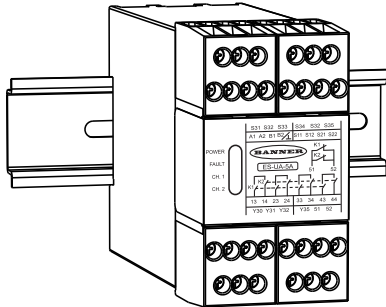


# ES-UA-5A and ES-VA-5A E-Stop Safety Modules



## Datasheet

Model ES-UA-5A for 12 to 24 V dc/115 ac operation; model ES-VA-5A for 12 to 24 V dc/230 ac operation



- Monitors emergency stop devices, such as palm buttons and rope/cable pulls, and positive-opening safety switches used for guard/gate interlocking
- The safety inputs can monitor:
  - Hard/relay contacts in a dual-channel hookup using terminals S11-S12 and S21-S22, or
  - A +24V dc source switched by hard/relay contacts in single-channel hookup
- Four normally open output switching channels for connection to control-reliable power interrupt circuits and three auxiliary output channels
- Automatic reset or monitored manual reset
- Design complies with standards ANSI B11.19, UL991, ISO 13850 (EN418), and ISO 13849-1 (EN954-1) (Safety Category 4)
- For use in functional stop category 0 applications per ANSI NFPA 79 and IEC/EN60204-1
- 6 amp safety output contacts; 5 amp aux. output contacts
- Plug-in terminal blocks

Models	Supply Voltage	Outputs	Output Rating
ES-UA-5A	12 to 24 V dc or 115 V ac	4 Normally open safety	N.O. Safety Outputs: 6 A
ES-VA-5A	12 to 24 V dc or 230 V ac	1 Normally closed aux. 2 Solid-state aux.	N.C. Aux. Outputs: 5 A SS Aux. Outputs: 100 mA



### WARNING: Not a Stand-Alone Safeguarding Device

This Banner device is not a stand-alone **point-of-operation** guarding device, as **defined** by OSHA regulations. It is necessary to install **point-of-operation** guarding devices, such as safety light screens and/or hard guards, to protect personnel from hazardous machinery. Failure to install **point-of-operation** guards on hazardous machinery can result in a dangerous **condition** which could lead to serious injury or death.

## Important: Read This First

The user is responsible for **satisfying** all local, state, and **national** laws, rules, codes, and regulations relating to the use of this product and its application. Banner Engineering Corp. has made every effort to provide complete application, installation, operation, and maintenance instructions. Please contact a Banner Applications Engineer with any questions regarding this product.

The user is responsible for making sure that all machine operators, maintenance personnel, electricians, and supervisors are thoroughly familiar with and understand all instructions regarding the installation, maintenance, and use of this product, and with the machinery it controls. The user and any personnel involved with the installation and use of this product must be thoroughly familiar with all applicable standards, some of which are listed within the specifications. Banner Engineering Corp. makes no claim regarding a specific recommendation of any organization, the accuracy or effectiveness of any information provided, or the appropriateness of the provided information for a specific application.

### Applicable U.S. Standards

ANSI B11 Standards for Machine Tools Safety

ANSI B11.19 Performance Criteria for Safeguarding

Contact: Safety Director, AMT – The Association for Manufacturing Technology, 7901 Westpark Drive, McLean, VA 22102, Tel.: 703-893-2900

ANSI NFPA 79 Electrical Standard for Industrial Machinery

Contact: National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, Tel.: 800-344-3555

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

Contact: Robotic Industries Association, 900 Victors Way, P.O. Box 3724, Ann Arbor, MI 48106, Tel.: 734-994-6088



Applicable **International Standards**

- ISO 12100-1 & -2 (EN 292-1 & -2) Safety of Machinery – Basic Concepts, General Principles for Design
- IEC 60204-1 Electrical Equipment of Machines Part 1: General Requirements
- IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems
- IEC 62061 Functional Safety of Safety-Related Electrical, Electronic and Programmable Control Systems
- ISO 13849-1 Safety-Related Parts of Control Systems
- ISO 13850 (EN 418) Emergency Stop Devices, Functional Aspects – Principles for Design
- Contact: Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112-5704, Tel.: 800-854- 7179

Overview

An Emergency Stop Safety Module is used to increase the control reliability of an emergency stop circuit. As shown in the wiring drawings, the models ES-UA-5A and ES-VA-5A E-Stop Safety Modules (the Safety Modules) are designed to monitor a 1-channel or 2-channel E-stop switch. A 2-channel E-stop switch has two electrically isolated contacts.

