

Product Selection

Description	Approximate Dimensions [mm (in.)]	Cat. No.
Power Bus Screw Terminal Connector	See Figure 1	897H-GDRCT
Power Bus T-Connector	See Figure 2	897H-GDRC

Accessories

Intrinsically Safe Wiring Labels/DIN Mounting Rail

Intrinsically Safe Wiring Labels

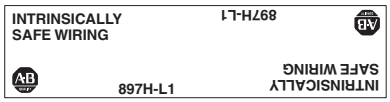


Figure 1



Figure 2

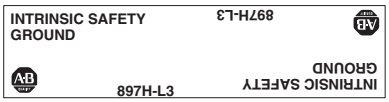


Figure 3

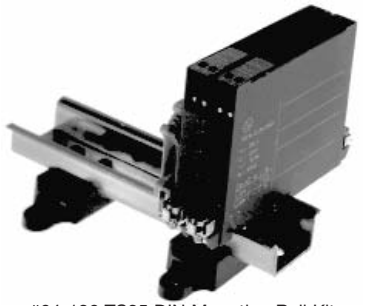
Description

It is recommended that wiring for intrinsically safe systems be identified as such through the use of light blue jacketing and/or through appropriate labels. Such labels are required by NEC Article 504 and ANSI/ISA RP–12.6 to be placed at no more than 25 foot intervals. When installing intrinsically safe equipment the user should refer to all relevant national standards and/or those standards set forth by the "authority having jurisdiction" at the installation site.

Product Selection

Pkg. Quantity	Description	Figure	Cat. No.
25	Intrinsically Safe Wiring	Figure 1	897H-L1-25
100	Intrinsically Safe Wiring		897H-L1-100
25	Intrinsically Safe Wiring	Figure 2	897H-L2-25
100	Intrinsically Safe Wiring		897H-L2-100
25	Intrinsically Safe Wiring	Figure 3	897H-L3-25

DIN Mounting Rail



#64-136 TS35 DIN Mounting Rail Kit
(Barriers not included)



#64-134 TS35 DIN Mounting Rail

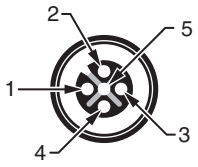
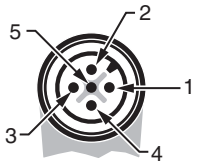
Description

DIN rail provides convenient and simple mounting of barriers, isolators, and other control equipment. DIN rail is available from Rockwell Automation/Allen-Bradley in one meter sections (Cat. No. **64-134**) or as part of a mounting kit (Cat. No. **64-136**). By isolating the DIN rail from the mounting surface, the mounting kit allows 897H- series shunt diode barriers to be grounded directly to the rail.

Product Selection

Description	Cat. No.
1 m (3.3 in) prepunched zinc-jplated and chromated steel mounting rail per EN 50022/DIN 46277 (TS35)	64-134
DIN Rail Mounting Kit includes 12 inch DIN rail, two insulated standoffs, and two grounding terminals	64-136

Pinout and Color Code

	Face View Pinout	
	4-Pin	
		
	Female	Male
Color Code	1 Brown 2 White 3 Blue 4 Black 5 NA	

Description

As defined in the National Electric Code (NEC), intrinsically safe wiring must be identified by color coding with light blue jacketed cable or by labeling at regular 25 foot or less intervals. When installing intrinsically safe equipment, the user should refer to all relevant national standards and/or those standards set forth by the "authority having jurisdiction" at the installation site. Rockwell Automation cordsets and patchcords with blue PVC jacketing provide a cost effective solution for easy identification of intrinsically safe wiring. Unlike tags, that may fall off or become unreadable, this rugged cable maintains its visibility, even in harsh environments. No labor time is required for labeling the cable while it is being installed or during maintenance.

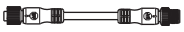
Product Selection

Cordsets



Pin Count	Color Code	Jacket Color	Wire Gauge	Cat. No.			
				Straight Female	Right Angle Female	Straight Male	Right Angle Male
4-Pin	A	Blue	22 AWG	889D-F4LC-∗	889D-R4LC-∗	889D-M4LC-∗	889D-E4LC-∗

Patchcords



Pin Count	Color Code	Jacket Color	Wire Gauge	Cat. No.			
				Straight Female Straight Male	Straight Female Right Angle Male	Right Angle Female Straight Male	Right Angle Female Right Angle Male
4-Pin	A	Blue	22 AWG	889D-F4LCDM-❄	889D-F4LCDE-❄	889D-R4LCDM-❄	889D-R4LCDE-❄

∗ Replace symbol with 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.
❄ Replace symbol with 0M3 (1 ft), 1 (1 m), 2 (2 m), 5 (5 m) or 10 (10 m) for standard cable lengths.

Note: See DC Micro Style Cordsets and Patchcords on page 7-12 for complete specifications.

Lifeline 4 and Rotacam



Description

Pneumatic Rotacam

Based on the highly successful conventional Rotacam, the Pneumatic Rotacam has the same design features except that it gives positive acting isolation of a machine's compressed air supply instead of an electrical power source.

The switch is mounted at the hinge point of the guard door. The bored stainless steel operating shaft is mounted in a sealed bearing which is so robust that it enables the switch itself to be used as the hinge pin if necessary.

The pneumatic valve specifications are shown below. The external switch dimensions and operating shaft specifications are the same as the conventional Rotacam.

Note: The Pneumatic Rotacam does not have the adjustable cam used with the standard Rotacam.

Pneumatic Lifeline 4

Based on the conventional Lifeline 4 this rope operated pneumatic safety switch can be used for guarding exposed pneumatic machinery and conveyor equipment.

The Pneumatic Lifeline 4 is immune to machine vibration thus overcoming the problem of nuisance tripping.

The pneumatic valve specifications are shown below. The external switch dimensions are the same as the conventional Lifeline 4.

Features

Pneumatic Rotacam

- Can be used as a hinge pin with light and medium weight guard doors on pneumatic machinery
- Isolates pneumatic power within 5° of guard movement

Pneumatic Lifeline 4

- Switches pneumatic power with up to 75 meter span
- Lid mounted emergency stop button, designed to EN418
- Switch lockout with indication of rope pulled and rope slack

Specifications

Standards Pnuematic Rotacam	IEC 60947-5-1, ISO 14119, ISOTR 12100
Standards Pneumatic Lifeline 4	IEC 60204-1, IEC 60947-5-1, ISO 14119, ISOTR 12100, IEC 60204-1, ISO 13850
Pneumatic Fluid	Compressed air or neutral gas
Pressure Range	2…8 bars
Passage Diameter	2.7 mm
Connection Type	Push in fittings for standard 4 mm Ø nylon tube, internal Ø 2.5 mm
Flow Rate	138 NL/min. (ie., number of liters of air at normal atmospheric pressure obtained with the output open to atmosphere and the supply pressure at 4 bars).
Mechanical Life	1,000,000 operations
Operating Temperature [C (F)]	10…60° (50…140°)

Note: For other specifications and dimensions see relevant specifications of standard product.

Product Selection

Type	Cat. No.
Rotacam	440H-P03035
Lifeline 4	440E-P13045

Note: See standard Lifeline 4 for installation kits, etc.

Safeguarding Applications and Wiring Diagrams

Application Selection Table 10-2

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Safeguarding Applications and Wiring Diagrams 10-5

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Configurable Relay—Single Zone . . . 10-17
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Application Selection

Page No.	SIL CL	PL	Cat.*	Stop Cat.	Light Curtain Guard-Shield	Mat	Laser Scanner	Tongue Switch	Non-Contact	Guard Locking	E-Stop 800F	Cable Pull Lifeline
					Input Device							
5	3	e	4	0	•						•	
6	2	d	3	0							•	•
7	2	d	4	0				Trojan 5	SensaGuard			
8	2	d	3	0	•							
9	3	e	4	0	•	•			Sipha		•	
10	2	d	3	0				Elf Trojan 15			•	
11	3	e	4	0	•	•			Sipha		•	
12	2	d	3	0				MT-GD2				
13	3	e	3/4	0/1						TLS-GD2	•	
14	3	e	4	0	•						•	
15	2	d	3	0				Cadet 3 Trojan 5 MT-GD2				
16	2	d	3	0				Trojan 5				
17	2	d	3	1							•	
18	2	d	3	0				Trojan 15				
19	3	e	3/4	0							•	
20	3	e	3/4	1							•	
21	3	e	4	0							•	
22	3	e	4	0	•		•		SensaGuard	440G-MT	•	
23	3	e	3/4	0/1	•		•		SensaGuard	440G-MT	•	
24	3	e	3/4	0/1	•	•			SensaGuard	440G-MT	•	
25	3	e	3/4	0/1	•		•		SensaGuard	440G-MT	•	
26	3	e	4	0/1	•					440G-MT		
27	3	e	4	0							•	
28	3	e	4	1								
29	2	d	3	1						TLS3-GD2	•	
30	2	d	3	0	•							
31	3	e	4	0	•							
32	3	e	4	0	•							
33	3	e	4	0								
34	3	e	4	0	•					TLS3-GD2		
35	3	e	4	1							•	
36	3	e	4	0/1							•	
37	2	d	3	1		•						
38	3	e	4	0	•							
39	3	e	4	0	•							
40	3	e	4	0	•							

* These ratings are general guidelines that would likely apply in most instances. Safety performance ratings are applied to safety functions. The safety rating must be applied from an input device through a logic device to an output device. Many of the application examples contain multiple devices and may have mulitple safety functions. Therefore, a detailed analysis of the application and complete implementation of the standard is required and may result in ratings that differ from the guidelines provided.

Enabling Device										Drive	Motion	
Grip Switch	Standard PLC	100 Series	Specialty	200 Series	300 Series	GuardPLC	SmartGuard	Guard I/O	Contactors	Drive-Guard	Guard-Motion	
Input Device		Logic							Output Devices			Page No.
		MSR127							100S			5
		MSR127							100S			6
	•	MSR127							100S			7
		MSR126	MSR35H						100S			8
				•					700S			9
	•	MSR127							100S			10
					•				100S-700S			11
•		MSR127	MSR178							•		12
		MSR138							700S			13
					•				100S			14
		MSR127								•		15
	•	MSR127			•					•		16
								CompactBlock		•		17
		MSR126							Flex I/O			18
		MSR138							100S		•	19
		MSR138									•	20
								CompactBlock	100S		•	21
						1600			100S			22
						1800			100S-700S			23
							•		100S			24
								CompactBlock	100S-700S			25
								CompactBlock	100S-700S			26
		MSR142							Valve			27
•		MSR138	MSR178						100S			28
•			MSR57							•		29
				MSR211					100S			30
			MSR22LM						100S			31
									100S			32
					•				100S			33
		MSR138							100S			34
		MSR144							100S-700S			35
		MSR210		MSR230/ MSR238					100S			36
			Mat Manager						100S			37
			MSR41						100S			38
			MSR42						100S			39
			MSR42						100S			40

Notes for Use with Application Circuit Examples

Note 1

In the following circuits the type of Allen-Bradley/Guardmaster device is shown as an example to illustrate the circuit principle. For specific applications the choice of device type should be based on the suitability of its characteristics for its intended use.

Note 2

In most of the following examples showing dual channel applications, one interlock switch is shown switching both channels (one contact set per channel). If it is foreseeable that damage to the guard (e.g., at the actuator mounting point) could allow it to be opened without operating the switch then two separate switches may be required. The electrical principle of the circuit will remain the same.

Note 3

In most cases the circuits are shown with the guard door closed and ready for motor starting by operating the normal start control.

It must be possible to start the machine only by voluntary actuation of the control provided for the purpose (see ISO 12100-2 4.11.8). For the purposes of these examples the use of a conventional contactor latching circuit has been assumed. If this is not the case, then a restart interlock will be required to prevent an automatic or unintended starting of the motor when the guard is closed. For example, a Minotaur safety relay with a momentary action push button installed in the output monitoring circuit can be used to achieve this.

If the guard is designated as a Control Guard (see ISO 12100-2 5.3.2.5) these requirements do not apply but the use of control guards is only allowed under certain conditions including:

- A control guard can only be used where there is no possibility of an operator or part of his body staying in or reaching into the danger zone whilst the guard is closed.
- The control guard must be the only access to the hazard area.
- The interlocking system must have the highest possible reliability. It is often advisable to use a solenoid locking switch such as the Guardmaster Atlas or TLS-GD2.

Note 4

Safety monitoring relay units used in dual channel circuits with infrequent operation or with more than one switching device connected. This note applies to all monitoring devices which use the technique of comparing the signal at the change of state of dual channels.

Certain faults are only detected at a change of state of the input switching device (interlock switch or E-Stop switch). If there are long periods (e.g. months as opposed to days) between switching actions, it may be possible for multiple faults to accumulate which could lead to a dangerous situation. Therefore a regular check should be performed on the system in order to detect single faults before an accumulation occurs. This check may be manual or initiated by part of the machines control system.

If, for example, 3 interlock switches are connected to the monitoring unit, certain faults will only be detected at the switch on the first guard to be opened and the switch on the last guard to be closed. This is because any switching between the first opening/last closing will not change the state of the monitoring unit input circuits. Therefore in some applications it may be necessary to use one monitoring device per switch.

Most of the following examples show an interlock switch and an emergency stop switch combined in the circuit. When a monitoring safety relay (e.g. Guardmaster Minotaur) is used for fault detection it is important to note the following:

- All safety critical single faults, except for certain faults over the contact sets at the E-Stop, will be detected at the next opening of the guard.
- All safety critical single faults, except for certain faults over the contact sets at the interlock switch, will be detected at the next operation of the E-Stop.
- Because the E-Stop device is not likely to be operated frequently, it is recommended that its function is checked (with the guard closed) on a regular basis (start of shift or daily) to enable the Minotaur to detect single faults. If the guard is rarely opened, the interlock switch should be checked in a similar manner.

Note 5

This symbol indicates that the associated component or device features direct opening (positive opening) operation. In the event of a fault, welded contacts will be forced open by the motion of the safety guard.

This symbol denotes mechanically linked contacts; if one contact welds closed, all other dependent (auxiliary) contacts remain in position, i.e. they cannot change state.

General Safety Information

IMPORTANT This application example is for advanced users and assumes that you are trained and experienced in safety system requirements. Contact Rockwell Automation to find out more about our safety risk assessment services.

ATTENTION

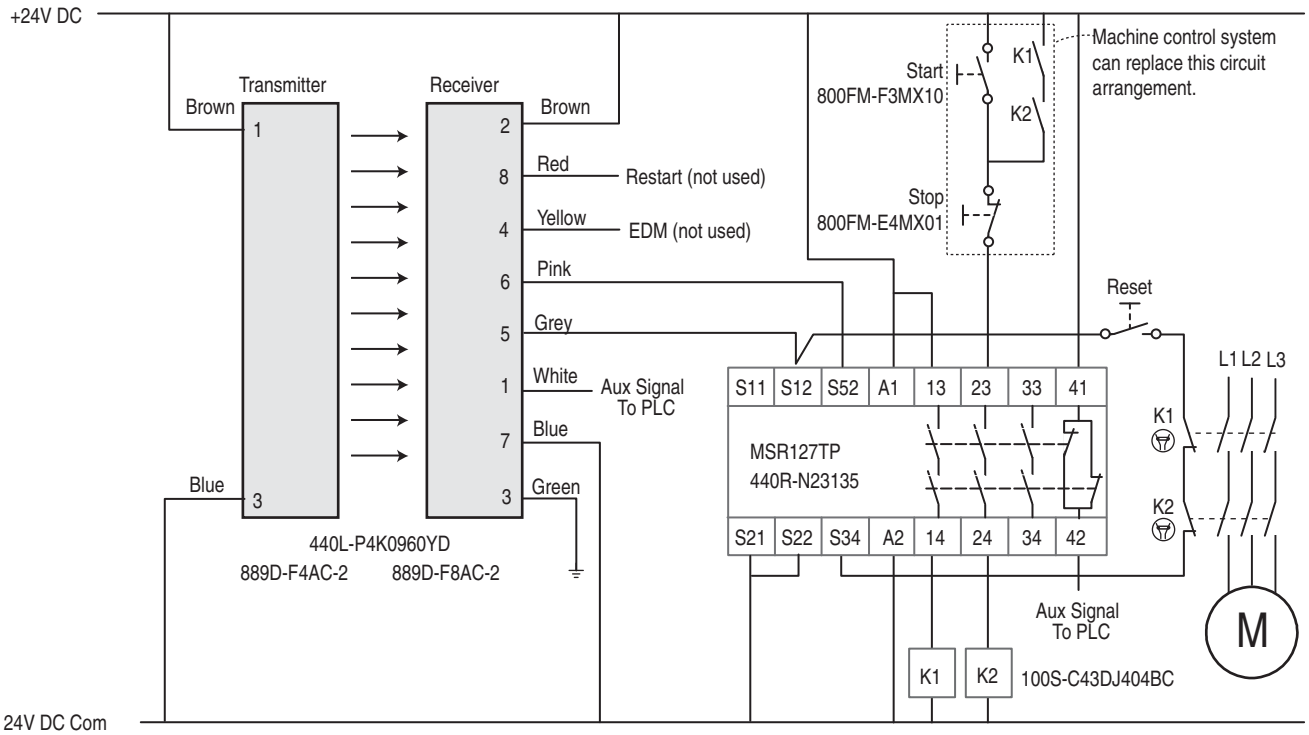


A risk assessment should be performed to make sure all tasks and hazard combinations have been identified and addressed. The risk assessment may require additional circuitry to reduce the risk to a tolerable level. Safety circuits must take into consideration safety distance calculations which are not part of the scope of this document.

For other Important User Information and Safety Guidelines, please review pages G-2 and G-3 in the General section of this catalog.

Light Curtain—Point of Operation Control

GuardShield, 800F, MSR127, 100S



Circuit Status

The light curtain is configured with the factory default settings (Guard only mode) and is unobstructed. The outputs of the safety relay are open. The motor is off and ready to run.

Operating Principle

STARTING: Press the Reset button to close the outputs of the MSR127. Press the Start button to energize contactors K1 and K2. The motor starts with the two normally open contacts of K1 and K2 holding the circuit energized.
STOPPING: Obstructing the light curtain de-energizes the safety outputs of the MSR127, which in turn drops out K1 and K2. The contactors disconnect the motor from its power source, and the motor coasts to a stop. Clearing the obstruction in the light curtain does not cause the motor to energize (the Reset and Start buttons must be pressed). The motor can also be turned off by pressing the stop button.

Fault Detection

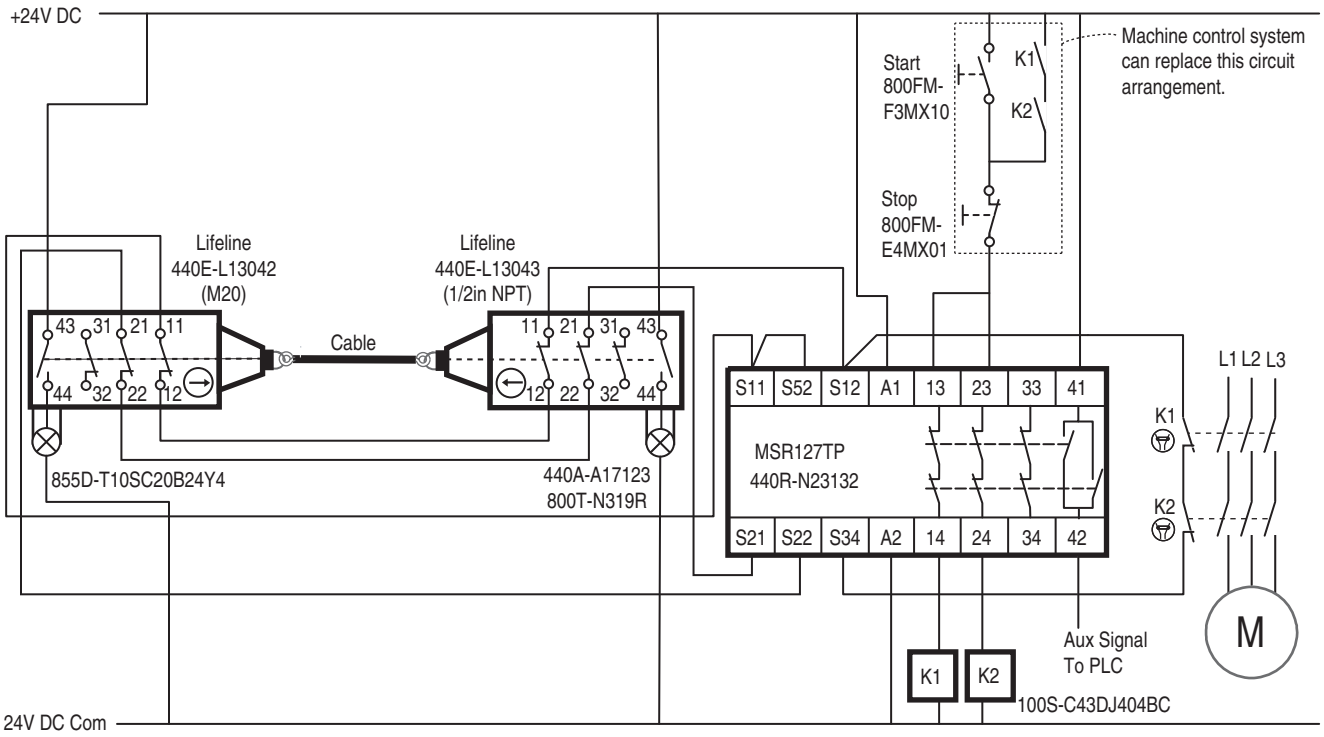
Upon successful completion of internal checks on power up, the GuardShield light curtain energizes its outputs with no objects present. The GuardShield light curtain outputs turn on. If a crossfault is detected, the GuardShield light curtain goes to a lockout state with its outputs off. After successful completion of internal checks, the MSR127 checks the signals from the light curtain. If OK, the MSR127 then checks the status of the K1 and K2 contactors. If either K1 or K2 fails in the actuated state, the other contactor will disconnect the motor. The MSR127 will detect the faulted contactor and will not allow the motor to restart until the fault is corrected.
Contactors K1 and K2 are controlled by the safety system. Contactor K2 is controlled by both the machine control system and the safety system. This increases the probability of performance of the safety function because K1 is significantly less likely to weld at the same time as K2 due to the diversity of expected wear out times.

Ratings

The safety function intiated by the GuardShield light curtain meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Cable Pull

Lifeline, 800F, MSR127, 100S



Circuit Status

Both Lifeline cable pull switches are taut and reset; their contacts are closed. The MSR127 safety relay is energized, as its inputs and monitoring circuits are satisfied. The motor is off and ready to run.

Operating Principle

Two cable pull switches are used to protect an area over 10 meters in length. Auxiliary lights provide indication as to which switch has been actuated to stop the motor. The difference between the two switches is the conduit thread and is shown for example purposes.

STARTING: Press the Start button to energize contactors K1 and K2. The motor starts and the two normally open contacts of K1 and K2 close to hold the circuit energized across the Start button.

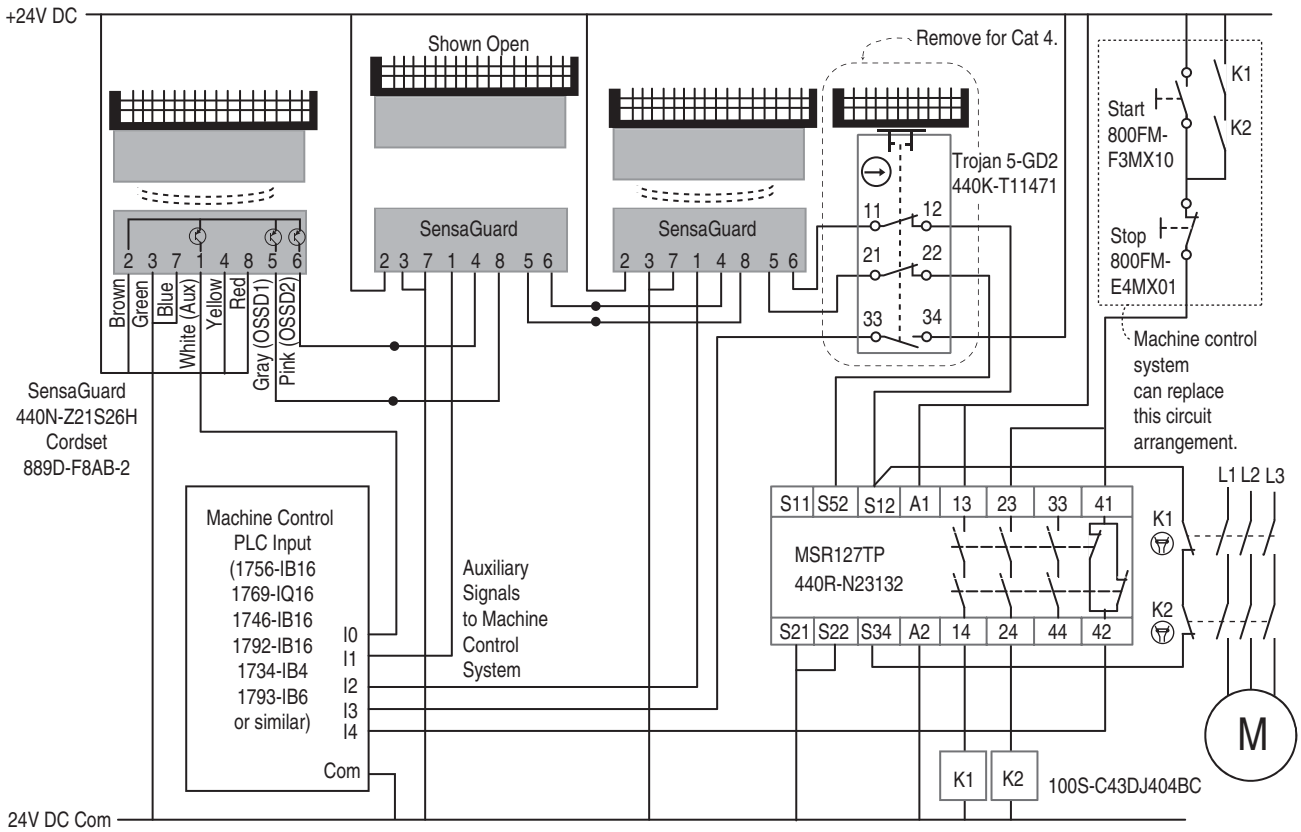
STOPPING: Pull the Lifeline cable or press the e-stop button on the Lifeline switch to de-energize the outputs of the MSR127 and turn off the motor. To restart the motor, make sure the area is clear of hazards, pull out the e-stop button (if pressed) and rotate the reset knob on the Lifeline 4 to the Run position. Then press the Start button to start the motor. As an alternative, the motor can be stopped by pressing the Stop pushbutton. It can then be restarted by pressing the Start pushbutton.