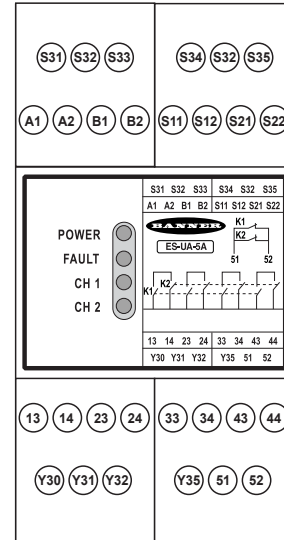


Figure 1. Features and Terminals

Safety Circuit Integrity and ISO 13849-1 (EN954-1) Safety Circuit Principles

Safety circuits involve the safety-related functions of a machine that minimize the level of risk of harm. These safety-related functions can prevent initiation, or they can stop or remove a hazard. The failure of a safety-related function or its associated safety circuit usually results in an increased risk of harm.

The integrity of a safety circuit depends on several factors, including fault tolerance, risk reduction, reliable and well-tried components, well-tried safety principles, and other design considerations.

Depending on the level of risk associated with the machine or its operation, an appropriate level of safety circuit integrity (performance) must be incorporated into its design. Standards that detail safety performance levels include ANSI B11.19 Performance Criteria for Safeguarding and ISO 13849-1 Safety-Related Parts of a Control System.

Safety Circuit Integrity Levels

The safety circuits in International and European standards have been segmented into categories, depending on their ability to maintain their integrity in the event of a failure. The most recognized standard that details safety circuit integrity levels is ISO 13849-1 (EN954-1), which establishes five levels: Categories B, 1, 2, 3, and 4 (most strict).

In the United States, the typical level of safety circuit integrity is called *control reliability*. Control reliability typically incorporates redundant control and self-checking circuitry and is relatively similar to ISO 13849-1 Categories 3 and 4 (see CSA Z432 and ANSI B11.19).

Perform a risk assessment to determine the appropriate category to make sure that the expected risk reduction is achieved to implement the requirements described by ISO 13849-1. This risk assessment must also take into account the national regulations, such as U.S. control reliability or European "C" level standards, to comply with the mandated minimum levels of performance.

**WARNING: Risk Assessment**

The level of safety circuit integrity can be greatly affected by the design and installation of the safety devices and the means of interfacing of those devices. A risk assessment must be performed to determine the appropriate level of safety circuit integrity to ensure the expected risk **reduction** is achieved and all relevant **regulations** and standards are complied with.

## Fault Exclusion

An important concept within the category requirements of ISO 13849-1 is the probability of the occurrence of the failure, which can be decreased using the "fault exclusion" method. This method assumes that the possibility of certain well-defined failure(s) can be reduced to a point where the resulting fault(s) can be disregarded.

Fault exclusion is a tool a designer can use during the development of the safety-related part of the control system and the risk assessment process. It allows the designer to eliminate the possibility of various failures and justify it through the risk assessment process to meet the requirements of Categories 2, 3 or 4. See ISO 13849-1/-2 for further information.

## Monitoring of Safety Devices

Requirements vary widely for the level of control reliability or safety category per ISO 13849-1 (EN954-1) in safety applications. While Banner Engineering always recommends the highest level of safety in any application, it is the responsibility of the user to safely install, operate and maintain each safety system and comply with all relevant laws and regulations.

Although only a few applications are listed, the Module can monitor a variety of devices as long as the input requirements are complied with (see Electrical Installation and Specifications). The Safety Module does not have 500 ms simultaneity between inputs and thus cannot be used for monitoring a two-hand control. In all cases, the safety performance (integrity) must reduce the risk from identified hazards as determined by the machine's risk assessment.

**WARNING: Emergency Stop Functions**

Do not mute or bypass any Emergency Stop device. ANSI B11.19, ANSI NFPA79 and IEC/EN 60204-1 require that the Emergency Stop **function** remain **active** at all **times**.

## Emergency Stop Push **Buttons** and Rope/Cable Pull Switches

The safety inputs can be interfaced with positive-opening switches to monitor an emergency-stop (E-stop) push button or rope/cable pull. The switch must provide one or two contacts for safety which are closed when the switch is armed. Once activated, the E-stop switch must open all its safety-rated contacts, and must require a deliberate action (such as twisting, pulling, or unlocking) to return to the closed-contact, armed position. The switch must be a "positive-opening" (or direct-opening) type, as described by IEC 60947-5-1.

Standards ANSI NFPA 79, ANSI B11.19., IEC/EN60204-1, and ISO 13850 specify additional emergency stop switch device requirements, including the following:

- Emergency-stop push buttons shall be located at each operator control station and at other operating stations where emergency shutdown is required.
- Stop and emergency-stop push buttons shall be continuously operable and readily accessible from all control and operating stations where located. Do not mute or bypass E-stop buttons or rope/cable pulls.
- Actuators of emergency-stop devices shall be colored red. The background immediately around the device actuator shall be colored yellow (where possible). The actuator of a push-button-operated device shall be of the palm or mushroom-head type.
- The emergency-stop actuator shall be a self-latching type.

In addition, for Rope/Cable Pull Installations Only:

- The wire rope should be easily visible and readily accessible along its entire length. Red markers or flags may be fixed on the rope to increase its visibility.
- The rope or cable pull must provide constant tension and must have the capability to react to a force in any direction.
- Mounting points, including support points, must be rigid.
- The rope should be free of friction at all supports. Pulleys are recommended.
- The switch must have a self-latching function that requires a manual reset after actuation

Some applications may have additional requirements; comply with all relevant regulations. See the device manufacturer installation instructions for complete information (such as SSA-EB1... p/n 162275, or RP-RM83F.. p/n 141245 data sheets).

**WARNING: Emergency Stop Functions**

Do not mute or bypass any Emergency Stop device. ANSI B11.19, ANSI NFPA79 and IEC/EN 60204-1 require that the Emergency Stop **function** remain **active** at all **times**.

## Interlocked Guards (Gates)

The safety inputs can be interfaced with positive-opening safety switches to monitor the position of an interlock guard or gate. Each switch must provide electrically isolated contacts: at minimum, one normally closed (N.C.) contact from each individually mounted switch. The contacts must be of "positive-opening" (direct-opening) design, as described by IEC60947- 5-1, with one or more normally closed contacts rated for safety. In addition, the switches must be mounted in a "positive mode," to move/disengage the actuator from its home position and open the normally closed contact when the guard opens.

The design and installation of the interlocked guard and the safety switches should comply with ANSI B11.19, ISO14119, ISO 14120, and/or other applicable standards. See the device manufacturer installation instructions for complete information (such as GM-FA-10J p/n 60998, SI-LS83/-LS100 p/n 59622, or SI-HG63 p/n 129465 datasheets).

In higher levels of safety performance, the design of a dual-channel coded magnetic switch typically uses complementary switching, in which one channel is open and one channel is closed at all times. The inputs of the Safety Module do not support complementary switching, and thus should not be used with coded magnetic safety switches.

## Mechanical Installation

The Safety Module must be installed inside an enclosure.

It is not designed for exposed wiring. It is the user's responsibility to house the Safety Module in an enclosure with NEMA 3 (IEC IP54) rating, or better. The Safety Module mounts directly to standard 35 mm DIN rail.

**Heat Dissipation Considerations:** For reliable operation, ensure that the operating specifications are not exceeded. The enclosure must provide adequate heat dissipation, so that the air closely surrounding the Module does not exceed the maximum operating temperature stated in the Specifications. Methods to reduce heat build-up include venting, forced airflow (for example, exhaust fans), adequate enclosure exterior surface area, and spacing between modules and other sources of heat.