Fault Detection

Upon successful completion of internal checks on power up, the MSR127 checks its input circuits. With both Lifeline switches reset, the MSR127 checks the output contactors through the S12/S34 circuit. If the contactors are off, the MSR127 energizes its outputs and turns on the contactors which turn on the motor. A short or open circuit fault in the Lifeline cable pull switches will be detected by the MSR127. If either the K1 or K2 faults in the energized state, the motor will be stopped by the other contactor and the fault will be detected by the MSR127 on the next attempt to restart. An internal fault in the MSR127 will be detected by itself. Depending on the type of fault, the result will be de-energization of the K1 and K2 contactors or prevention of re-start.

Ratings

The safety function initiated by the Lifeline cable pull switches meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. The series connection of the Lifeline cable switches limits the circuit to SIL CL2 and Category 3. This circuit executes a Category 0 stop.



Circuit Status

The first, third and fourth gates are closed. The second gate is open. The MSR127 safety relay S12 and S52 inputs are open due to the open gate, and therefore, the MSR127 safety outputs are open. The machine control PLC has a 24V auxiliary signal at terminal I1 from the second gate because the gate is open. The 1st, 3rd and 4th auxiliary signals are off, as their gates are closed. The PLC also has an auxiliary signal from the MSR127 indicating that the safety system is not ready. The motor is off.

Operating Principle

STARTING: Closing the second gate satisfies the input of the MSR127. The MSR127 verifies that both K1 and K2 contactors are off and energizes its safety outputs. Pressing the start button energizes the motor. The Stop/Start circuit is not part of the safety system and can be replaced by the machine control system (e.g., a PLC).
STOPPING: Press the Stop button to turn the motor off, without affecting the status of the safety system. Opening any of the gates will cause the safety system to stop the motor.

Fault Detection

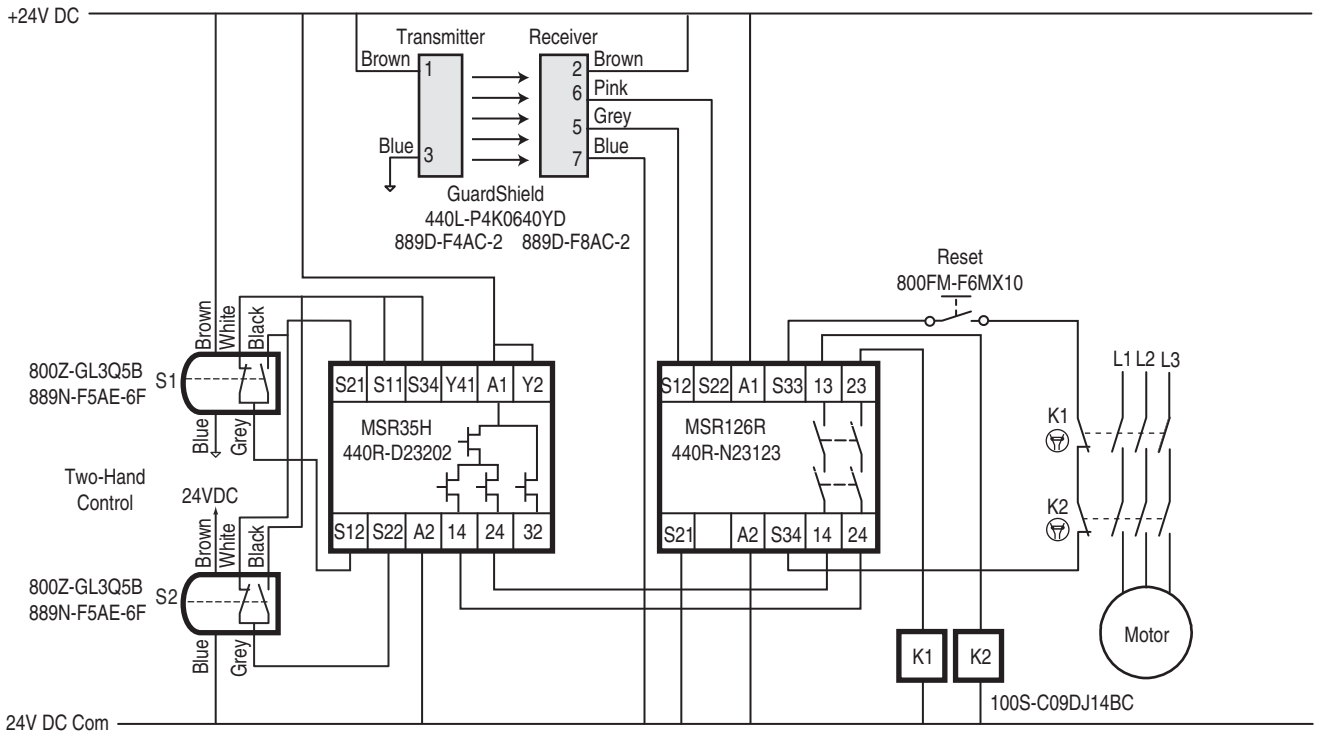
Upon successful completion of internal checks on power up, the SensaGuard interlocks check for 24V at pins 4 and 8. If the actuator is within range, the SensaGuard will activate its OSSD outputs. The OSSD outputs perform continuous checking for short circuits to 24V, ground and crossfaults. Upon detection of a fault, the OSSD outputs turn off. The MSR127 also performs internal checks on power-up. It then checks for input signals. If okay, the MSR127 checks the S12/S34 monitoring circuit to determine whether both contactors are off. If one of the contactors gets stuck on, the other contactor will de-energize the motor, and the MSR127 will detect the fault at the next attempt to start the motor. The contactors have mechanically linked auxiliary contacts to help ensure fault detection of the contactors. Contactors K1 and K2 are controlled by the safety system. Contactor K2 is controlled by both the machine control system and the safety system. This increases the probability of performance of the safety function because K1 is significantly less likely to weld at the same time as K2 due to the diversity of expected wear out times.

Ratings

The safety function initiated by the Lifeline cable pull switches meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. When a device with two mechanically operated contacts is connected in series with the SensaGuard, the maximum rating is Category 3. If the Trojan 5 GD2 were removed from the circuit, the safety performance meets the requirements of Category 4. The SensaGuard interlocks are designed to meet Category 4 when connected in series. The MSR127 is rated to Category 4. The design and connection of the contactors meets category 4. This example circuit performs a Stop Category 0 function (coast to stop).

Light Curtain & Two-Hand Control—Punch Press

GuardShield, 800Z, MSR35H, MSR126, 100S



Circuit Status

The operator's hands are not on the two 800Z palm buttons. The outputs of the MSR35H are off. The light curtain is configured with the factory default settings (Guard only mode) and is unobstructed. The outputs of the MSR126R safety relay are off. The motor is off and ready to run.
The light curtain is protecting one portion of the machine. An operator, using two-hand control is accessing a different portion of the machine and has full view of his or her area.

Operating Principle

STARTING: Press the Reset button to energize the output of the MSR126. The operator places both hands on the 800Z buttons simultaneously (within 0.5 s). The outputs of the MSR35H (terminals 14, 24) energize the 100S contactors, which start the motor.
STOPPING: Removing one or both hands from the 800Z palm buttons causes the outputs of the MSR35H to turn off, which drops out K1 and K2 and stops the motor. Obstructing the light curtain de-energizes the safety outputs of the MSR126R, which in turn drops out K1 and K2 and turns the motor off. Clearing the light curtain does not restart the motor, even if the operator has their hands on the palm buttons. The reset button must be pressed after the light curtain is cleared.

Fault Detection

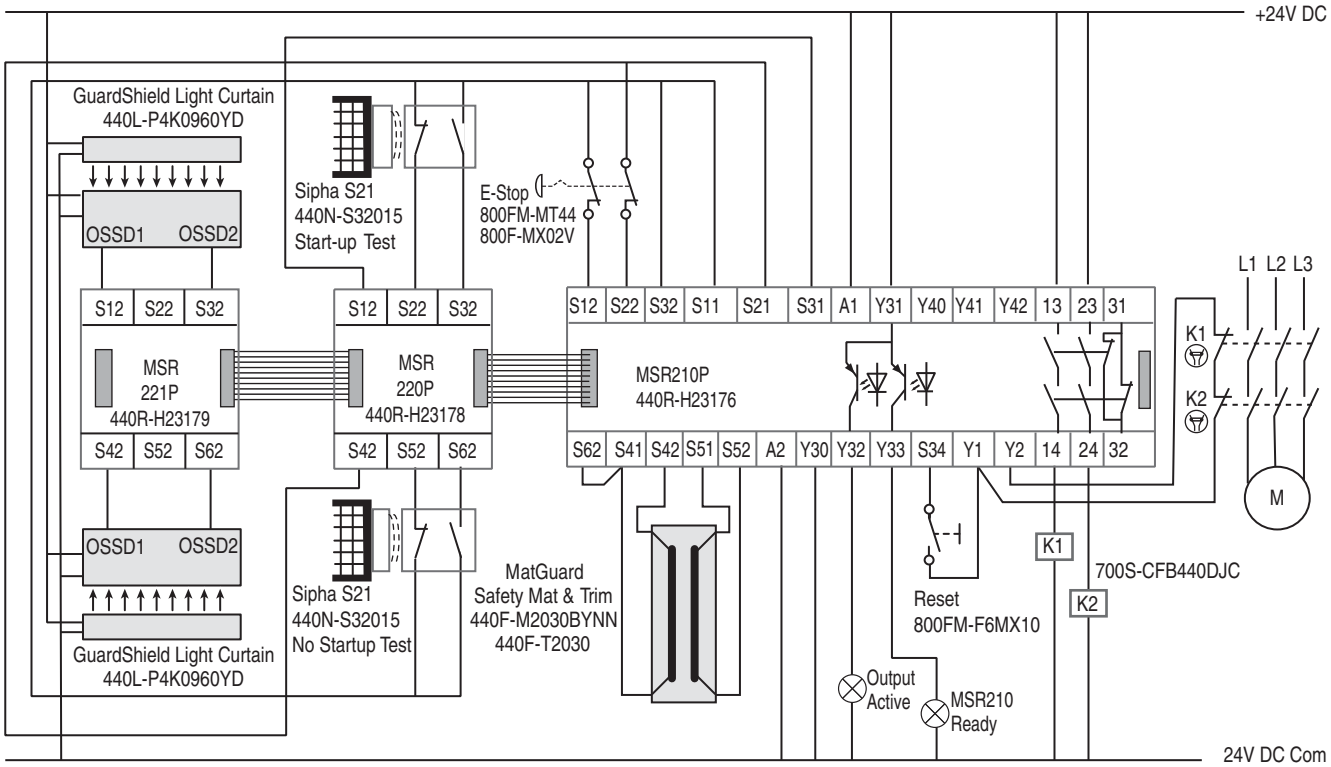
Upon power up, the 800Z, GuardShield, MSR35H and MSR126 perform internal checks. After passing internal checks, the MSR35H waits for a change of state of its inputs. Faults (opens and shorts) at the inputs will be detected by the MSR35H and prevent the outputs from being energized. The GuardShield light curtain also performs checks on its OSSD output signals for crossfaults, shorts and opens. The MSR126 looks for dual signals at its inputs. It then checks the status of the contactors. If one contactor fails in the actuated state, the other contactor will stop the motor. The MSR126 will detect if one of the contactors are stuck in the energized position, and prevents restart.

Ratings

The safety function initiated by the light curtain meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure, which can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. The safety function initiated by the 800Z palm buttons meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Configurable Relay—Two Zones

GuardShield, Sipha, MatGuard, 800F, MSR310P, MSR320P, 100S, 700S



Circuit Status

The light curtains are unobstructed. The safety gates are closed. The e-stop is reset and the safety mat is unoccupied. The MSR210 outputs are off. The motor is ready to run.

Operating Principle

The MSR200 is chosen as the safety relay for its modularity and ability to handle diverse devices, and to allow each device to be connected to individual inputs. The MSR200 has communication modules (not shown) to allow individual status information to be transmitted to the machine control system.
STARTING: Press the reset button to energize the outputs of the MSR210 and turn the motor on.
STOPPING: Activating any one of the safety devices (light curtain, e-stop, safety mat, or gate) de-energizes the MSR210 outputs and the motor coasts to a stop. If a safety device is activated, the motor cannot start.

Fault Detection

Upon successful completion of internal checks on power up, the MSR210P checks the input circuits. Shorts from the inputs to power, to ground or to other inputs will be detected immediately by the MSR210P and will prevent energization or will de-energize all of its outputs. If one of the 700S safety control relays (K1 or K2) fails in an actuated state, the motor will be able to stop by the 2nd relay (K2 or K1). This type of fault will be detected by the MSR210P on the next attempt to restart, and the MSR210P will not energize its outputs when the reset button is pressed. Upon power-up, one of the safety gates must be opened and closed to confirm proper operation.

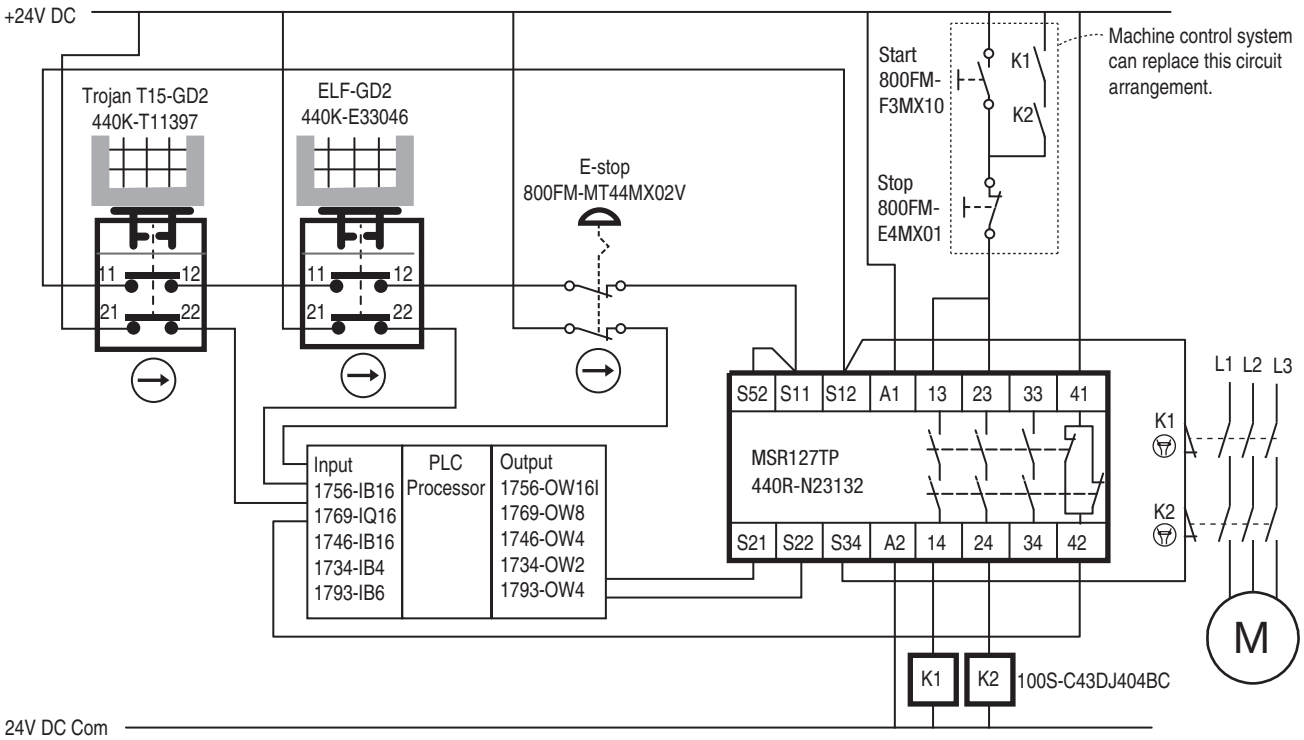
Since the noncontact sensor uses a N.O. contact, a broken wire may exist prior to usage. A startup test confirms the operation of the N.O. contact. For Start-up test, connect terminal S12 or S42 to terminal S31. If startup test is not desired, connect S12 or S42 to S21. With the start-up test, the gates must be opened and closed to confirm operation of both the N.O. and N.C. contacts. After successful completion of the start-up test, the reset button must be pressed momentarily to energize the outputs of the MSR210P.

Ratings

The safety functions initiated by the GuardShield light curtains, Sipha non-contact interlocks, and the 800F e-stop button meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. The safety functions initiated by the safety mat are limited to SIL CL 2 and Category 3, PLd. This example circuit performs a Stop Category 0 function (coast to stop).

Interlock Switches—Multiple Gate Access

Trojan T15, Elf-GD2, 800F, MSR127, 100S



Circuit Status

Circuit shown with the safety gates closed and e-stop released. The safety relay is de-energized. The motor is off.

Operating Principle

With 2 N.C. + 1 N.O. interlocks, a potential exists for the gate to be slightly open which results in the auxiliary contact being closed and the safety being open. The machine cannot start and the PLC does not know which gate is open. By sending the second safety channel through the PLC, the machine control system knows which door is open, when the safety system is off due to a gate that may be slightly open. The infinite simultaneity feature of safety relays like the MSR127 allow enough time for the PLC to process all the gates and close the second channel of the safety relay without creating a lockout condition.

When a safety gate is opened, the interlock opens Ch1 directly to the safety relay and opens Ch2 which is connected to the input of a PLC. The PLC must then open Ch2 of the safety relay. The logic in the PLC must open the Ch2 signal if any one or more of the safety gates are open and must only close the Ch2 circuit when all of the safety gates and e-stop are closed. The PLC can also use the information on the inputs on PanelView or similar device. The auxiliary signal (41/42) from the MSR127 must be an input to the PLC. This PLC program must only close its output when all the safety inputs are closed and the auxiliary signal from the MSR127 is closed. This allows the PLC to indirectly confirm that its own output is working properly.

STARTING: Channel 1 input (S11/S12) of the MSR127 is satisfied. Using isolated relay contacts in its output module, the PLC closes the second safety channel (21/22 of the MSR127). The safety outputs of the MSR127 close. Press the Start button to start the motor.
STOPPING: Opening any one of the safety gates or pressing the e-stop causes the motor to turn off. Closing the gate or releasing the e-stop does not cause the motor to start due to the start-stop interlocking circuit. To restart the motor, close the safety gate or release the e-stop. Then press the start button.

Fault Detection

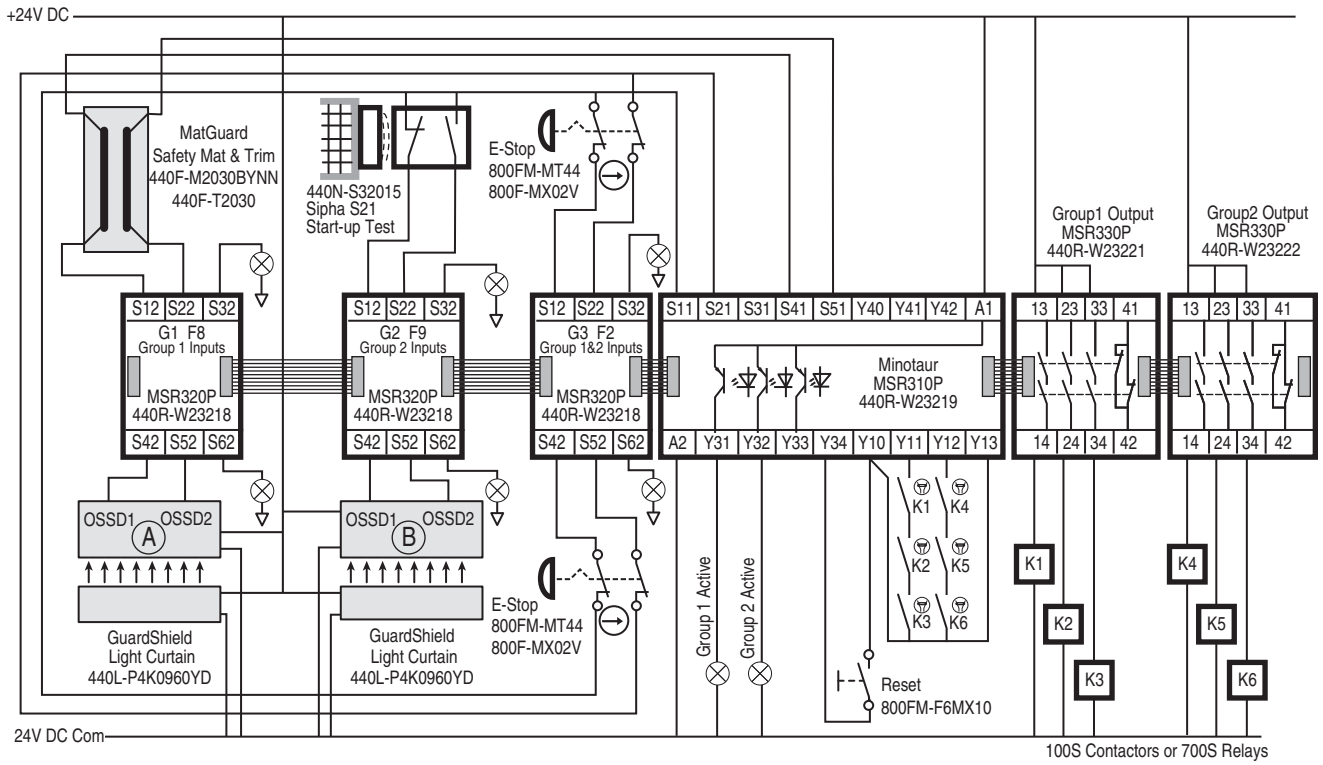
If the PLC fails with its output closed, the safety relay will detect the difference between the safety gate and the PLC and stop the motor. A single fault (open or short) across one of the interlocks will be detected by the safety relay and the motor will be turned off. The motor will remain off until the fault is corrected or power is cycled. If either contactor K1 or K2 sticks ON—the motor will stop on command due to the other contactor, but the MSR127 cannot be reset (thus the fault is revealed to the operator). A single fault detected on the MSR127 input circuits will result in the lock-out of the system to a safe state (OFF) at the next operation of the safety gate or e-stop device.

Ratings

The safety function initiated by the Trojan T15 safety gate interlocks and the 800F e-stop meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. This circuit executes a Category 0 stop.

Configurable Relay—Two Zones

GuardShield, Sipha, MatGuard, 800F, MSR310P, MSR320P, 100S, 700S



Circuit Status

The light curtains are unobstructed. The safety gate is closed. The e-stops are reset, and the safety mat is unoccupied. The MSR330P outputs are off. K1-K6 are ready to be energized.

Operating Principle

The MSR300 is chosen as the safety relay for its zoning capability. The two e-stops operate globally—turning off both sets of outputs for Groups 1 and 2. The light curtain A and safety mat control the outputs of Group 1. The light curtain B and safety gate control the outputs of Group 2. With no connections to Y40-Y42, all outputs have monitored manual reset.

STARTING: Press the reset button to energize all MSR330P outputs.

STOPPING: Obstructing the light curtain A or stepping on the safety mat turns off the Group 1 outputs while leaving the Group 2 outputs energized. The reset button must be pressed to re-energize the Group 1 outputs after light curtain A and safety mat are cleared. Obstructing the light curtain B or opening the safety gate turns off the Group 2 outputs. The reset button must be pressed to re-energize the Group 2 outputs after light curtain B is cleared and the safety gate is closed. Pressing either e-stop de-energizes both Group 1 and Group 2 outputs. The e-stop must be released and the reset button must be pressed to re-energize the Group 1 and 2 outputs.

Fault Detection

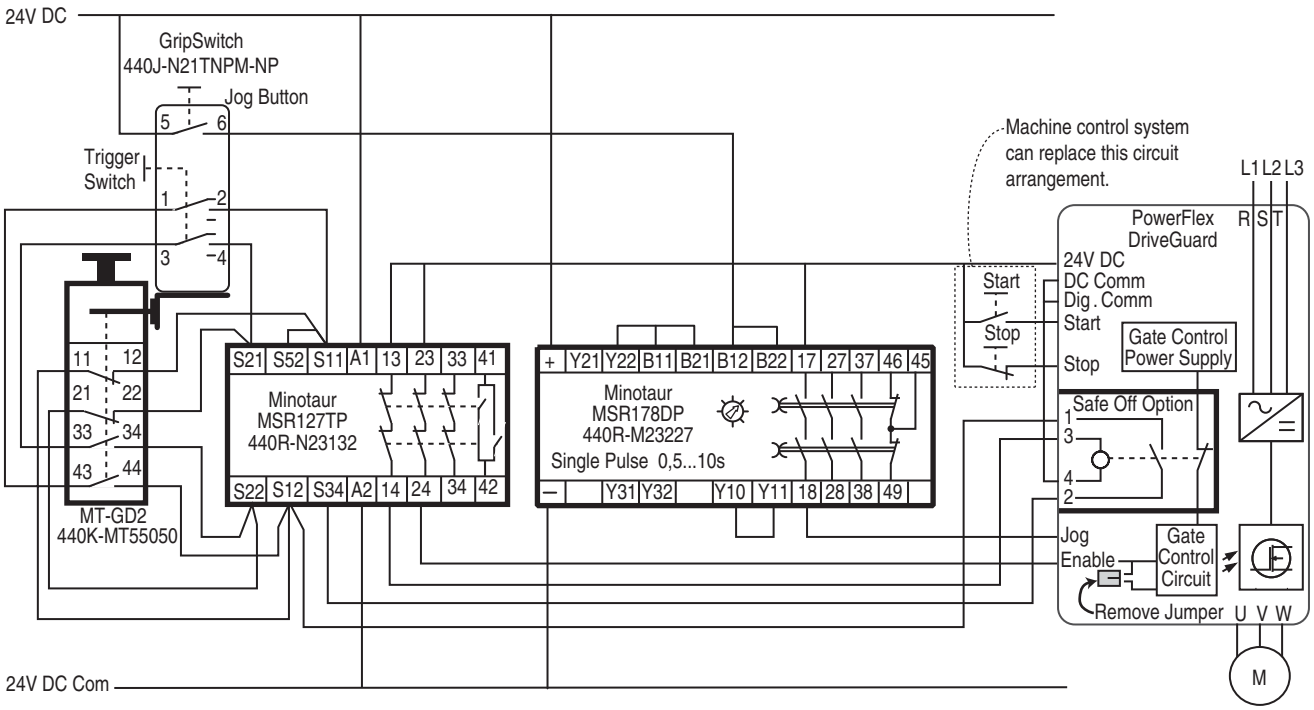
Upon successful completion of internal checks on power up, the MSR310P checks the input circuits. Shorts from the inputs to power, ground or other inputs will be detected immediately and will prevent energization or will de-energize the MSR330P outputs. If one of the 100S or 700S output devices (K1-K6) is stuck in an actuated state, the MSR310P will prevent startup because the Y11 or Y12 feedback loop will remain open.

Ratings

The rating assumes that two contactors are connected in series to power a hazard (not shown). The safety function initiated by the GuardShield light curtains, Sipha interlocks and 800F e-stop meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. The safety function initiated by MatGuard safety mats meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Enabling Device & Drive—Safe Jog

440G-MT, GripSwitch, MSR127, MSR178, PowerFlex DriveGuard



Circuit Status

The 440J GripSwitch is held by the MT-GD2. The MSR127 safety outputs are closed. The PowerFlex Enable and Safe-off option are energized. The MSR178 safety outputs are de-energized. The motor is ready to run.

Operating Principle

The MSR178 is chosen for its ability to perform timing functions. In this case, the MSR178 is set up to jog the PowerFlex drive with a single pulse having a duration set between 0.5 to 10 s (no jumpers form Y10 to Y31 or Y32 and fine adjustment made by potentiometer on front of MSR178). While in the MT-GD2 holder, the GripSwitch is disabled, and the drive can be controlled by the machine control system (not shown).

STARTING: Close the three-position trigger switch to the mid-position. Remove the enabling switch from the MT-GD2 holder. Press and hold the Jog button on the GripSwitch to initiate the operation of the MSR178. The MSR178 closes its safety outputs for the set duration.

STOPPING: The jog function stops after the set time expires. To restart, momentarily release the jog button and then re-close it to repeat the jog. Releasing or squeezing the three-position switch opens the outputs of the MSR127, and the PowerFlex drive executes a coast to stop.

Fault Detection

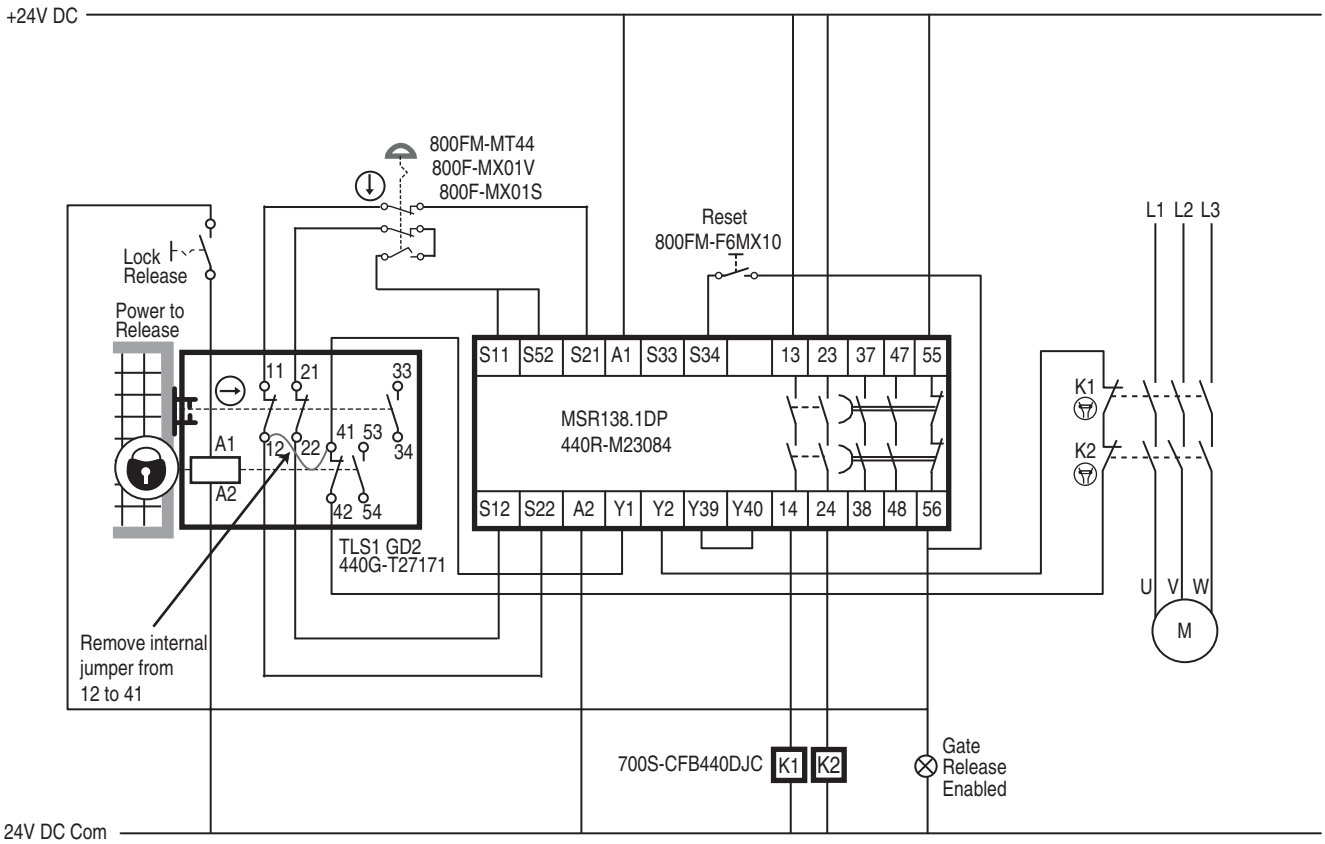
Upon successful completion of internal checks by the MSR127, MSR178 and the PowerFlex drive, the drive awaits the closure of the MSR127 safety outputs. If the MSR127 fails, the drive will not energize the motor and the fault will be detected by non-operation of the motor. The MSR127 uses dual channel to detect faults to power, ground and cross channel faults on the GripSwitch or the MT-GD2. A short across the jog switch will be detected as a subsequent jog attempt will be prevented by the MSR178. A fault in the Safe-Off option of the drive will be detected by the MSR127 on the next attempt to restart the drive. Internal faults in the MSR127 will result in non-operation of the motor. Internal faults of the MSR178 will result in non-operation of the jog function.

Ratings

The safety function initiated by GripSwitch enabling device meets the safety performance requirements of SIL CL 2 per IEC62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO13849-1:2006. This circuit executes a Category 0 stop.

Interlock Switches—Guard Locking with Time Delay

800F, MSR138, TLS1 GD2, 700S



Circuit Status

The e-stop is reset and the safety gate is closed. The outputs of the safety relay are open and the motor is off.

Operating Principle

STARTING: Press the Reset button to energize the outputs of the MSR138. The immediate outputs of the MSR138 energize the 700S control relays and start the motor.
STOPPING: When the e-stop is pressed, the immediate outputs of the MSR138 open and the motor coasts to stop. After the time delay of the MSR138 expires, the delayed N.C. output closes and provides voltage to the Lock Release button. Press the Lock Release button to power the solenoid and open the Gate.

Closing the Gate or resetting the e-stop does not re-energize the 700S safety control relays. Press the reset to re-energize the 700S control relays.

Fault Detection

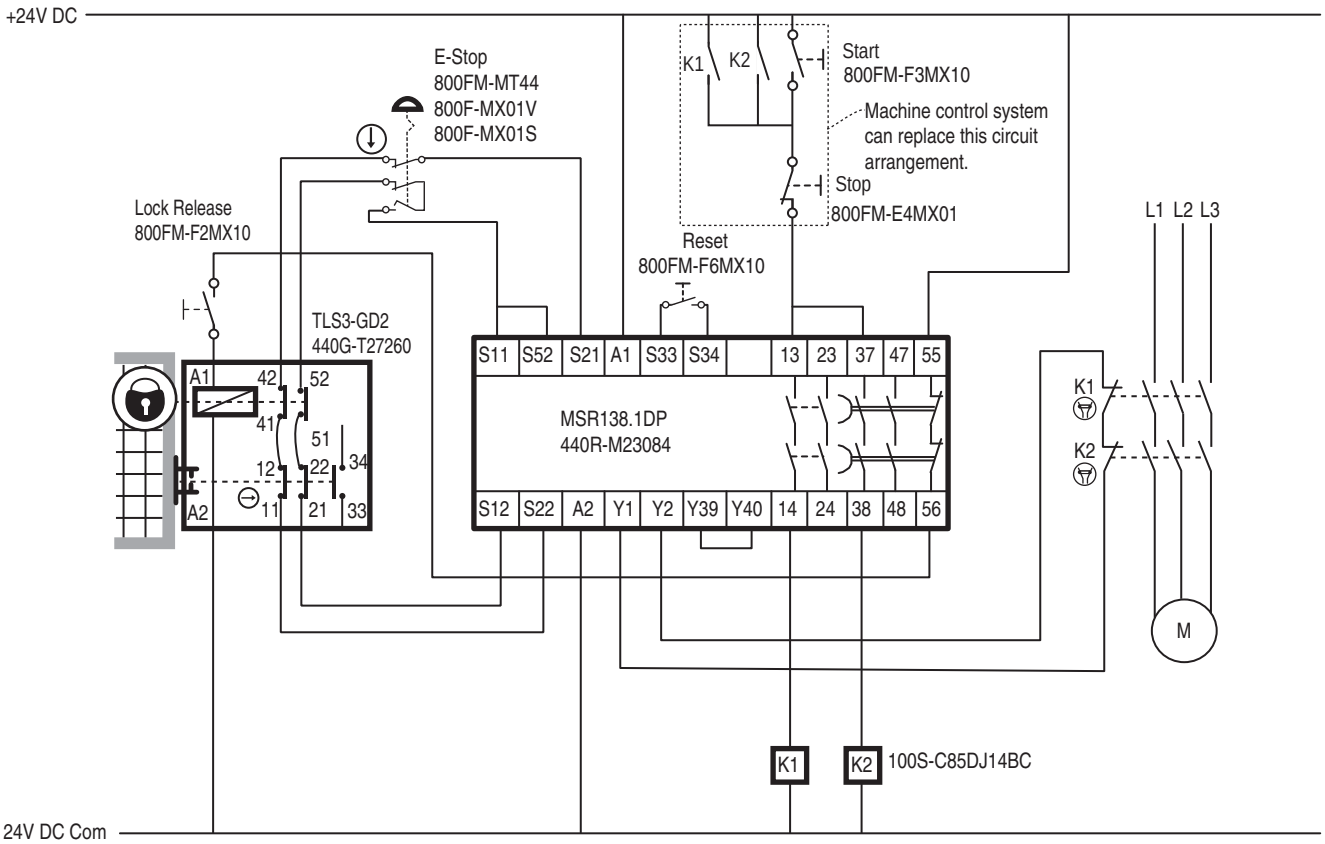
Upon power-up, the MSR138 perform internal checks. The MSR138 then looks for dual signals from the e-stop and the TLS1 GD2. The e-stop has a self-monitoring contact, which opens if the contact block falls off the control panel. With the e-stop signals made, the MSR138 checks the Y1/Y2 monitoring circuit when the reset button is pressed. If these checks are okay, the output energizes. The Reset button is linked to the delayed N.C. output in order to supply +24V for reset only when delay time has lapsed. If any of the MSR138 contacts faults to the ON state, the motor is stopped by the redundant outputs. The fault will be detected by the S56/S34 monitoring circuit on the next attempt to re-start. If the Gate is not interlocked by the TLS1 solenoid or one of the 700S control relays faults to the ON state, the MSR138 will detect the fault in the Y1/Y2 circuit on the next attempt to start. Single point failures related to the tongue interlock are excluded if actuator speed, alignment and mechanical stops meet installation instruction requirements, and a periodic proof test confirms proper operation.

Ratings

The safety function intiated by TLS1-GD2 guard locking interlock and the 800F e-stop meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Interlock Switch—Guard Locking with Time Delay

TLS3-GD2, 800F, MSR138, 100S



Circuit Status

The e-stop is reset and the safety gate is closed. The outputs of the safety relay are open, and the motor is off.

Operating Principle

The guard locking interlock and delayed outputs of the safety relay keep the guard closed and locked during the rundown time of the motor.
STARTING: Press the reset button to energize both the immediate and delayed outputs of the MSR138. Press the start button to energize contactors K1 and K2, which start the motor.
STOPPING: Press the e-stop to initiate a stop command. The immediate outputs of the MSR138 de-energize and the MSR138 timing cycle starts. Contactor K1 drops out and the motor begins a coast to stop. After the time delay of the MSR138 expires, the N.C. output closes and provides voltage to the lock release button. Press the lock release button to power the solenoid and open the gate. After the time delay, the normally open safety contact opens, dropping out K2.

Fault Detection

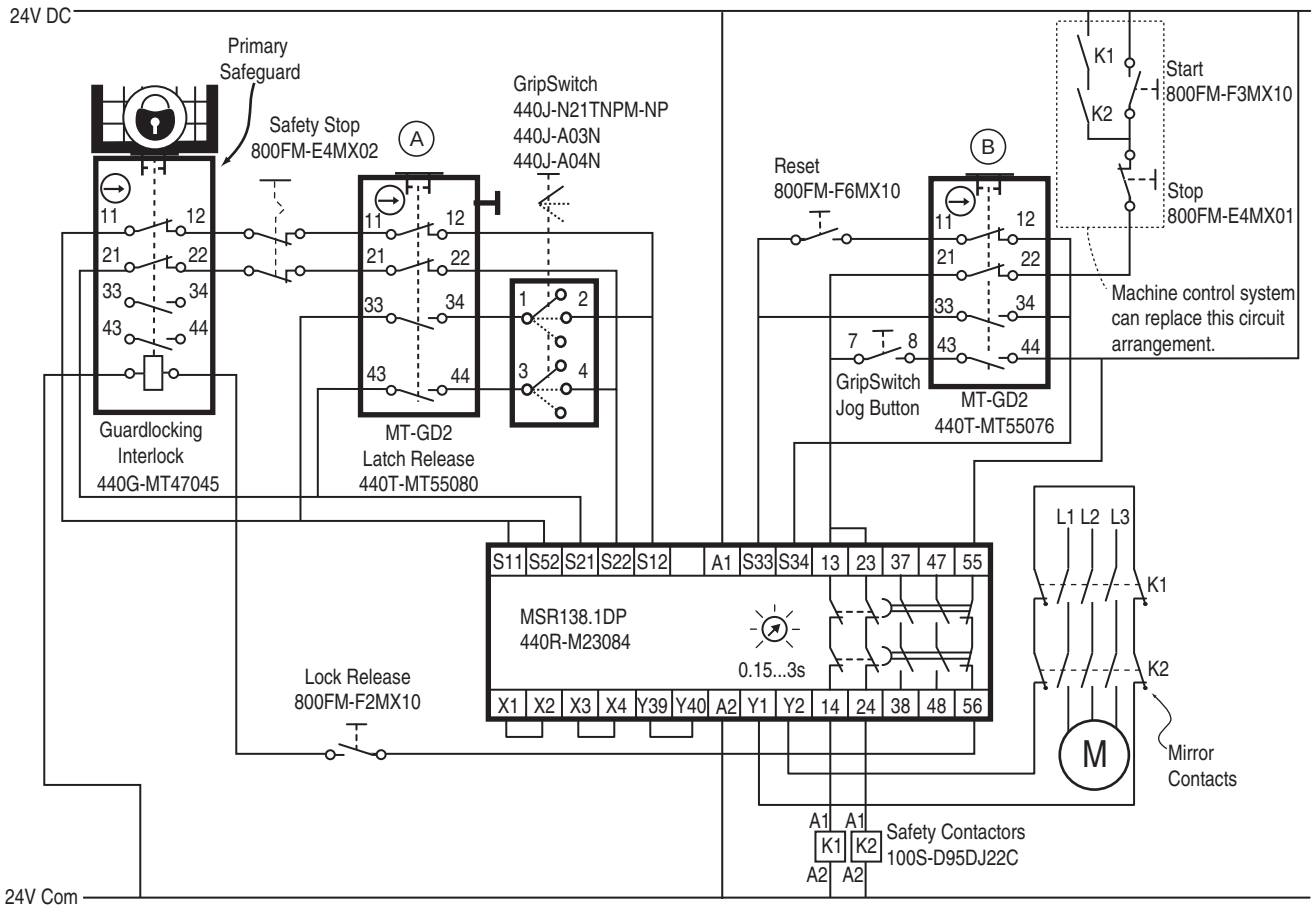
Upon power-up, the MSR138 performs internal checks. The MSR138 then looks for dual signals from the e-stop and the TLS3 GD2. The e-stop has a self-monitoring contact, which opens if the contact block falls off the control panel. With the e-stop signals made, the MSR138 checks the Y1/Y2 monitoring circuit when the reset button is pressed. If these checks are OK, the output energizes. If any of the MSR138 contacts faults to the ON state, the motor is stopped by the redundant outputs. The fault will be detected by internal crosschecking in the MSR138. With K1 on the immediate output of the MSR138, if performs the primary breaking of the motor circuit. If K1 fails due to welded contacts, the K2 will break the motor circuit. The failure of K1 will be detected by the Y1/Y2 monitoring circuit on the next attempt to restart the motor. Single point failures related to the tongue interlock are excluded if actuator speed, alignment and mechanical stops meet installation instruction requirements, and a periodic proof test confirms proper operation.

Ratings

The safety function initiated by the TLS3-GD2 guard locking interlock and the 800F e-stop button meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).

Interlock Switch and Enabling Device—Guard Locking with Time Delay

GripSwitch, MT-GD2, 400G-MT, 800F, MSR138, 100S



Circuit Status

The 440J GripSwitch is held by two MT-GD2 tongue interlocks by its mounting plate accessories. The safety gate is closed and the 440G-MT guard locking interlock is locked. The MSR138DP safety outputs are open. Contactors K1 and K2 are de-energized. The motor is off and the application ready to run.

Operating Principle

The GripSwitch enabling device is used to access the hazardous area while the motor is running. The access is of the full body type. With the safety gate unlocked, the operator walks into the hazardous area with the GripSwitch. Before accessing the hazard area, the motor must be stopped. After entering the hazard area, the motor can be restarted with the GripSwitch. One MT-GD2 interlock is used to bypass the gate interlock safety circuit. The other MT-GD2 is used to reset the safety system and prevent the starting of the motor from outside the cell, when the GripSwitch is used.

STOPPING: Press the Safety Stop. The immediate outputs of the MSR138.1DP open and the motor initiates a coast to stop. After the time expires on the MSR138.1DP, the delayed outputs change state. The contacts across 55 and 56 close and the safety gate can be unlocked. Press the lock release button to momentarily power the solenoid of the 440G-MT and open the gate.
STARTING: Remove the enabling switch from the MT-GD2 holders. Squeeze the GripSwtich trigger to the middle position. The MSR138.1DP resets and closes its safety outputs and the motor is ready to run. Press the jog button on the GripSwitch to momentarily turn on the motor.
STOPPING DURING ENABLING: Release the jog switch to stop the motor. Releasing or applying further pressure to the trigger switch on the GripSwitch will stop the motor.

Fault Detection

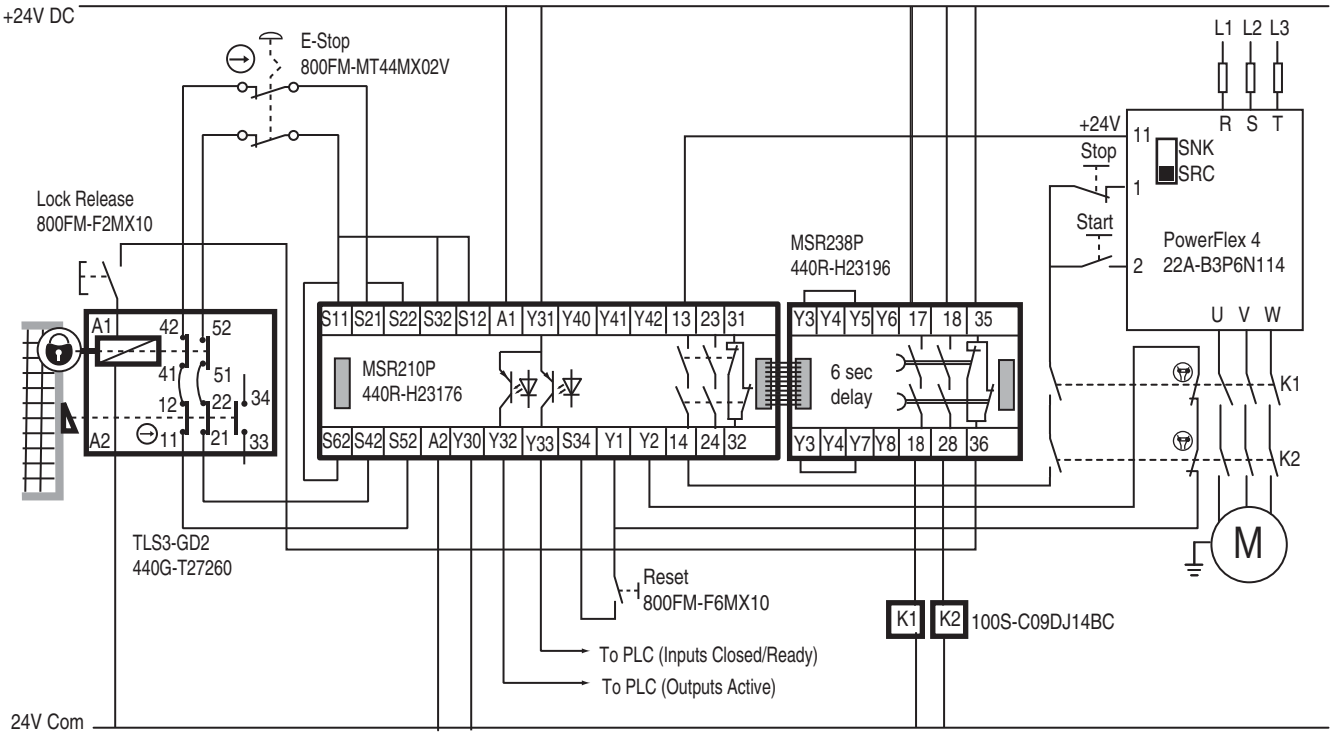
Upon successful completion of internal checks on power-up, the MSR138.1DP checks the gate and GripSwitch circuit. If both circuits have been closed, the MSR138.1DP checks the reset circuit. Upon closure of the reset button, the MSR138.1DP checks the status of the contactors. Due to the size of the 100S-D contactors, mirrored contacts (on either side of the unit) are used to safely reflect the staus of the armature. If all mirrored contacts are closed, then the MSR138.1DP energizes its outputs. If one contactor welds in the closed state, the second contactor will shut off the motor and the fault will be detected by the MSR138.1DP, upon the next attempt to start the motor. Single channel faults on the input devices (GripSwitch, Interlocks and Stop switch) will be detected by the MSR138.1DP either on or before a demand is placed on the safety system (depending on the nature of the fault).

Ratings

The safety function initiated by the MT-GD2 guard locking interlock and the GripSwitch button meets the safety performance requirements of SIL CL 2 per IEC62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).

Interlock Switch & Modular Relay—Guard Locking with Standard Drive

TLS-GD2, 800F, MSR200, 100S, PowerFlex 4



Circuit Status

The guard door is closed and locked (mechanical lock, power to release). The e-stop is released. K1 and K2 are off. The drive is powered, but not enabled. The motor is off.

Operating Principle

Access to the hazard is prevented (i.e., locked) by the guard locking TLS3-GD2 while the motor is running and for a fixed duration (controlled by the MSR238) after the e-stop command is initiated.

STARTING: Momentarily press the reset button. The contacts in the MSR210P and MSR238P close. K1 and K2 energize and connect the motor to the drive and also connects 24V to the start button. This ensures that the motor is connected to the drive, before the start button becomes effective. The PowerFlex 4 drive is allowed to start. Start the motor by momentarily pressing the start switch. The motor can be stopped by momentarily pressing the stop switch. The start and stop switches can be replaced by more elaborate control devices (like a PLC).

STOPPING: Press the e-stop. The MSR210P opens its immediate output (13-14) and begins the timing sequence in the MSR238. The PowerFlex 4 also begins its programmed deceleration as the stop signal is opened. After six seconds, the MSR238 times out and contacts 17-18 and 27-28 open. K1 and K2 de-energize and disconnect the motor from the drive. Contacts 35-36 close and provide power to the release button of the TLS3-GD2. Press and hold the release button to open the gate.

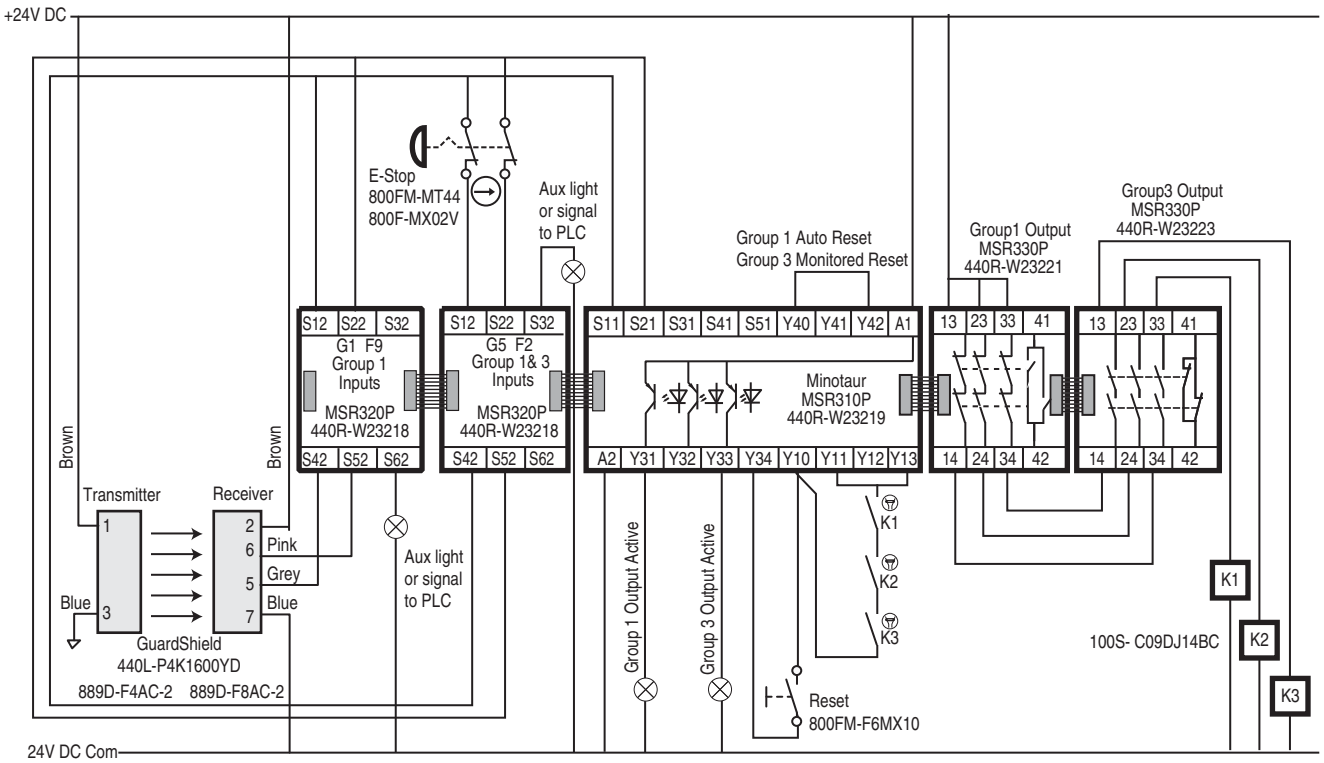
Closing the gate or releasing the e-stop will not cause the motor to turn on. Two separate and deliberate actions are needed: 1) momentarily press the reset button to activate the safety relay and then 2) momentarily close the start switch to turn the motor on. In this application, the user must ensure that the time delay of the MSR238P provides sufficient time for the hazards, driven by the motor, to stop. Ramping to stop or dynamic braking are recommended to speed up the braking process. The time delay of the MSR238P should be set longer than the stopping time of the PowerFlex 4 or the motor will coast to its final stop. The PowerFlex 4 will not be able to start while the K1 and K2 contactors are de-energized.

Fault Detection

If the drive output faults to an energized state, the motor can be turned off by pressing the e-stop. If K1 welds in an energized state, the motor can be stopped by K2. If either K1 or K2 welds closed, the MSR210P will not be able to start due to the feedback loop (Y1-Y2) being open. A short across the interlock or e-stop will be detected by the MSR210P. The MSR210P will also detect if the reset is held or stuck in the closed position, and will prevent the motor from starting.

Ratings

The safety function initiated by the TLS3-GD2 guard locking interlock and the 800F e-stop button meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. This example circuit performs a Stop Category 1 function (brake and then remove power to motor).



Circuit Status

The light curtain is set at the factory default setting (guard only) and is unobstructed. The e-stop is reset. The Group 1 MSR330P safety outputs (13/14, 23/24, 33/34) are on. The Group 3 MSR330P safety outputs are off. K1-K3 are off and ready to be energized.

Operating Principle

Since the safety outputs of the two MSR330P modules are connected in series, both the light curtain and e-stop will control (turn on and off) the K1-K3 loads. The light curtain is set to automatic reset mode. The e-stop stop operates in monitored reset mode. The jumper from Y40 to Y42 sets the Group 1 output to automatic reset and the Group 3 output to monitored reset. The MSR310P must have the monitoring circuit connected to both Y11 and Y13 to allow both the Group1 and Group 3 outputs to energize.

STARTING: Press the reset button to energize the Group 3 outputs, which energize the loads K1-K3.

STOPPING: Obstructing the light curtain turns off the Group 1 safety outputs and de-energizes K1-K3. Clearing the light curtain automatically re-energizes K1-K3. This arrangement is known as presence sensing device initiation, and additional precautions (e.g., limited to partial body access, part sensing, limited speed) may be necessary to ensure safe operation of the machine. Pressing the e-stop turns off both the Group 1 and Group 3 safety outputs and de-energizes K1-K3. Resetting the e-stop re-energizes the Group 1 outputs, but the Group 3 outputs remain off. The Reset button must be pressed to turn on the Group 3 outputs and energize the loads K1-K3.

Fault Detection

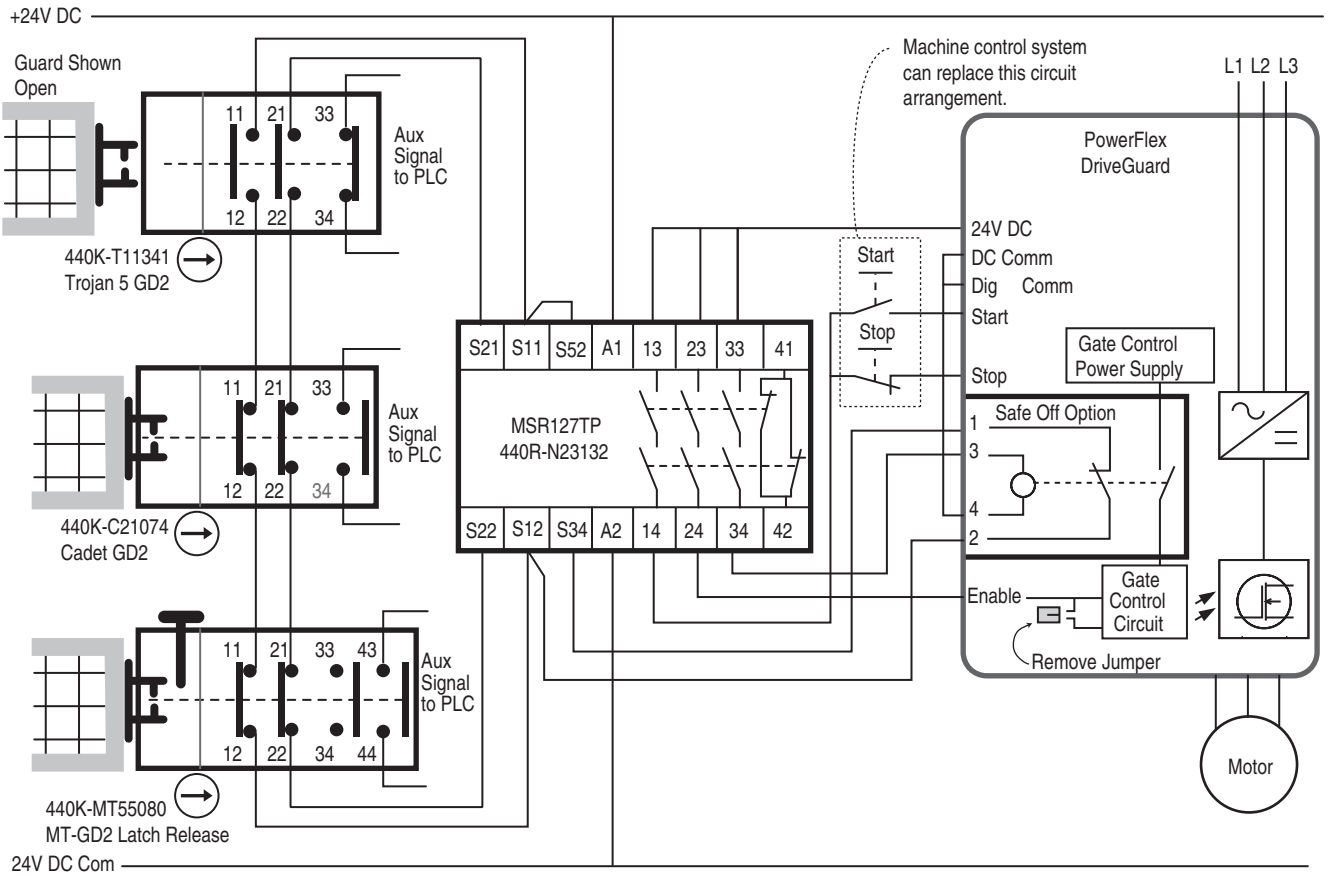
Upon successful completion of internal checks on power up, the GuardShield energizes its outputs. Cross-channel shorts and shorts to ground or power are detected by the GuardShield. The MSR310P also performs internal checks, and then scans the input circuits. The MSR310P uses pulse testing from S11 and S21 to detect shorts from the inputs to power, ground or other inputs. These faults will be detected immediately and will prevent energizating or will de-energize the MSR330P outputs. If one of the 100S output devices (K1-K3) is stuck in an actuated state, the MSR310P will prevent start-up because the Y10/Y11/Y13 feedback loop will remain open.

Ratings

When two contactors are connected in series to power a hazard (not shown), the safety functions intiated by GuardShield light curtains and the 800F e-stop meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. If only one contactor is used to power a hazard, the safety function can meet SIL CL 2, Category 2 structure and PLd.

Drive—Multiple Gate Access

Trojan 5 GD2, Cadet GD2, MT-GD2, MSR127, PowerFlex DriveGuard



Circuit Status

One of the gates is open. The safety outputs of the MSR127 are de-energized. The PowerFlex with DriveGuard is de-energized and not enabled. The motor is off.

Operating Principle

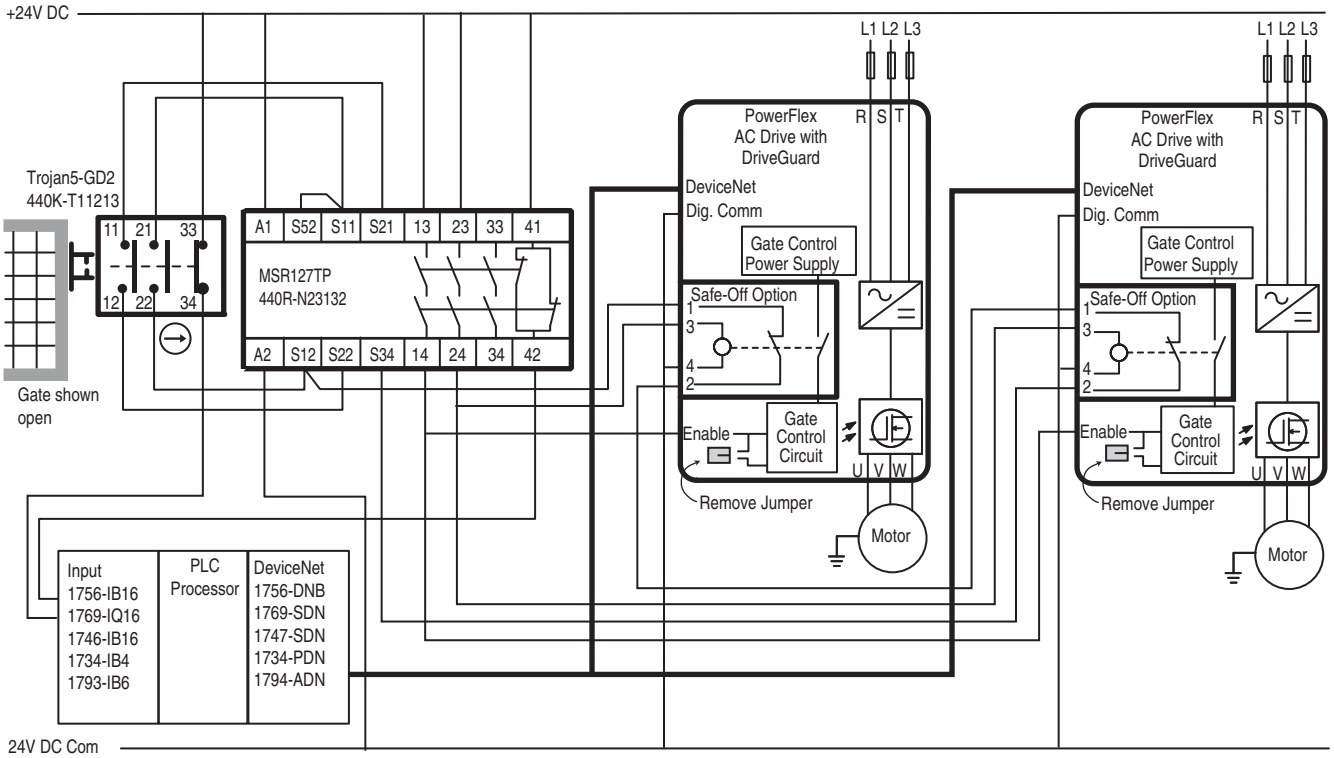
STARTING: When the last gate closes, the safety outputs of the MSR127 close and apply power to the drive enable circuit, Safe-Off option, Start and Stop buttons. Pressing the Start and Stop buttons turns the motor on and off. The motor is controlled by parameters set within the PowerFlex drive.
STOPPING: Opening any of the guard doors causes the MSR127 safety outputs to de-energize. This removes power to the PowerFlex enable, Safe-Off, Start, and Stop circuits. The motor performs a coast to stop.

Fault Detection

Upon power-up the PowerFlex drive and MSR127 perform internal checks. The MSR127 then looks for dual signals from the gate interlocks. With the gates closed, the MSR127 checks the wiring of the drive Safe-Off option. If closed, then the MSR127 energizes its outputs and the motor can be started. A single open circuit fault at the gate interlocks will be detected immediately, and the motor will coast to a stop. A crossfault (channel 1 to channel 2) at the gate interlocks will be detected immediately. A short across one gate interlock contact will be detected when an attempt to re-start is made. This type of short can be masked by opening and closing another gate interlock and may result in a loss of the safety function due to an accumulation of contact shorts. The MSR127 is rated for Category 4 and will not lose the safety function due to an accumulation of faults. The PowerFlex 70 DriveGuard is rated at Category 3, as it will perform the safety function in the presence of a single internal fault.

Ratings

The safety function intiated by gate interlocks meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.



Circuit Status

The safety gate is open. The MSR127TP safety outputs (13/14, 23/24, 33/34) are open. The Enable and Safe-Off Option on both PowerFlex drives are off. Auxiliary signals from the Trojan 5 GD2 (33/34) and the MSR127 (41/42) inform the PLC that the safety system is OFF. The motors of both drives are off.

This circuit is intended to show that multiple drives can be connected in parallel. The number of drives that can be connected in parallel is dependent on: the load (the safe-off option plus the enable of each drive), appropriate de-rating to prevent early wear out of the MSR127TP contacts, the application requirements (e.g., zoning) and the risk assessment (e.g., some drives may require separate safety systems).

Operating Principle

STARTING: Upon closing the gate, the Trojan 5 GD2 closes the safety inputs of the MSR127TP (S11/S12 and S21/S22) and opens the signal to the PLC. The safety outputs of the MSR127TP close and enable both PowerFlex drives. The auxiliary signal of the MSR127TP opens. The PLC compares the gate and safety relay auxiliary signals. When both signals are open, the PLC knows that the safety system is ready. The PLC can now start and control the drives over the DeviceNet network. The PLC must ensure that the drives are not started upon the closing of the gate; a separate, intentional action must initiate the motor movement (this is not shown in the diagram).
STOPPING: Normal stopping is performed by the PLC. If the gate is opened, the input signals to the MSR127TP open. The MSR127TP opens its safety outputs which disable all the drives connected to them via the Safe-Off option. The drives perform an immediate coast to stop.

Fault Detection

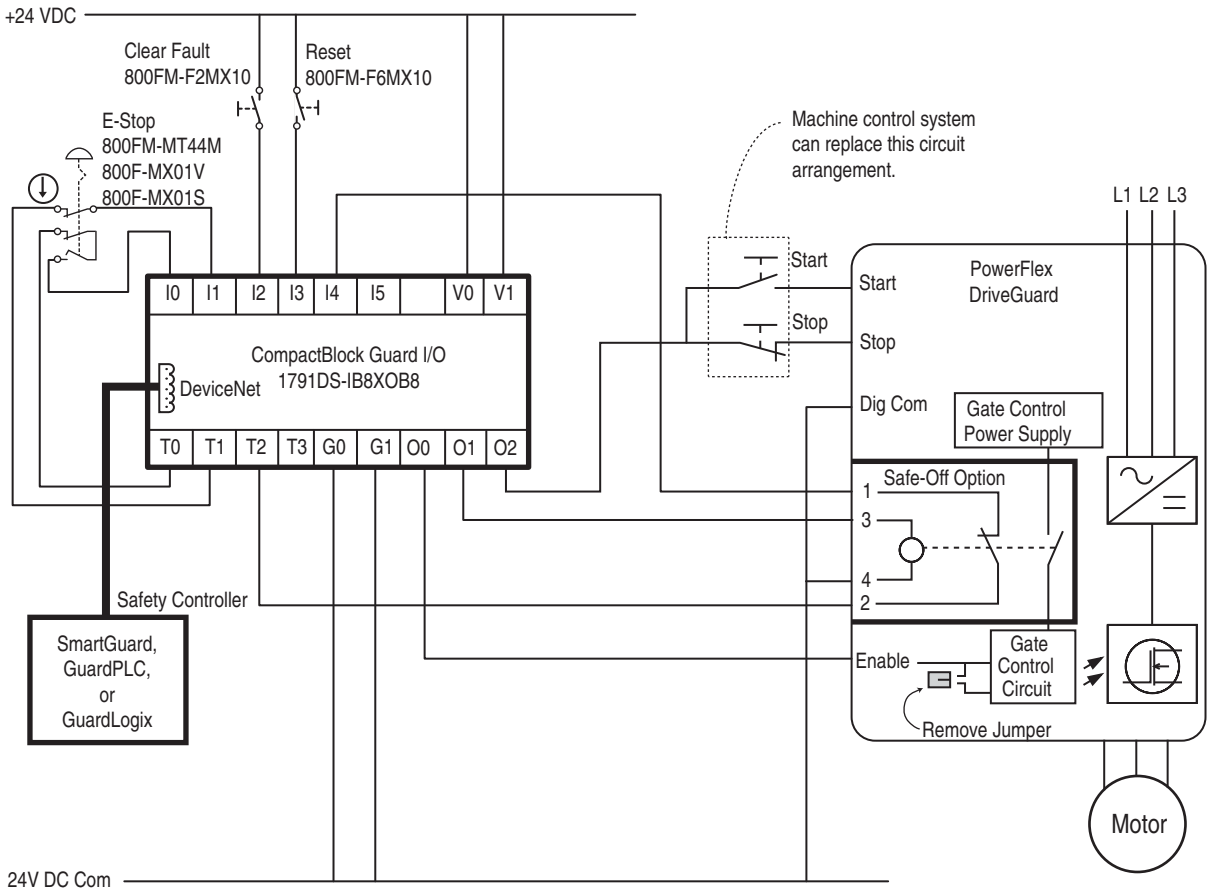
Upon power-up, the MSR127TP performs internal checks. The MSR127TP then looks for dual signals from the Trojan5-GD2. If only one signal is present, or a crossfault exists, the MSR127TP assumes a fault is present and does not energize its safety outputs. With the gate closed, the MSR127TP checks the S12/S34 monitoring circuit. If the Safe-Off options are de-energized, the MSR127TP assumes the drives are off and are ready to be enabled. The MSR127TP energizes its safety outputs. If the monitoring circuit remains open, the MSR127TP will assume a fault is present and not allow its safety outputs to energize. Single point failures related to the tongue interlock are excluded if actuator speed, alignment and mechanical stops meet installation instruction requirements, and a periodic proof test confirms proper operation.

Ratings

The safety function intiated by the Trojan 5-GD2 gate interlocks meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Drive & Safety I/O—Integrated Architecture

800F, CompactBlock Guard I/O, PowerFlex DriveGuard



Circuit Status

The e-stop is reset. The outputs of the CompactBlock Guard I/O are off. The PowerFlex output is off. The motor is off.

Operating Principle

STARTING: Press and release the reset button to energize the outputs of the 1791DS. This action energizes the Safe-Off option which connects the Gate Control Power Supply to the Gate Control Circuit. It also provides the Enable signal which allows the Gate Control Circuit to turn the output drive transistor on and off. Output O2 applies power to the Start and Stop controls, which can then be used to control the drive for production operations.

STOPPING: When the e-stop is pressed, the O2 output sends a stop command to the drive, which executes its pre-programmed stopping routine. After a short delay (programmed in the safety controller), the O0 and O1 outputs turn off. This disables the drive. The normally closed contact in the Safe-Off option closes and sends a signal back to terminal I4 to inform the safety system that the drive is ready for restart.

Fault Detection

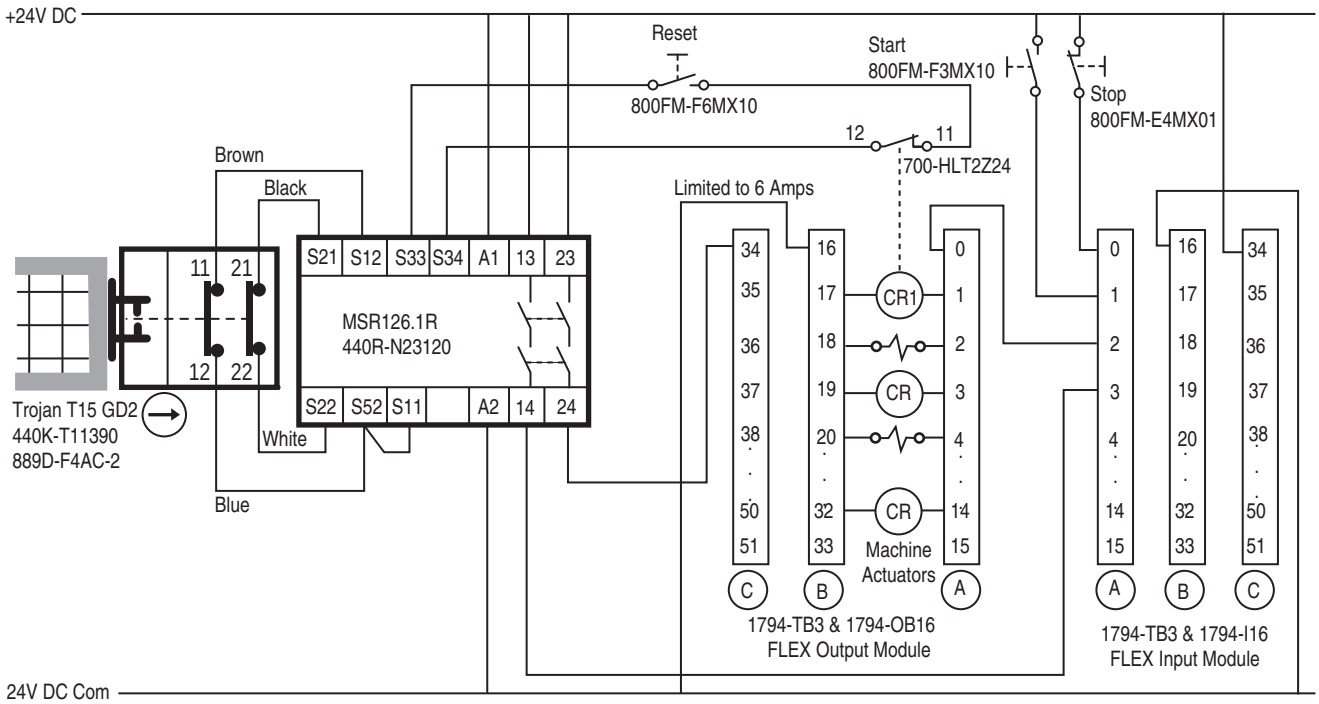
Upon power-up, the PowerFlex drive and 1791DS perform internal checks. The 1791DS then looks for dual signals from the e-stop. The pulsed outputs T0 and T1 are used to help check for open and short circuit fault conditions in the e-stop circuit. The e-stop has a self-monitoring contact, which opens if the contact block falls off the control panel. With the e-stop signals made, the 1791DS checks the monitoring circuit (terminal I4) when the reset button is pressed. If these checks are OK, the outputs energize. If the O2 output of the 1791DS faults to the ON state, the motor is stopped by the O0 and O1 outputs, and the fault will be detected on the next attempt to re-start by the self-checking in the 1791DS. If the drive control faults to an ON state, the motor will stop because the power to the drive control circuit will be removed by the Safe-Off option.

Ratings

The safety function intiated by the 800F e-stop meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 1 stop, by the program in the safety controller.

Interlock Switch Gater with High Current Outputs

Trojan T15 GD2, 800F, MSR126, Flex I/O



Circuit Status

The safety gate is closed. The outputs of the MSR126.1R safety relay are open and the machine actuators are off. Control Relay CR1 is de-energized and its 11/12 contact is closed.

Operating Principle

The MSR126.1R is chosen for this application because its thermal (non-switching) current carrying capacity is 6 A in one circuit. The Flex output module performs the normal switching of the machine actuators during the manufacturing process. The safety system enables the machine functions by providing power to the FLEX Output Module. One of the Flex outputs must drive an electro-mechanical output whose normally closed contact is in the monitoring loop of the safety relay. The machine logic must energize this output while the machine is running, as it is used by the MSR126.1R to confirm that power is removed from the output module, before restarting.

STARTING: Press the reset button to energize the output contacts 13/14 of the MSR126.1R. This connects the 24V supply to terminal C34 of Flex 1974-OB16 output module and also sends a signal to the A3 terminal of the 1794-IB16. The logic system is informed that the gate is closed and the machine is ready to run. Press the Start button to start the machine process.
STOPPING: Press the Stop button to stop the machine. Then, open the gate to access the machine. While the gate is open, the machine actuators cannot operate because power is removed from the output module. If the gate is inadvertently opened while the machine is running, power will be removed from output module and the machine actuators will be de-energized.

Fault Detection

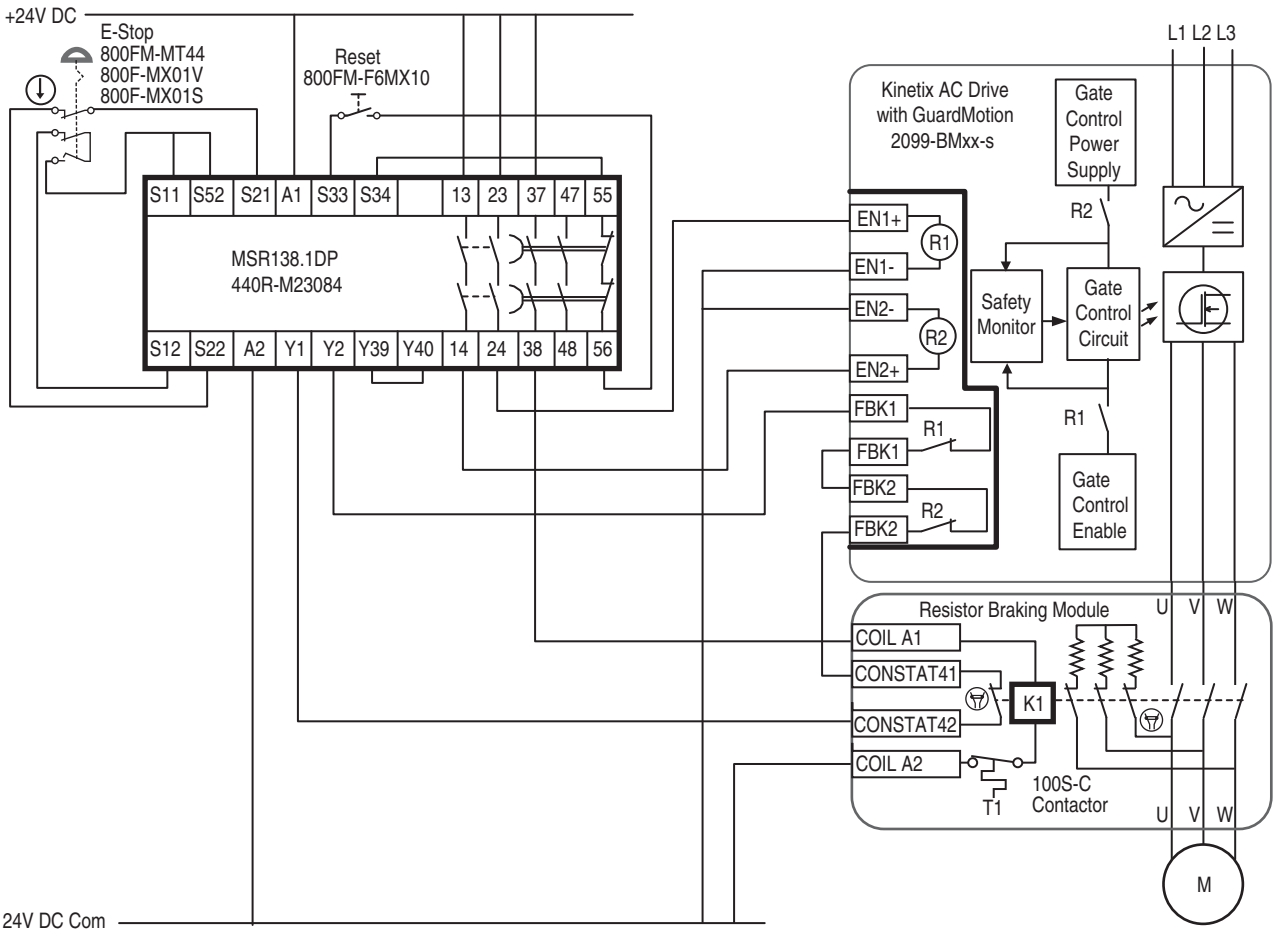
Upon successful completion internal checks on power up, the MSR126.1R checks the input circuits. With the gates closed, the MSR126.1R checks the dual circuits and then waits for the reset signal. A single fault, a short from 24V to terminal 14 of the MSR126.1R, may lead to the loss of the safety function. With the MSR126.1R and Flex system mounted in the same cabinet and with proper validation, this fault may be excluded. If not mounted in the same cabinet, a signal from the output (A0) should be fed back into the input module (A2). The logic can perform a comparison of input A2 and A3, and turn the machine off if these signals are not in agreement. If CR1 is not de-energized when the gate is closed, the MSR126.1R will not close its outputs.

Ratings

The safety function intiated by the Trojan T15-GD2 gate interlocks meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Safety Motion—Delayed Braking

800F, MSR138, Kinetix GuardMotion, RBM



Circuit Status

The e-stop is reset. The outputs of the safety relay are open, and the motor is off.

Operating Principle

STARTING: Press and release the reset button to energize the outputs of the MSR138. This action energizes the 100S contactor in the resistor braking module, which connects the motor to the drive and enables the operation of the Kinetix drive. When the Kinetix drive is enabled, an internal signal is sent back to its controller (not shown) to inform it that the drive is enabled. The motor is then controlled by its controller.

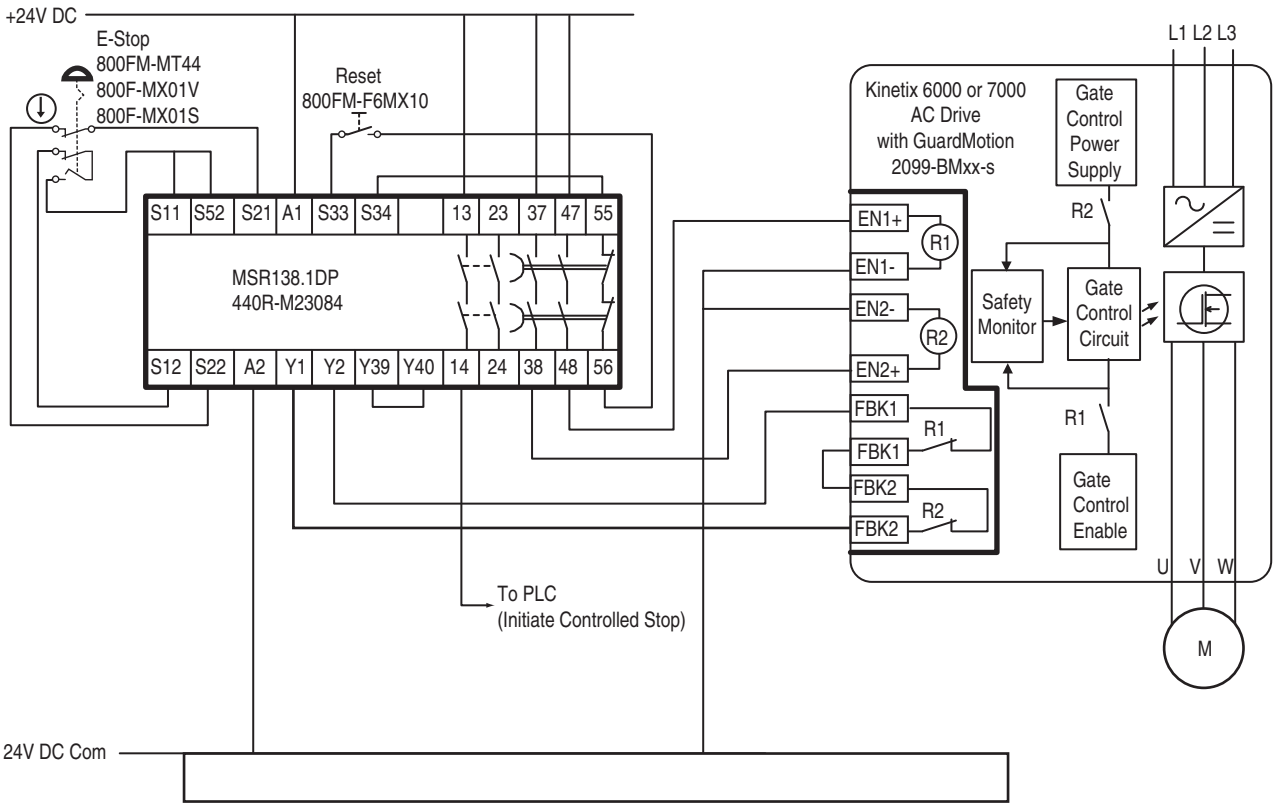
STOPPING: When the e-stop is pressed, the immediate outputs of the MSR138 open and disable the drive. The motor begins to coast to a stop. After the time delay of the MSR138 expires, the delayed outputs open and drop out the 100S contactor in the Resistor Braking Module. This disconnects the motor from the drive and engages the braking resistors, which rapidly stop the motor.

Fault Detection

Upon power-up, the Kinetix drive and MSR138 perform internal checks. The MSR138 then looks for dual signals from the e-stop. The e-stop has a self-monitoring contact, which opens if the contact block falls off the control panel. With the e-stop signals made, the MSR138 checks the Y1/Y2 monitoring circuit when the reset button is pressed. If these checks are OK, the output energizes. If the delayed outputs of the MSR138 fault to the ON state, the motor is stopped by the MSR138 immediate outputs. The fault will be detected by the Y1/Y2 monitoring circuit on the next attempt to re-start because K1 will remain energized. If the drive faults to an ON state, the motor will stop because it will be disconnected by K1. This fault will be detected by the Y1/Y2 monitoring circuit on the next attempt to re-start because the Kinetix feedback circuit will remain off. If K1 gets stuck or welded closed, the motor will stop by the drive and the fault will be detected by the Y1/Y2 monitoring circuit of the MSR138 on the next attempt to re-start.

Ratings

The safety function intiated by the 800F e-stop meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 1 stop.



Circuit Status

The e-stop is reset. The outputs of the safety relay are open, and the motor is off.

Operating Principle

STARTING: Press and release the reset button to energize the outputs of the MSR138. This action enables the operation of the Kinetix drive. When the Kinetix drive is enabled, an internal signal is sent back to its controller (not shown) to inform it that the drive is enabled. The motor is then controlled by its controller.
STOPPING: When the e-stop is pressed, the immediate outputs of the MSR138 open and sends a signal the to the machine control PLC to initiate a controlled stop. After the time delay of the MSR138 expires, the delayed outputs open and drop out the GuardMotion feature which disables the drive.

Fault Detection

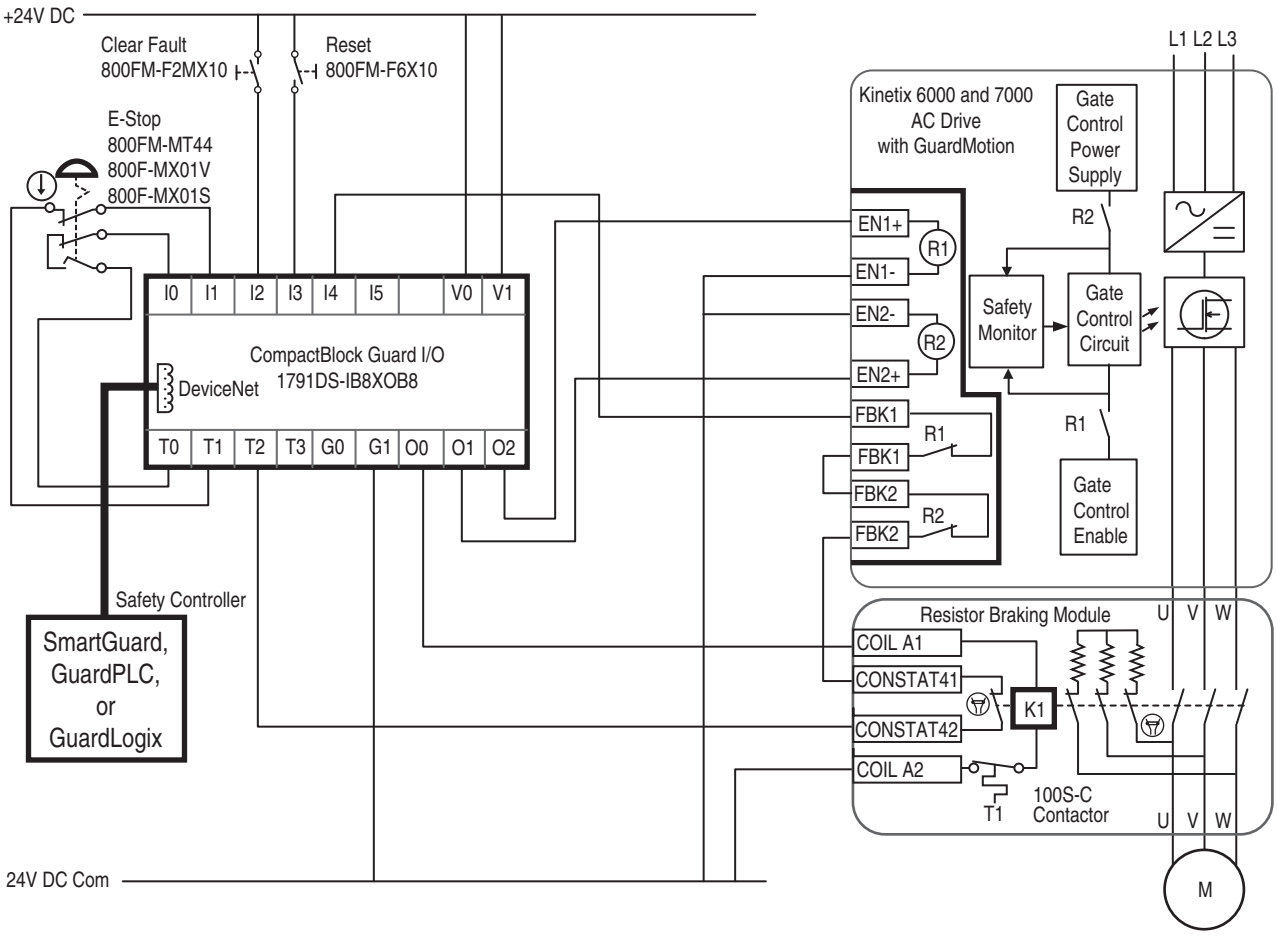
Upon power-up, the Kinetix drive and MSR138 perform internal checks. The MSR138 then looks for dual signals from the e-stop. The e-stop has a self-monitoring contact, which opens if the contact block falls off the control panel. With the e-stop signals made, the MSR138 checks the Y1/Y2 monitoring circuit when the reset button is pressed. If these checks are OK, the output energizes. If the delayed outputs of the MSR138 fault to the ON state, the motor is stopped by the MSR138 immediate outputs. The fault will be detected by the S33/S34 monitoring circuit on the next attempt to re-start. If one of the safe-off relays faults to the ON state, the MSR138 will detect the fault in the Y1/Y2 circuit on the next attempt to start the drive.

Ratings

The safety function intiated by the 800F e-stop meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 1 stop.

Safety Motion & Safety I/O—Integrated Architecture

800F, CompactBlock Guard I/O, Kinetix GuardMotion, RBM



Circuit Status

The e-stop is reset. The outputs of the CompactBlock Guard I/O are off. The Kinetix outputs are off. The Resistor Braking Module is off. The motor is off.

Operating Principle

STARTING: Press and release the reset button to energize the outputs of the CompactBlock Guard I/O. This action energizes the 100S contactor in the resistor braking module, which connects the motor to the drive and enables the operation of the Kinetix drive. When the Kinetix drive is enabled, an internal signal is sent back to its controller (not shown) to inform it that the drive is enabled. The motor is then controlled by its controller.

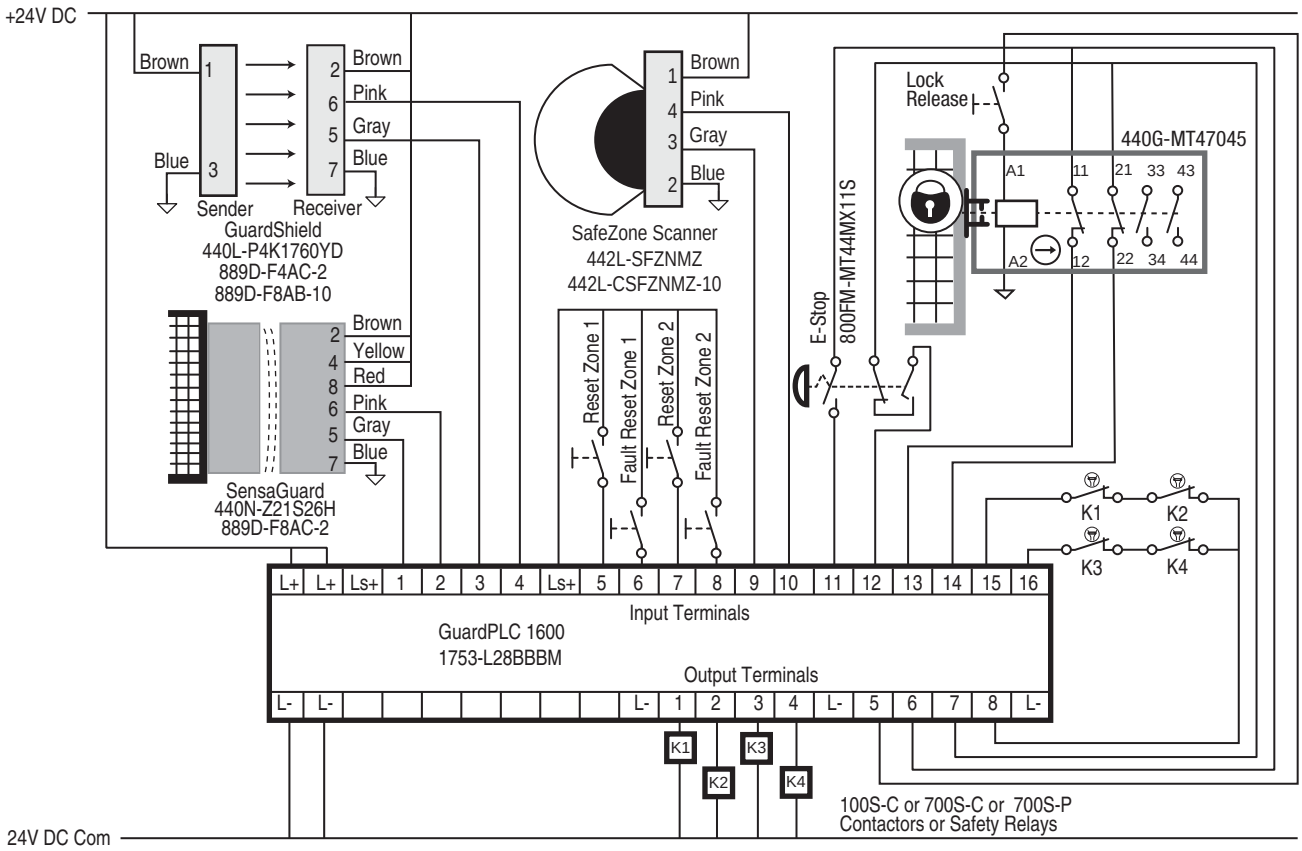
STOPPING: When the e-stop is pressed, the O1 and O2 outputs of the 1791DS open and disable the drive. The motor begins to coast to a stop. After a short delay (determined by a risk assessment or stop time measurement and programmed in the safety controller), the O0 output turns off and drops out the 100S contactor in the resistor braking module. This disconnects the motor from the drive and engages the braking resistors, which rapidly stop the motor.

Fault Detection

Upon power-up, the Kinetix drive and 1791DS perform internal checks. The 1791DS then looks for dual signals from the e-stop. The pulsed outputs T0 and T1 are used to help check for open and short circuit fault conditions in the e-stop circuit. The e-stop has a self-monitoring contact, which opens if the contact block falls off the control panel. With the e-stop signals made, the 1791DS checks the monitoring circuit when the reset button is pressed. If these checks are OK, the outputs energize. If the O0 output of the 1791DS faults to the ON state, the motor is stopped by the O1 and O2 outputs. The fault will be detected by the safety controller on the next attempt to re-start because K1 will remain energized. If the drive faults to an ON state, the motor will still be able to stop because it will be disconnected by K1. This fault will be detected on the next attempt to re-start because the Kinetix feedback circuit will remain off. If K1 gets stuck or welded closed, it will still be possible to stop the motor by the drive, and the fault will be detected by the safety controller on the next attempt to re-start.

Ratings

The safety function intiated by the 800F e-stop meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. This circuit executes a Category 0 stop. To achieve a Category 1 stop, the machine control system must be notified of the e-stop command through DeviceNet, command the Kinetix to execute a stop, and delay the outputs O0, O1, and O2 until the stop condition is completed.



Circuit Status

The GuardPLC is programmed to control two zones without a DIO connection. The GuardShield and SensaGuard are associated with Zone 1 and contactors K1 and K2. The SafeZone Laser Scanner and 440G-MT are associated with Zone 2 and contactors K3 and K4. The SafeZone, located behind the locked safety gate, is used to detect someone in the hazard area. The E-Stop applies to both zones. The two safety gates are closed, the light curtain and zone scanner are clear and the e-stop is released. Both zones are ready to be activated.

Operating Principle

STARTING: Press the reset button for each zone to energize the safety outputs of the GuardPLC. The safety contactors K1 through K4 become energized and allow the zones to operate. The GuardPLC signals the machine control system over an Ethernet/IP connection that the zones are ready to run. The machine control system (not shown) controls the zones.

STOPPING: Obstructing the light curtain or opening the SensaGuard gate will de-energize the K1 and K2 contactors. Clearing the light curtain or closing the gate will not cause the contactors to re-energize. The Zone 1 Reset button must be pressed to restart Zone 1. The e-stop acts as a global stop. When pressed, both zones are de-energized. The GuardPLC energizes Output 5 to provide voltage for the 440G-MT guard locking solenoid. Pressing the Gate Release button allows the gate to be opened. Closing the gate or resetting the e-stop does not re-energize the K1-K4 contactors. The respective Zone Reset buttons must be pressed after the input devices are cleared.

Fault Detection

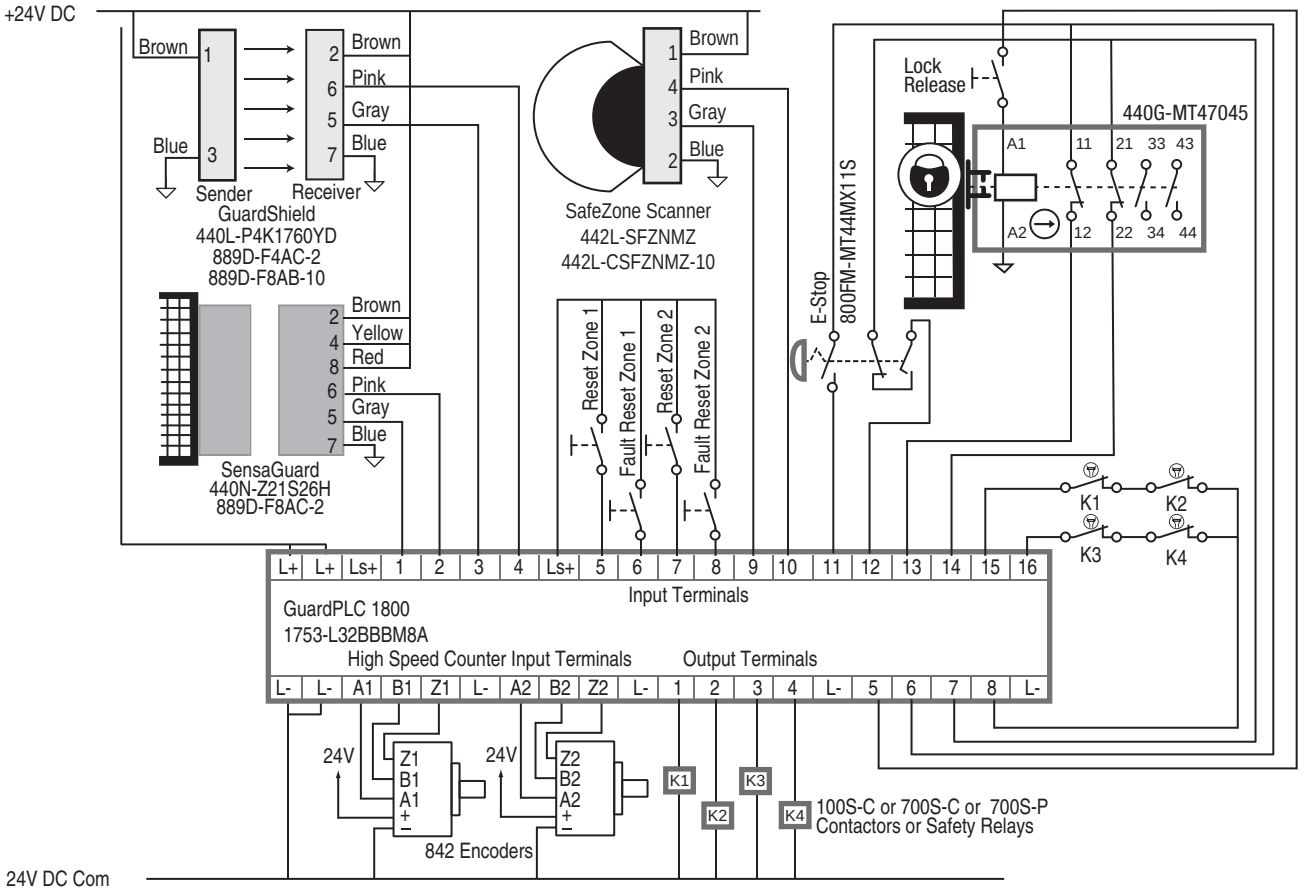
Upon successful completion of internal checks on power up, the GuardPLC checks the input devices. Outputs 6 and 7 are configured as pulse test sources and are used by the GuardPLC to help check for open and short-circuit fault conditions of the E-Stop and 440G-MT interlock. If a fault is detected, the GuardPLC will not energize the respective outputs. The GuardPLC checks the status of the K1-K4 contactors. If the contactors are energized, stuck or welded closed, the GuardPLC will detect this due to the open circuit to Inputs 15 or 16, and will not energize the respective zone. Output 8 is configured as a pulse test source to help detect wiring faults on these contactor feedback circuits. The programmable safety function blocks associated with each device performs self checking. If a fault occurs, the respective Fault Reset button must be pressed, after the fault is cleared. Then, the Reset button must be pressed and released for the machine to restart.

Ratings

The ratings assume that two contactors are connected in series to power the hazards. The safety function intiated by the SensaGuard interlock, GuardShield light curtains, and 800F e-stop meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. The safety functions initiated by the SafeZone scanner and 440G-MT interlock meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and have a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

Safety PLC—Two Zones with Encoders

GuardShield, SensaGuard, SafeZone, 800F, 440G-MT, 842 Encoders, GuardPLC 1800, 100S, 700S



Circuit Status

The GuardPLC is programmed to control two zones. The GuardShield and SensaGuard control Zone 1 with contactors K1 and K2. The SafeZone Laser Scanner and 440G-MT control Zone 2 with contactors K3 and K4. The SafeZone, located behind the locked safety gate, is used to detect someone in the hazard area. The E-Stop applies to both zones. The dual encoders monitor the machine for zero speed and safe speed. The safety gates are closed; the light curtain and zone scanner are clear; the machine is at zero speed; and the e-stop is released. Both zones are ready to be activated.

Operating Principle

STARTING: Press the reset button for each zone to energize the safety outputs of the GuardPLC. The safety contactors K1 through K4 become energized and allow the zones to operate. The GuardPLC signals the machine control system over an Ethernet/IP connection that the zones are ready to run. The machine control system (not shown) controls the zones.

STOPPING: Obstructing the light curtain or opening the SensaGuard gate will de-energize the K1 and K2 contactors. Clearing the light curtain or closing the gate will not cause the contactors to re-energize. The Zone 1 Reset button must be pressed to restart Zone 1. The e-stop acts as a global stop. When pressed, both zones are de-energized. The GuardPLC energizes Output 5 to provide voltage for the 440G-MT guard locking solenoid. Pressing the Lock Release button allows the gate to be opened. Closing the gate or resetting the e-stop does not re-energize the K1-K4 contactors. The respective Zone Reset buttons must be pressed after the input devices are cleared.

Fault Detection

Upon successful completion of internal checks on power up, the GuardPLC checks the input devices. Outputs 6 and 7 are configured as pulse test sources and are used by the GuardPLC to help check for open and short-circuit fault conditions of the E-Stop and 440G-MT interlock. If a fault is detected, the GuardPLC will not energize the respective outputs. The GuardPLC checks the status of the K1-K4 contactors. If the contactors are energized, stuck or welded closed, the GuardPLC will detect this due to the open circuit to Inputs 15 or 16, and will not energize the respective zone. Output 8 is configured as a pulse test source to help detect wiring faults on these contactor feedback circuits. The programmable safety function blocks associated with each device performs self checking. If a fault occurs, the respective Fault Reset button must be pressed, after the fault is cleared.

Ratings

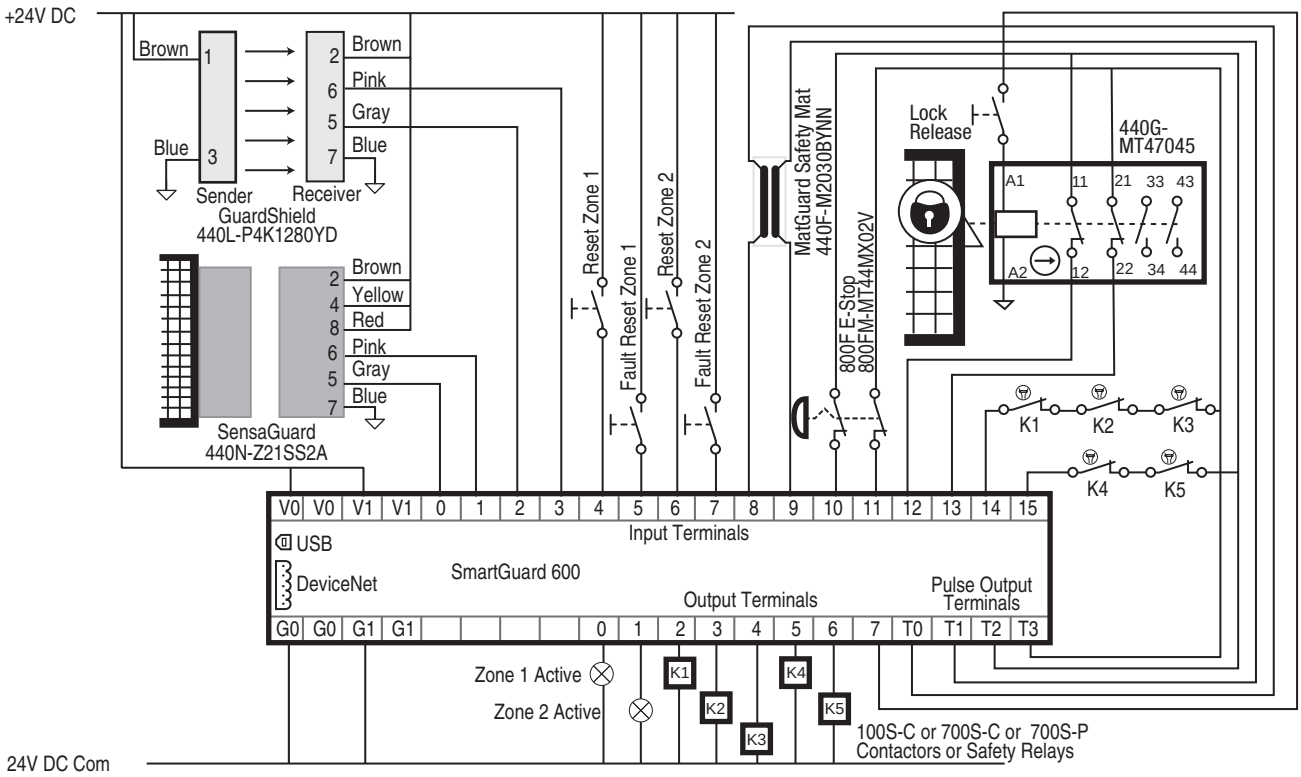
The ratings assume that two contactors are connected in series to power the hazards. The safety function intiated by the SensaGuard interlock, GuardShield light curtains, and 800F e-stop meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. The safety functions initiated by the SafeZone scanner and 440G-MT interlock meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and have a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.

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Allen-Bradley
GuardMaster®

Safety PLC—Two Zones

GuardShield, SensaGuard, MatGuard, 800F, 440G-MT, SmartGuard 600, 100S, 700S



Circuit Status

The SmartGuard is programmed to control two zones without a DeviceNet connection. The GuardShield and SensaGuard control zone 1 with contactors K1, K2 and K3. The MatGuard and the 440G-MT control zone 2 with contactors K4 and K5. The MatGuard, located behind the locked safety gate, is used to detect someone in the hazard area. The e-stop applies to both zones. The two safety gates are closed, the light curtain and safety mat are clear and the e-stop is released. Both zones are ready to be activated.

Safety Mat Principles

Outputs T0 and T1 are configured as standard diverse outputs to source the 24V for the safety mat circuits. When a demand is placed on the mat, the circuits short together and both inputs (IN8 and IN9) are HI. Software detects the non-diversity and de-energizes zone 2. In this application, stepping on the mat cannot be differentiated from an actual channel to channel short between the mat circuits. Due to this, stepping on the mat must stop the hazard, and a manual reset is required to restart after each demand on the mat.

Operating Principle

STARTING: Press the reset button for each zone to energize the safety outputs of the SmartGuard. Two indicators are illuminated to show the zones are active. The safety contactors K1 through K5 become energized and allow the zones to operate. Spare contacts (not shown) on the K1-K5 devices signal the machine control system that the zones are ready to run. The machine control system (not shown) controls the zones.

STOPPING: Obstructing the light curtain or opening the SensaGuard gate will de-energize the K1-K3 contactors. Clearing the light curtain or closing the gate will not cause the contactors to energize. The zone 1 Reset button must be pressed to restart zone 1. The e-stop acts as a global stop. When pressed, both zones are de-energized. The guard locking gate is associated with the e-stop. After pressing the e-stop, the SmartGuard energizes output 7 which provides voltage for the guard locking solenoid. Press the Lock Release push button to power the solenoid and open the gate. Closing the gate or resetting the e-stop does not re-energize the K1-K5 contactors. The respective zone reset buttons must be pressed after the input devices are cleared.

Fault Detection

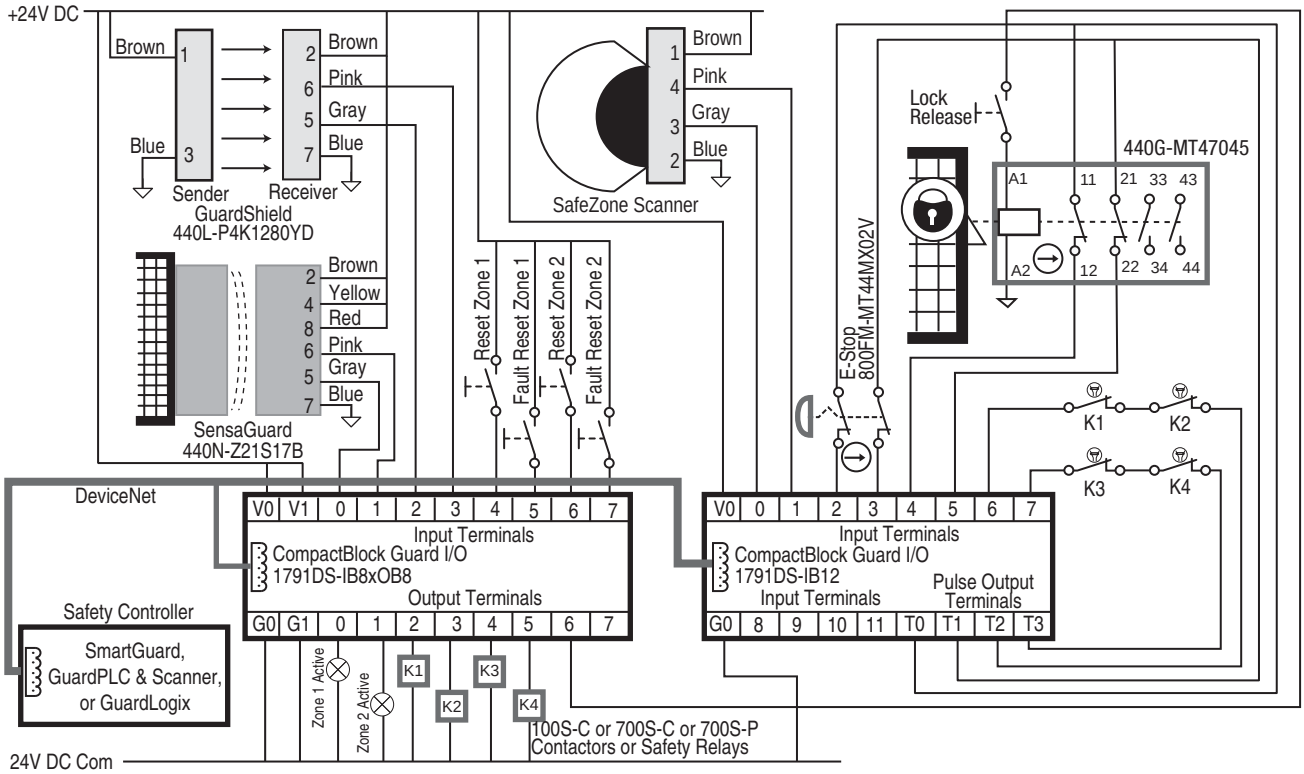
Upon successful completion of internal checks on power up, the SmartGuard checks the input devices. The pulsed outputs T2-T3 are used by the SmartGuard to help check for open and short-circuit fault conditions. If a fault is detected, the SmartGuard will not energize the respective outputs. When the zone reset buttons are pressed, the SmartGuard checks the status of the K1-K5 contactors. If the contactors are energized, stuck or welded closed, the SmartGuard will detect this due to the open circuit to Inputs 14 or 15, and will not energize the respective zone. The programmable safety function blocks associated with each device performs self-checking. If a fault occurs, the respective fault reset button must be pressed, after the fault is cleared.

Ratings

The ratings assume that two contactors are connected in series to power the hazards. The safety function intiated by the SensaGuard interlock, GuardShield light curtains, and 800F e-stop meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. The safety functions initiated by the MatGuard safety mat and 440G-MT interlock meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and have a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop. If only one contactor is used to power a hazard, the safety function can meet SIL CL 2, Category 2 structure and PLd.

Safety I/O—Two Zones Distributed

GuardShield, SensaGuard, SafeZone, 800F, 440G-MT, CompactBlock Guard I/O, 100S, 700S



Safety Control System

Compact Block Guard I/O resides on a DeviceNet safety network and operates as a safety slave. Safety Masters that can 'own' the Compact Block Guard I/O modules include GuardLogix, SmartGuard, and the GuardPLC safety controllers. Note the GuardPLC requires a 1753-DNSI Safety Scanner to 'own' Compact Block Safety I/O. For the remainder of this application note, the Safety Master will be referred to as the 'safety controller.' Since the various Safety Controllers have varied communication interfaces to the standard machine control system, this application note will make no references to this link.

Circuit Status

The safety controller is programmed to control two zones. The GuardShield and SensaGuard control zone 1 with contactors K1 and K2. The SafeZone Laser Scanner and 440G-MT control zone 2 with contactors K3 and K4. The SafeZone, located behind the locked safety gate, is used to detect someone in the hazard area. The E-Stop applies to both zones. The two safety gates are closed, the light curtain and laser scanner are cleared and the e-stop is released. Both zones are ready to be activated.

Operating Principle

STARTING: Press the reset button for each zone to allow the safety controller to energize the safety outputs of the CompactBlock Guard I/O. The safety contactors K1 through K4 become energized and allow the zones to operate. The safety controller signals the machine control system that the zones are ready to run. The machine control system (not shown) controls the zones.

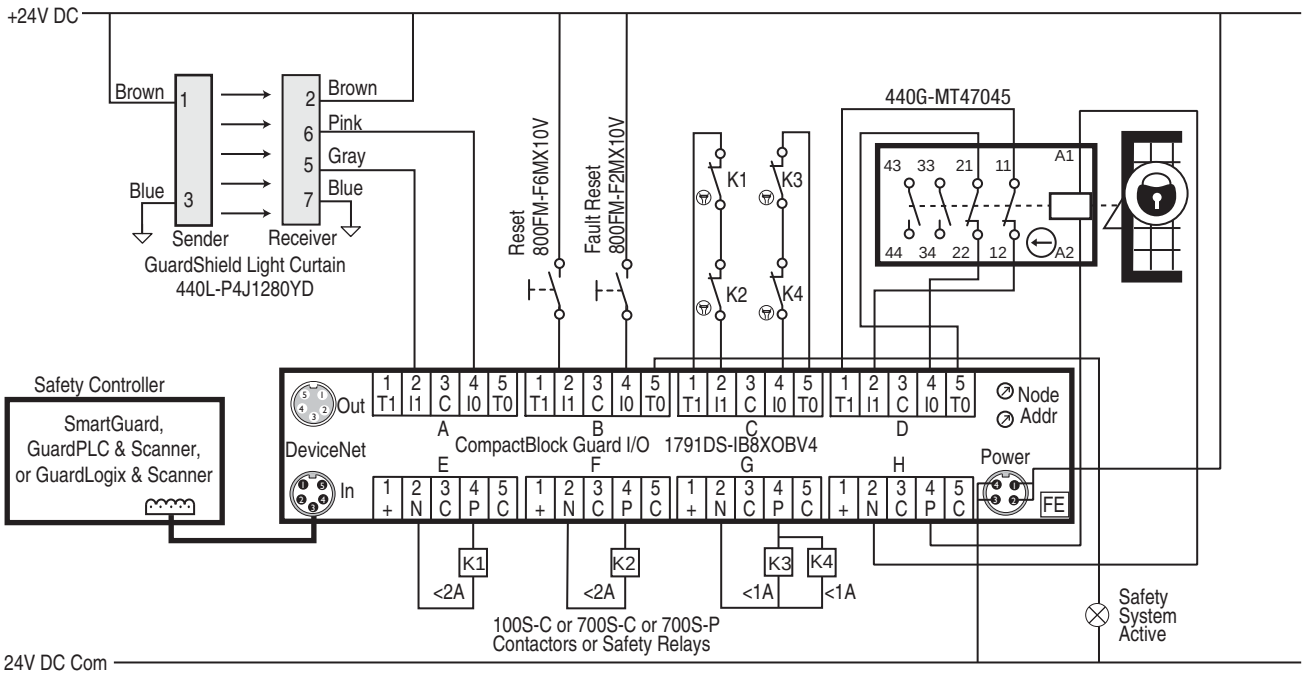
STOPPING: Obstructing the light curtain or opening the SensaGuard gate will de-energize the K1 and K2 contactors. Clearing the light curtain or closing the gate will not cause the contactors to energize the zone 1 Reset button must be pressed to restart zone 1. The e-stop acts as a global stop. When pressed, both zones are de-energized. The safety controller energizes Output 6 to provide voltage for the 440G-MT guard locking solenoid. Press the Lock Release button and open the gate. Closing the gate or resetting the e-stop does not re-energize the K1-K4 contactors. The zone reset buttons must be pressed after clearing the input devices.

Fault Detection

Upon successful completion of internal checks on power up, the CompactBlock Guard I/O checks the input devices. Test outputs T2 and T1 are configured as pulse test sources and are used by the CompactBlock Guard I/O to help check for open and short-circuit fault conditions of the E-Stop and Gateswitch. If a fault is detected, the safety controller will not energize or will de-energize the respective outputs. The safety controller checks the status of the K1-K4 contactors. If the contactors are energized, stuck or welded closed, the safety controller will detect this due to the open circuit to Inputs 6 or 7 on the IB12, and will not energize the respective zone. Test outputs T2 and T3 are used to help detect wiring faults on these contactor feedback circuits. The programmable safety function blocks associated with each device performs self checking. If a fault occurs, the respective Fault Reset button must be pressed, after the fault is cleared.

Ratings

The ratings assume that two contactors are connected in series to power the hazards. The safety function intiated by the SensaGuard interlock, GuardShield light curtains, and 800F e-stop meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. The safety functions initiated by the SafeZone scanner and 440G-MT interlock meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and have a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop.



Circuit Status

The light curtain is cleared, and the 440G-MT guard locking switch is closed and locked. The contactors K1-K4 are off. The safety system is ready to be energized.

Operating Principle

The 1791DS-IB8X0BV4 has bi-polar outputs, which allows the module to switch both the positive and negative side of the load device (e.g. contactors and solenoids) and to check for faults on both the positive and negative side of the load.
STARTING: Press the reset button to energize the contactors K1-K4. The safety controller verifies that the monitoring circuits at terminals in the "C" connector are closed. The safety contactors K1 through K4 become energized and allow the machine to run. The Safety System Active indicator is turned on by the safety controller. The safety controller signals the machine control system that the safety system is ready to run. The machine control system (not shown) controls the machine.
STOPPING: Obstructing the light curtain de-energizes contactors K1-K4. The contactors may also be de-energized by the safety controller due to other safety demands (like a system level e-stop). When the contactors K1-K4 are de-energized, the solenoid of the 440G-MT can be energized and allow the gate to be opened. While the gate is open, the program in the safety controller must not allow the contactors to re-energize. Closing the gate or clearing the light curtain do not re-energize the contactors. Press the reset button to re-energize the contactors.

Fault Detection

Upon successful completion of internal checks on power up, the safety controller checks the input devices. Test outputs T0 and T1 in the "D" connector are configured as pulse test sources and are used by the safety controller to help check for open and short-circuit fault conditions of the 440G-MT gateswitch. If a fault is detected, the safety controller will not energize the K1-K4 contactors. The safety controller checks the status of the K1-K4 contactors. The safety controller will detect contactors that are energized, stuck or welded closed by the open circuits at inputs I0 and I1 and will not energize the respective zone. The contactors and the 440G-MT solenoid are switched on both the positive and negative side, so shorts to either the supply voltage or to ground will be detected. After clearing a fault, press the Fault Reset button to reset the module. Press the Reset button to allow the contactors to be energized.

Programming

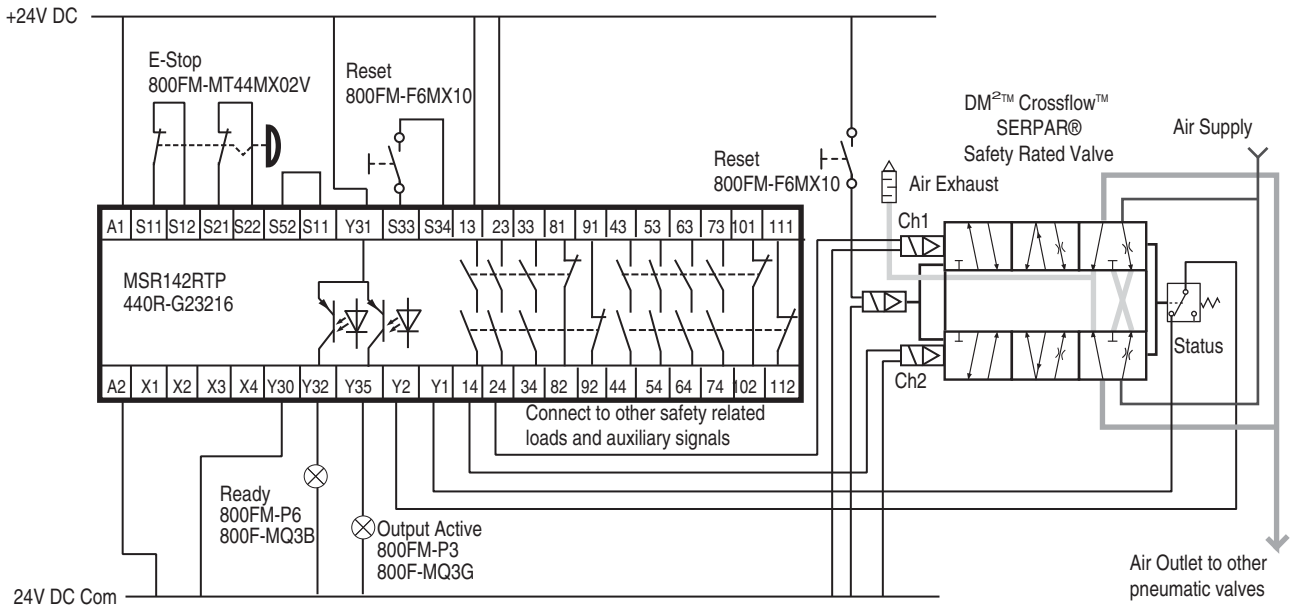
The safety outputs of the 1791DS-IB8XOBV4 are configured in firmware as four (4) dual channel pairs. Both outputs in the pair must be complementary or a fault occurs. Outputs TO and T` in the "D" connector must be configured as pulse outputs. Test outputs T0 in the "B" connector must be configured in software as 'standard outputs' to drive the Safety System Active indicators.

Ratings

The ratings assume that two contactors are connected in series to power the hazards. The safety function intiated by the GuardShield light curtain meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has a Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1:2006. The safety functions initiated by the 440G-MT interlock meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and have a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1:2006. This circuit executes a Category 0 stop. If only one contactor is used to power a hazard, the safety function can meet SIL CL 2, Category 2 structure and PLd.

Safety Valve & E-Stop—Air Supply Release

800F, MSR142, Pneumatic Safety Valve



Circuit Status

The e-stop button is released, the MSR142 safety relay outputs are off and the pneumatic valve is closed.

Operating Principle

STARTING: Press the reset button to energize the output contacts of the safety relay. The two solenoids in the valve energize and allow air to flow from the Air Supply to the Air Outlet.

STOPPING: Pressing the e-stop button de-energizes the safety outputs of the MSR142, which in turn drops out the solenoids of the safety valve. The valve closes the Air Supply and releases the air pressure to the Air Exhaust. Releasing the e-stop button does not cause the valve to turn back on.

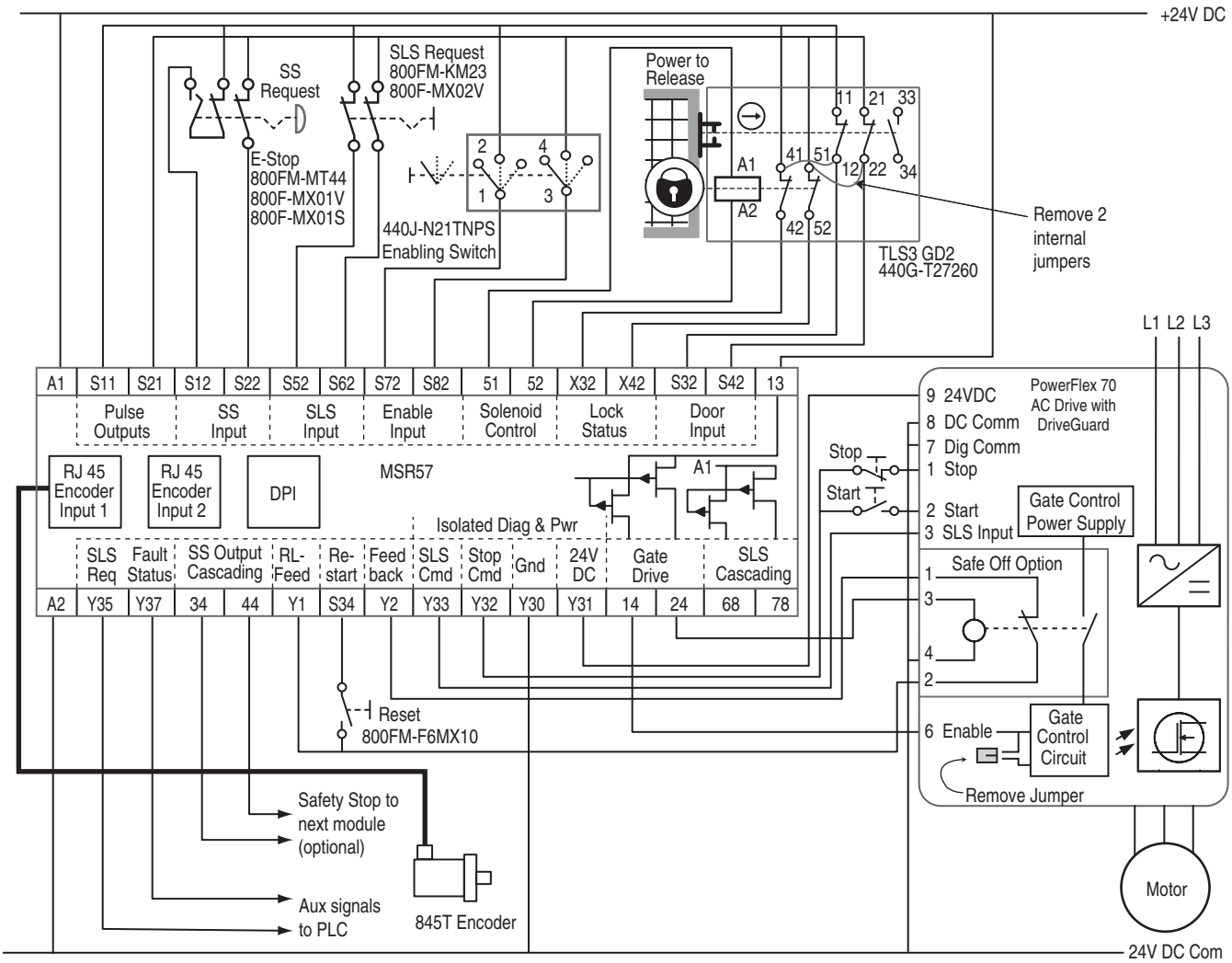
Fault Detection

Upon successful completion of internal checks on power up, the MSR142 checks the e-stop status. If an open or short circuit is detected, the MSR142 will not energize its outputs. If both input circuits are properly closed, the MSR142 checks the status of the safety valve. If one or both solenoids of the safety valve are energized, the Status contact will be open, and the MSR142 will not energize its outputs. If both solenoids are de-energized, Status contact will be closed and the MSR142 will turn on its Ready LED. Pressing the Reset button energizes the MSR142 safety outputs and opens the safety valve.

The safety valve performs its own internal checks. If one of the valves remains actuated, gets stuck or moves too slowly, the Air Outlet flow will be re-directed to the exhaust. To clear the fault condition, both valves must be de-energized and the valve reset button pressed.

Ratings

The safety function initiated by the 800F e-stop button meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. The MSR142 has seven safety rated outputs. To maintain the highest safety levels, these outputs must drive redundant actuators which must be monitored for proper performance. This example circuit performs a Stop Category 0 function (coast to stop).



Circuit Status

The safe stop (SS) request e-stop button is released. The safe limited speed (SLS) request button is released. The enabling switch is released. The guard locking interlock is closed and locked. The safety outputs (Gate Drive) of the MSR57 are off. The motor is off.

Operating Principle

The MSR57 performs the safe limited speed function. It provides a signal to the drive to initiate the slow speed. The MSR57 accepts encoder signals to monitor the speed. When the speed is within the safe speed limit, the guard locking device is allowed to open. If the speed exceeds the limit, a safe shutdown is initiated.
STARTING: Press the reset button to energize outputs of the MSR57. Then press the start button to turn on the motor. The motor will execute its programmed function.
SAFE LIMITED SPEED: Turn the key operated selector switch to the SLS position and remove the key. The MSR57 sends a command to the drive to go to its configured safe limited speed. When the motor reaches and stays at the limited speed, the guard locking door becomes unlocked. Grip the enabling switch to the middle position and enter the hazard area. Exit the hazard area while holding the GripSwitch. Switch the SLS request to run. Then press the reset button to allow the drive to rotate the motor at high speeds. The GripSwitch can then be released.
STOPPING: The e-stop can be pressed at any time to initiate a stop. If the speed exceeds the limit or the GripSwitch is released, a safe-off stop is initiated.

Fault Detection

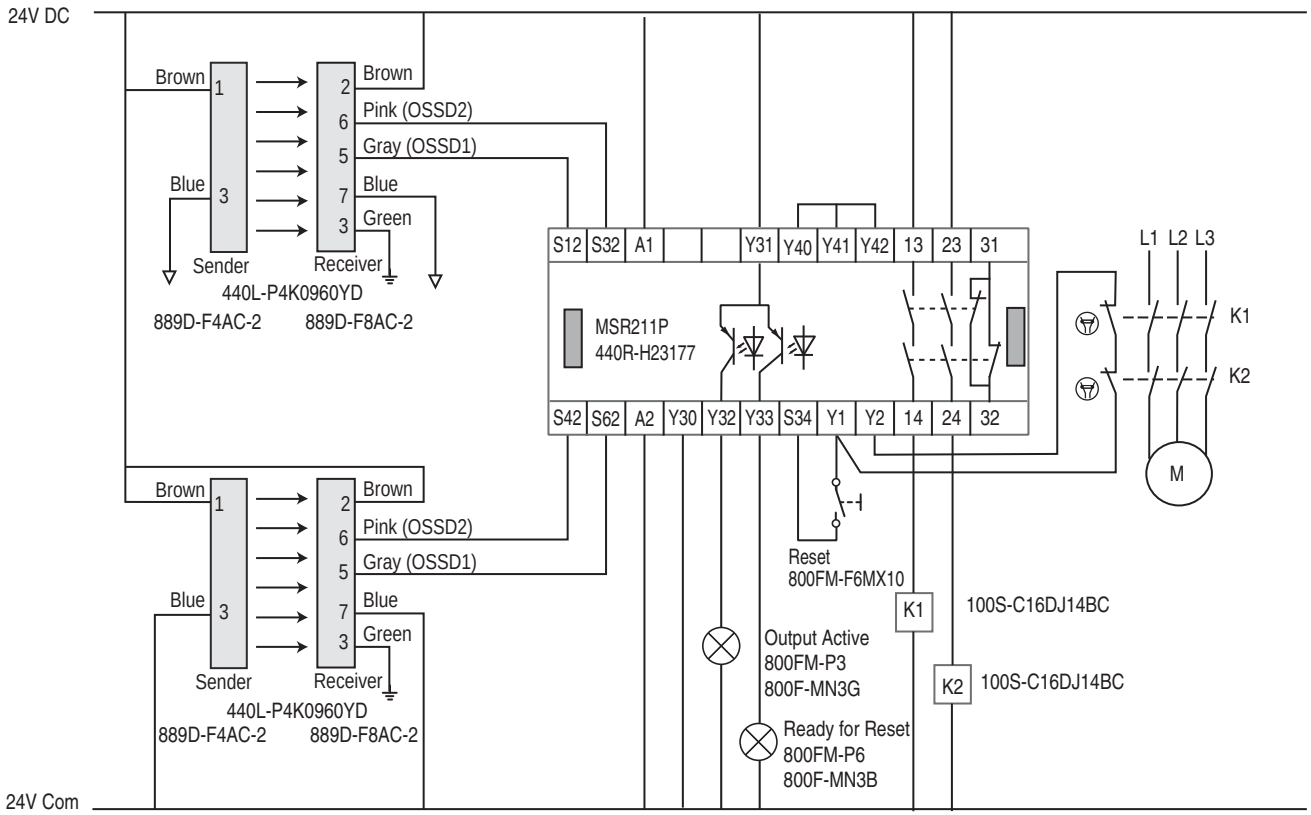
Upon power-up the MSR57 and PowerFlex 70 perform internal checks. The MSR57 generates continuous test pulses to check for short circuit at the input devices. Dual channel inputs and outputs provide single fault tolerance.

Ratings

The safety functions initiated by the 800F e-stop and TLS3-GD2 guardlocking device meet the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. This example circuit performs a Stop Category 1 function (brake and then remove power to motor).

Modular Relay—Single Zone

GuardShield, 800F, MSR211, 100S



Circuit Status

Both light curtains are clear. The MSR211P output contacts are de-energized. The motor is off and ready to run.

Operating Principle

The MSR211P accepts two light curtains and functions as an alternative to a cascaded arrangement of light curtains.
STARTING: Press the reset button to energize the outputs of the MSR211P, which turns the motor on.
STOPPING: Obstructing either light curtain causes the motor to stop.

Fault Detection

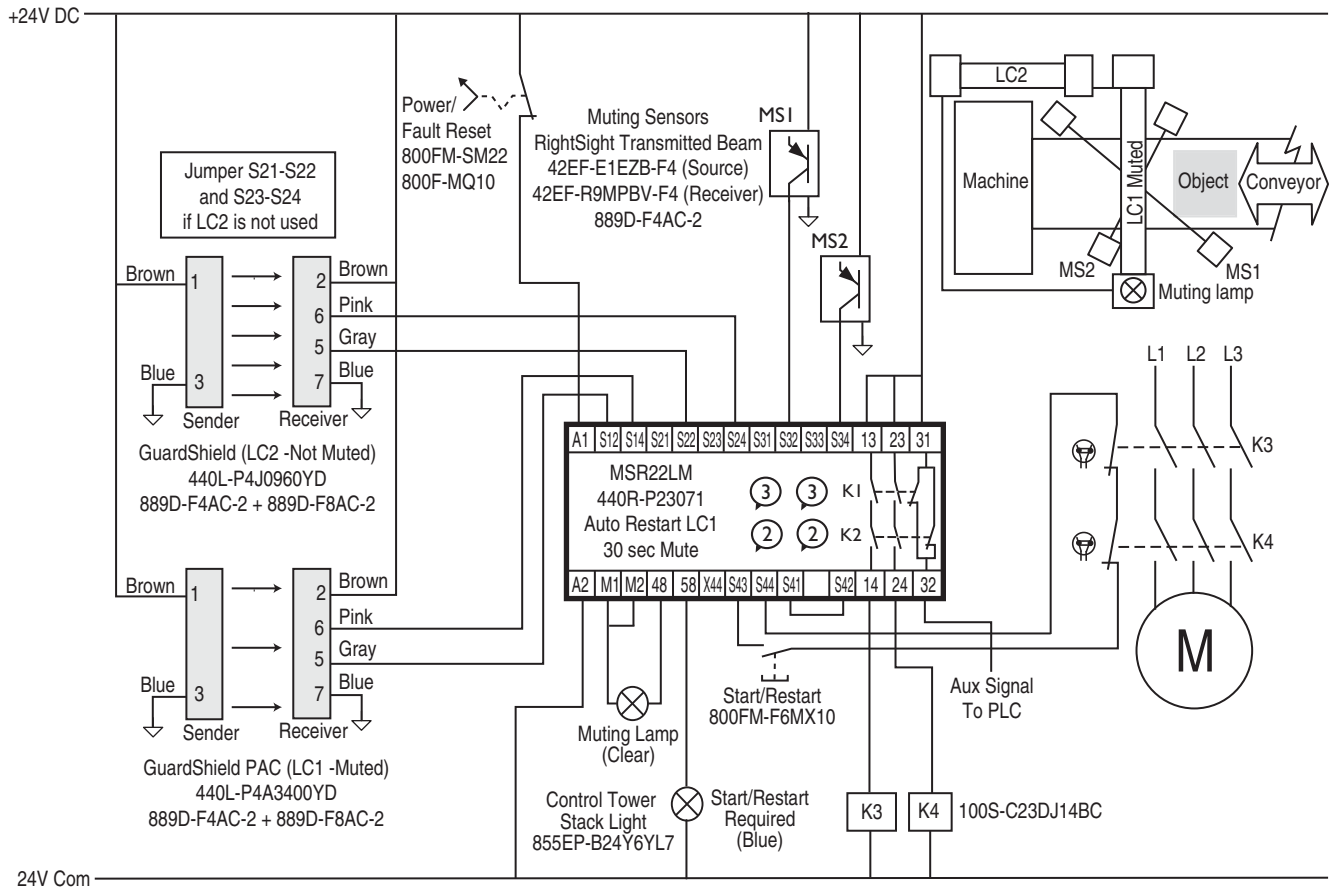
Upon successful completion of internal checks on power-up, the MSR211 checks the input signals from the GuardShield light curtains. If all four signals from the light curtains are present and no shorts exist, the MSR211P checks for the reset button. With the jumper from Y40 to Y42, the MSR211P checks to make sure the reset button is not held closed. When the reset button is pressed, the MSR211P checks the status of the two contactors. If the circuit on Y1/Y2 is closed, the MSR211 energizes its output. With the jumper from Y40 to Y41, the MSR2f11P confirms that both contactors are energized within 300 ms.

Ratings

The safety functions initiated by the two GuardShield light curtains meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).

Light Curtain—Muting with Two Sensors

GuardShield, RightSight, 800F, Control Tower, MSR22LM, 100S



Circuit Status

The light curtain is clear. The muting sensors are clear. The outputs of the safety relay are de-energized, and the motor is off.

Operating Principle

The MSR22LM is designed for automated conveyor applications, where an object moves through a light curtain into or out of a hazardous area. With two sensor muting, the object can move in both directions.

STARTING: Upon initial power-up, the start/restart button must be pressed to energize the outputs of the MSR22LM and start the motor.

MUTING: The object must block the sensor MS1 and then MS2 prior to passing through the light curtain. After passing through the light curtain, the object must clear MS2 and then MS1 for the motor to continue running during the muting operation.

STOPPING: Obstructing the light curtain without blocking sensors MS1 and MS2 de-energizes the MSR22LM safety outputs. After clearing the light curtain, press the start/restart button to re-energize the safety outputs of the MSR22LM.

Fault Detection

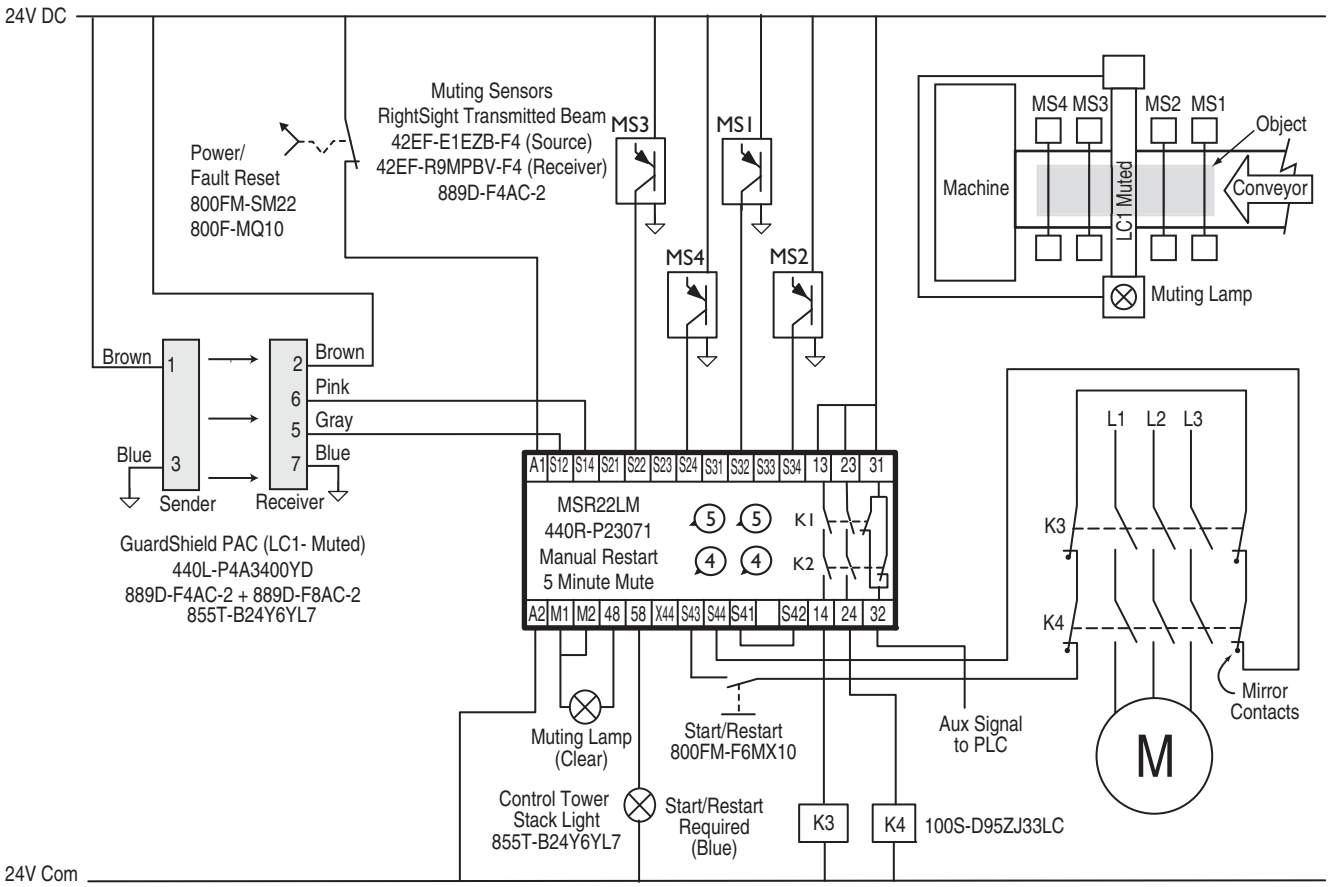
Upon power-up, the GuardShield and MSR22LM perform internal checks. If OK and clear, the GuardShield outputs turn on. The MSR22LM checks the muting inputs. If OK, the MSR22LM checks the light curtain for dual channel signals. If OK, the muting lamp blinks continuously and the start/restart required lamp turns on to indicate that the MSR22LM is ready to start. While running, an incorrect sequence of the muting sensors and light curtain operation or excessive time to move the object through the light curtain will de-energize the safety outputs of the MSR22LM. The run LEDs or the muting lamp blink at certain rates to indicate the type of fault that has occurred. The start/restart button can be held down for three seconds to manually move material through the conveyor. The motor will then run for 12 seconds. Some faults can be cleared by removing the object from the sensors. The start/restart required indicator will turn on when the MSR22LM is ready to go. Other faults may have to be cleared by cycling the power to the MSR22LM. The MSR22LM monitors the 100S contactors through mechanically linked contacts connected in series. If one contactor welds closed, the second contactor will stop the motor, and the MSR22LM will detect the fault at the next attempt to start the motor.

Ratings

The safety functions initiated by the two GuardShield light curtains meet the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).

Light Curtain—Muting with Four Sensors

GuardShield, RightSight, 800F, Control Tower, MSR22LM, 100S



Circuit Status

The light curtain is cleared. The muting sensors are cleared. The outputs of the safety relay are de-energized, and the motor is off.

Operating Principle

The MSR22LM is designed for automated conveyor applications, where an object moves through a light curtain into or out of a hazardous area. With four sensor muting, the object can only move in one direction.

STARTING: Upon initial power-up, the start/restart button must be pressed to energize the outputs of the MSR22LM and start the motor.

MUTING: The object must block the sensors MS1 and MS2 prior to passing through the light curtain. The object must be large enough to block all four sensors, for the motor to continue running during the muting operation.

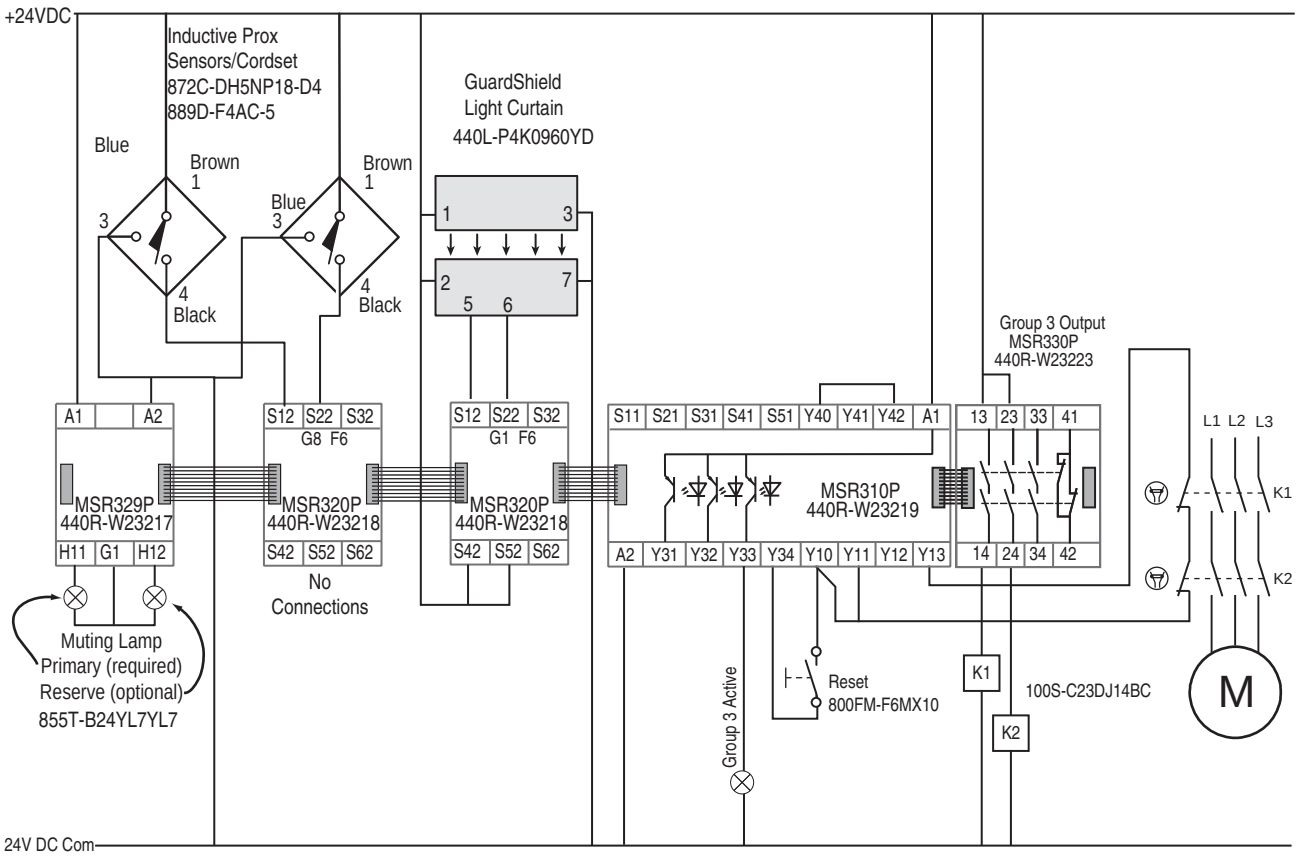
STOPPING: Obstructing the light curtain without blocking sensors MS1 and MS2 de-energizes the MSR22LM safety outputs. After clearing the light curtain, press the start/restart button to re-energize the safety outputs of the MSR22LM.

Fault Detection

Upon power-up, the GuardShield and MSR22LM perform internal checks. If OK and clear, the GuardShield outputs turn on. The MSR22LM checks the muting inputs. If OK, the MSR22LM checks the light curtain for dual channel signals. If OK, the muting lamp blinks continuously and the start/restart required lamp turns on to indicate that the MSR22LM is ready to start. While running, an incorrect sequence of the muting sensors and light curtain operation or excessive time to move the object through the light curtain will de-energize the safety outputs of the MSR22LM. The run LEDs or the muting lamp blink at certain rates to indicate the type of fault that has occurred. The start/restart button can be held down for three seconds to manually move material through the conveyor. The motor will then run for 12 seconds. Some faults can be cleared by removing the object from the sensors. The start/restart required button will turn on when the MSR22LM is ready to go. Other faults may have to be cleared by cycling the power to the MSR22LM. The MSR22LM monitors the 100S-D contactors through the mechanically linked "mirrored" contacts connected in series. If one contactor welds closed, the second contactor will stop the motor, and the MSR22LM will detect the fault at the next attempt to start the motor.

Ratings

The safety function initiated by the GuardShield light curtain meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).



Circuit Status

The light curtain is clear. The inductive proximity sensors are clear. The MSR330P outputs are de-energized. The motor is off.

Operating Principle

The MSR300 is configured for a muting function. When both proximity sensors detect appropriate targets, the light curtain function is muted. The proximity sensors operate as a pair and do not have to operate in a specific sequence. The application must be an automatic process where the muting function is temporary. A muting lamp indicates when the muting function is active. The muting lamp is monitored. If the muting lamp burns out, the MSR300 will continue to function if a reserve lamp is present; otherwise the output stay off until the primary muting lamp is replaced.

STARTING: Press the reset button to energize all MSR330P outputs. The contactors K1 and K2 energize and the motor is turned on.

STOPPING: Obstructing the light curtain when the proximity sensors are not active will cause the MSR310P to de-energize and stop the motor.

Fault Detection

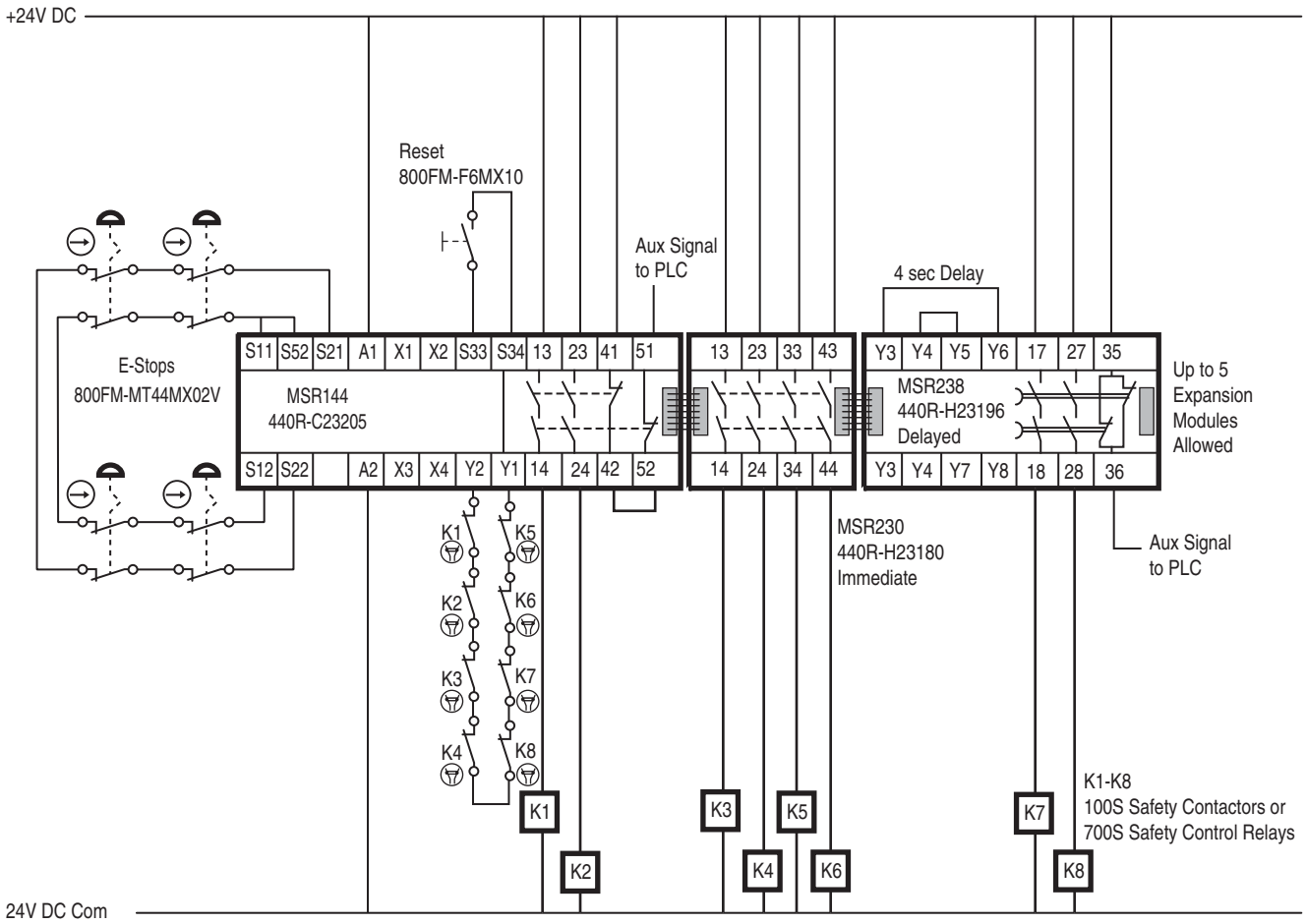
Upon successful completion of internal checks on power up, the MSR310P checks the input circuits. Shorts from the inputs to power, ground or other inputs will be detected immediately and will prevent energizing or will de-energize the MSR330P outputs. If one of the 100S output devices (K1 or K2) is stuck in an actuated state, the MSR310P will prevent startup because the Y10/Y13 feedback loop will remain open. The proximity sensors must be located in a way that prevents easy bypassing with spare targets.

Ratings

The safety function initiated by the GuardShield light curtain meets the safety performance requirements of SIL CL 3 per IEC 62061:2005 and has Category 4 structure that can be used in systems requiring Performance Levels up to PLe per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).

Expandable Outputs—E-Stop with Immediate and Delayed Outputs

800F, MSR144, MSR230, MSR238, 100S, 700S



Circuit Status

The e-stop is reset. The safety outputs of the MSR144, MSR230 and MSR238 are de-energized. The motor is off.

Operating Principle

The MSR144 was chosen for its ability to expand its outputs with a combination of MSR230 and MSR238 modules. Up to five modules can be added to one MSR144. Ribbon cables on the front of the relay extend control of the MSR144 to MSR230 and MSR238. Without jumpers to X1/X2 and X3/X4, the MSR144 is set to monitored manual reset.

STARTING: Press and release the reset button to energize the outputs of the MSR144, MSR230 and MSR238. K1-K8 safety contactors or safety control relays energize to control the hazardous portion of the machine.

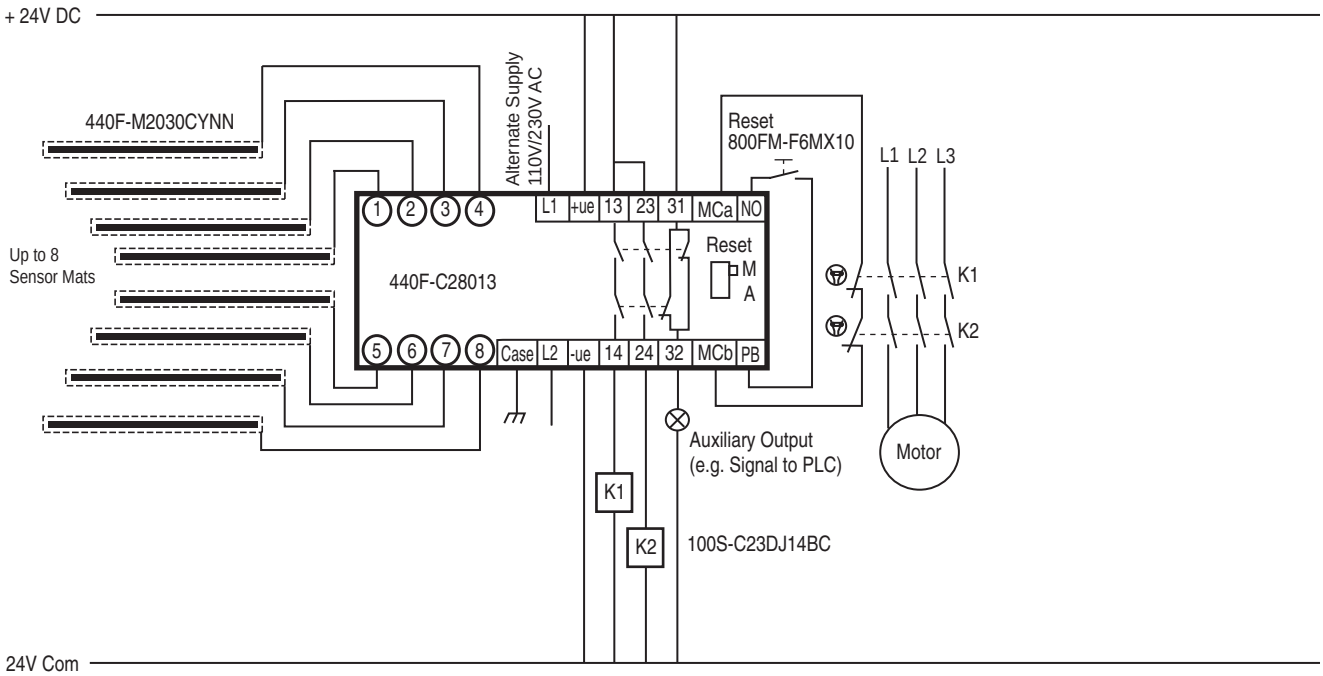
STOPPING: When an e-stop is pressed, the safety outputs of the MSR144 and MSR230 immediately turn off and de-energize K1-K6. Four seconds later, the safety outputs of the MSR238 turn off and de-energize K7 and K8.

Fault Detection

Upon power-up, the MSR144 performs internal checks. The checks also include verification that the MSR230 and MSR238 modules are in the off state. The MSR144 then looks for dual signals from the e-stop circuit. A crossfault on the e-stop circuit will be detected by the MSR144. With the e-stop signals made, closing the reset button places a voltage to the Y2 terminal. The external devices (K1 through K8) are checked to confirm they are off. A fault in K1 through K8 will cause their normally closed contacts to remain open, and this fault will be detected by the MSR144.

Ratings

The safety function initiated by the series connection of 800F e-stop buttons meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. The Category 3 rating requires the redundant usage of K1-K8 to de-energize the machine actuators, and the contactors must be monitored by the safety system. This example circuit performs a Stop Category 0 function (coast to stop).



Circuit Status

There is no presence on the safety mats. The safety outputs of the Mat Manager are de-energized. The motor is off.

Operating Principle

The Mat Manager monitors up to eight mats, which are individually connected to the Mat Manager by M12 connectors. LEDs on the front of the Mat Manager indicate which mat is actuated as well as providing status LED for power and safety outputs.
STARTING: Press the reset button to energize the outputs of the Mat Manager.
STOPPING: Stepping on any of the safety mats will turn off the safety outputs of the Mat Manager and de-energize the K1 and K2 contactors.

Fault Detection

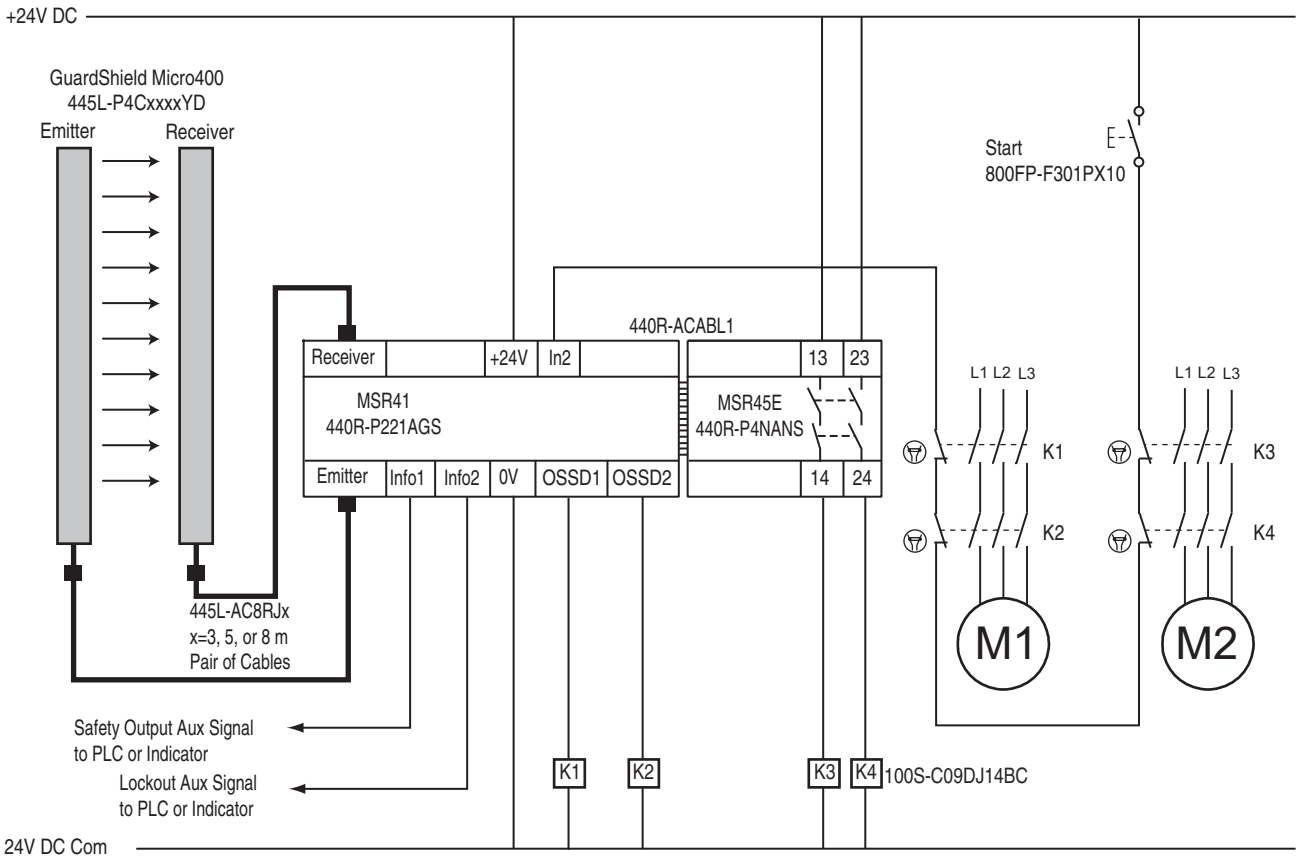
Upon power-up, the Mat Manager performs internal checks. The Mat Manager then looks for current flowing through each of the safety mats. A short or open circuit on any of the safety mats will be detected by the Mat Manager. With the safety mat signals made, the Mat Manager checks the reset button. With monitored manual reset selected, a short circuit or stuck pushbutton will be detected by the Mat Manager. Pressing the reset button, the Mat Manager checks the K1 and K2 contactors. A stuck or welded contactor will be detected by an open normally closed contact.

Ratings

The safety function initiated by the MatGuard safety mat meets the safety performance requirements of SIL CL 2 per IEC 62061:2005 and has Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. This example circuit performs a Stop Category 0 function (coast to stop).

Micro400 Light Curtain with Controller and Expansion Module

Micro400, MSR41, MSR45E, 100S



Circuit Status

The light curtain is clear. K1, K2, K3 and K4 are off. The motors are off and ready to run.

Operating Principle

STARTING: Momentarily press the Start button. The OSSD safety outputs and the safety contacts 13/14 and 23/24 close. The contactors K1-K4 energize, and the motors M1 and M2 start.
STOPPING: Breaking the light curtain causes the OSSD safety outputs and the safety contacts 13/14 and 23/24 to open. The contactors K1-K4 drop out and the motors coast to a stop.

Removing the object from the light curtain will not cause the motor to run. The operator must momentarily close the Start switch to turn the motor on.

Fault Detection

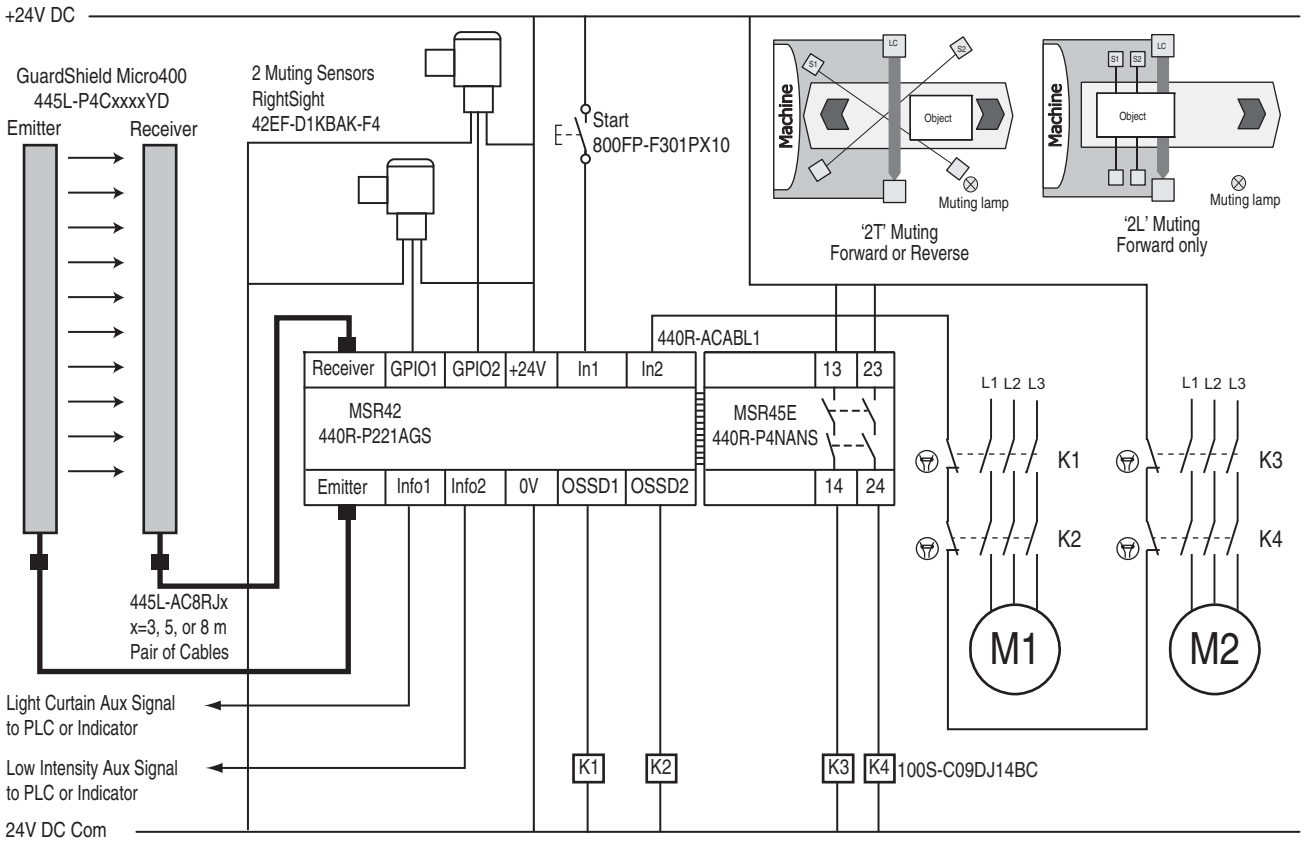
Upon successful completion of internal checks on power up, the GuardShield light curtain energizes its outputs with no objects present. The GuardShield light curtain outputs turn on. If a crossfault is detected, the GuardShield light curtain goes to a lockout state with its outputs off. After successful completion of internal checks, the MSR41 checks the signals from the light curtain. If it's okay, the MSR41 then checks the status of the K1-K4 contactors. If one of the pair of contactors fails in the actuated state, the other contactor will disconnect the motor. The MSR41 will detect the faulted contactor and will not allow the motor to restart until the fault is corrected.

Ratings

This circuit can meet the safety performance requirements of PLe per ISO13849-1: 2006 and SIL CL3 per IEC62061:2005. This circuit executes a Category 0 stop.

Two Sensor Muting with Micro400 Light Curtain

42EF, Micro400, MSR42, 100S



Circuit Status

The light curtain and muting sensors are clear. K1, K2, K3 and K4 are off. The motors are off and ready to run.

Operating Principle

STARTING: Momentarily press the Start button. The OSSD safety outputs turn on and the safety contacts 13/14 and 23/24 close. The contactors K1-K4 energize, and the motors M1 and M2 start.

MUTING: The MSR42 must be configured for two sensor L-type or T-type sensing. When the object passes by the sensors in the proper sequence, the light curtain becomes muted. The muting process is complete when the object passes by both sensors, and the light curtain becomes active again.

STOPPING: Breaking the light curtain causes the OSSD safety outputs and the safety contacts 13/14 and 23/24 to open. The contactors K1-K4 drop out and the motors coast to a stop.

Fault Detection

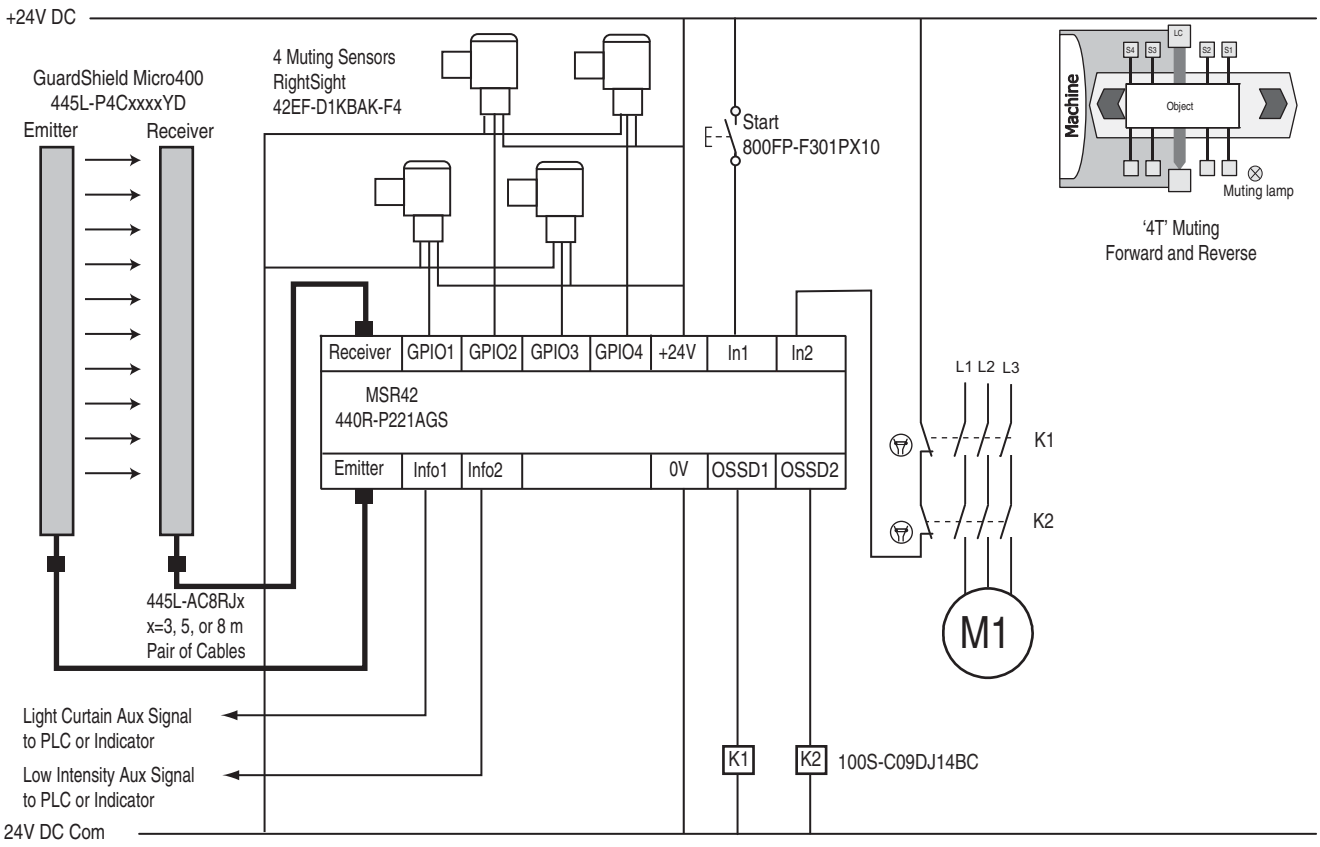
Upon successful completion of internal checks on power up, the GuardShield light curtain energizes its outputs with no objects present. The GuardShield light curtain outputs turn on. If a crossfault is detected, the GuardShield light curtain goes to a lockout state with its outputs off. After successful completion of internal checks, the MSR42 checks the signals from the light curtain. If it's okay, the MSR42 then checks the status of the four sensors and the K1 and K2 contactors. If a sensor is shorted in the ON state, the MSR42 will not allow the OSSD outputs to turn ON. If one of the contactors fails in the actuated state, the other contactor will disconnect the motor. The MSR42 will detect the faulted contactor and will not allow the motor to restart until the fault is corrected.

Ratings

This circuit can meet the safety performance requirements of PLe per ISO13849-1: 2006 and SIL CL3 per IEC62061:2005. This circuit executes a Category 0 stop.

Four Sensor Muting with Micro400 Light Curtain

42EF, Micro400, MSR42, 100S



Circuit Status

The light curtain and muting sensors are clear. K1 and K2 are off. The motor is off and ready to run.

Operating Principle

STARTING: Momentarily press the Start button. The OSSD safety outputs turn on. The contactors K1-K2 energize, and the motor M1 starts.
MUTING: The MSR42 must be configured for four sensor T-type sensing, with appropriate time settings. When the object passes by the sensors in the proper sequence, the light curtain becomes muted. The muting process is complete when the object passes by all the sensors and the light curtain becomes active again.
STOPPING: Violating the muting timing constraints and breaking the light curtain causes the OSSD outputs to turn off. The contactors K1-K2 drop out and the motors coast to a stop. If the object stops in the light curtain, the Start button can be used to temporarily override the muting function and energize the OSSD outputs.

Fault Detection

Upon successful completion of internal checks on power up, the GuardShield light curtain energizes its outputs with no objects present. The GuardShield light curtain outputs turn on. If a crossfault is detected, the GuardShield light curtain goes to a lockout state with its outputs off. After successful completion of internal checks, the MSR42 checks the signals from the light curtain. If it's okay, the MSR42 then checks the status of the four sensors and the K1 and K2 contactors. If a sensor is shorted in the ON state, the MSR42 will not allow the OSSD outputs to turn ON. If one of the contactors fails in the actuated state, the other contactor will disconnect the motor. The MSR42 will detect the faulted contactor and will not allow the motor to restart until the fault is corrected.

Ratings

This circuit can meet the safety performance requirements of PLe per ISO13849-1: 2006 and SIL CL3 per IEC62061:2005. This circuit executes a Category 0 stop.

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Pan-Europe
EP0467942, EP0620948, EP0736218, EP0821829, EP0864169, EP0935721, EP0968384, EP0985077, EP1089014, EP1136723, EP1139362, EP1255262

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Worldwide
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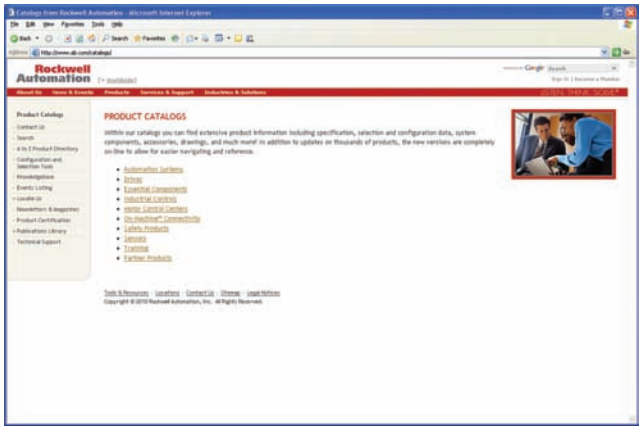
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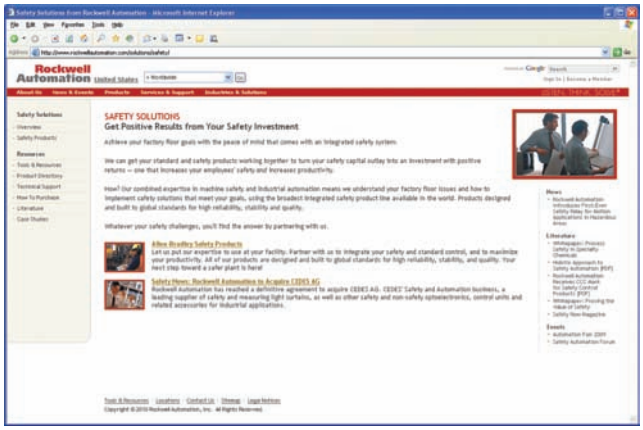
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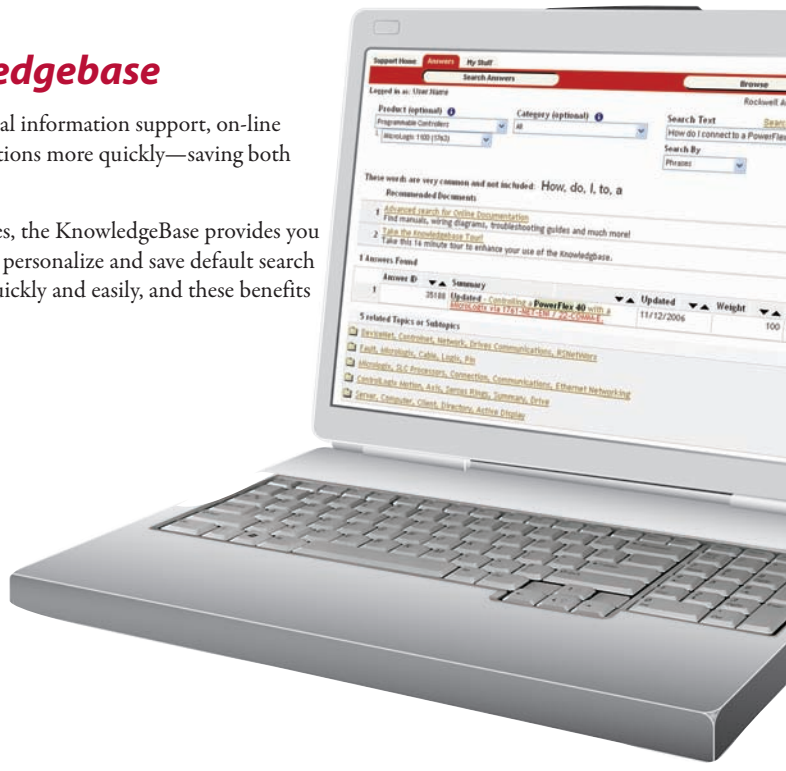


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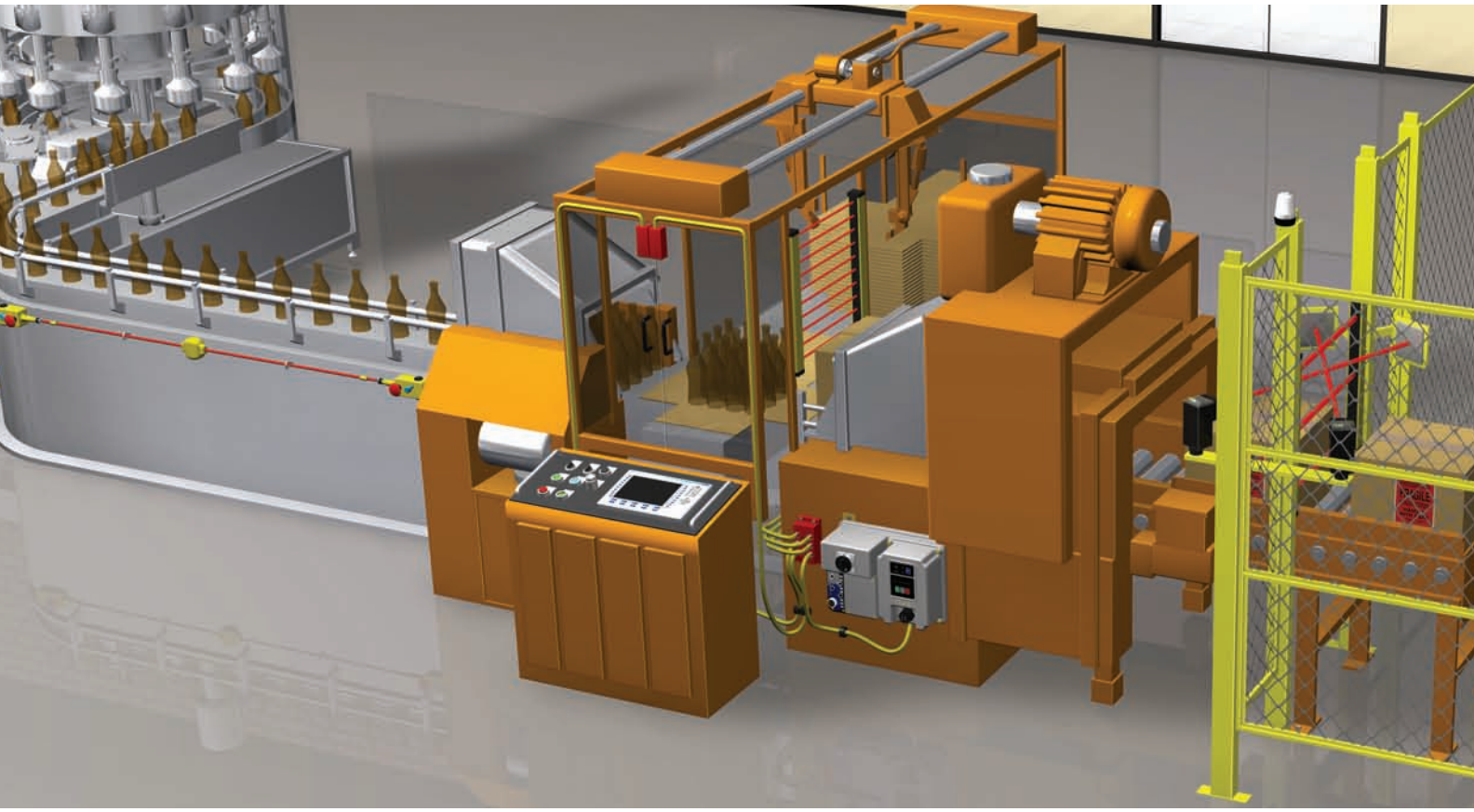
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