## Electrical Installation



**WARNING:** Shock Hazard and Hazardous Energy

Always disconnect power from the safety system (for example, device, module, interfacing, etc.) and the machine being controlled before making any **connections** or replacing any component.

Electrical installation and wiring must be made by Qualified Personnel<sup>¶</sup> and must comply with the relevant electrical standards and wiring codes, such as the NEC (National Electrical Code), ANSI NFPA79, or IEC 60204-1, and all applicable local standards and codes.

Lockout/tagout procedures may be required. Refer to OSHA 29CFR1910.147, ANSI Z244-1, ISO 14118, or the appropriate standard for controlling hazardous energy.

It is not possible to give exact wiring instructions for a Safety Module that interfaces to a multitude of machine control configurations. The following guidelines are general in nature.

The Safety Module has no delay function. Its output relay contacts open within 25 milliseconds after a safety input opens. This classifies the Safety Module as a functional stop "Category 0" control, as defined by ANSI NFPA 79 and IEC/EN 60204-1.

The Safety Module is powered by either a 12-24V dc supply at 4W or an ac supply (115V ac, model ES-UA-5A, or 230V ac, model ES-VA-5A) at 7VA. The safety inputs can be connected to:

- A +24V dc source that is switched by a hard/relay contact in single-channel hookup configuration, or
- Hard/relay contacts in a dual-channel hookup configuration using terminals S11-S12 and S21-S22.

## Safety Input Device Hookup Options

The operation of all dual-channel hookup options is concurrent, meaning that input channel 1 and input channel 2 must be in the same state in both the STOP and RUN condition, but with no simultaneity (timing) requirement between the channels.

The dual-channel hookup **configuration** is able to detect certain failures and faults, such as short circuits, that could result in a loss of the safety function. Once such a failure or fault is detected, the Safety Module will turn OFF (open) its safety outputs until the problem is fixed. This circuit can meet ISO 13849-1 Category 2, 3, or 4 requirements, depending on the safety rating and the installation of the safety input device. This circuit can detect a short circuit between channels or to another source of power, at a minimum, when the device is actuated.

A single device with redundant outputs that can fail in such a manner to lose the safety function, such as a single safety interlocking switch, can typically meet only a Category 2. See below for means to eliminate or minimize the possibility of failures and faults that could result in the loss of the safety function(s).

The single-channel hookup **configuration** cannot detect short circuits to secondary sources of +24V dc or detect the loss of the switching function of the safety input device (that is, it is not redundant) and thus this circuit typically can meet only ISO 13849-1 Category 2.

It is recommended that in all circumstances the installation of the Safety Module and its associated safety input devices are installed to eliminate or minimize the possibility of failures and faults that could result in the loss of the safety function(s). Methods to eliminate or minimize the possibility of these failures include, but are not limited to:

- Physically separating interconnecting control wires from each other and from secondary sources of power.
- Routing interconnecting control wires in separate conduit, runs, or channels.
- Locating all elements (modules, switches, and devices under control) within one control panel, adjacent to each other, and directly connected with short wires.

<sup>¶</sup> A person who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

- Properly installing multi-conductor cabling and multiple wires through strain-relief fittings. (Over-tightening of a strain-relief can cause short circuits at that point.)
- Using positive-opening components as described by IEC 60947-5-1 that are installed and mounted in a positive mode.
- Periodically checking the functional integrity / safety function and training operators, maintenance personnel, and others associated with the operation of the machine to recognize and immediately correct such failures.

If you have any questions about your intended use, please contact a Banner applications engineer.

### Connection of Multiple Switches

Connect the poles of multiple switches, such as E-Stop switches, as shown in the following hookup figures. The switches are shown in the "armed" position with both contacts closed. Multiple switches connected to one Safety Module must be series connected (see the warning, Multiple Switching Devices).



**WARNING: Multiple Safety Devices**

When two or more safety devices are used, each device must be individually actuated, causing a Stop or open-contact **condition**, then reset/rearmed and the Safety Module reset (if using manual reset mode). This allows the monitoring circuits to check each device and its wiring to detect faults. Failure to test each device individually in this manner may result in undetected faults and create an unsafe **condition** which may result in serious injury or death.

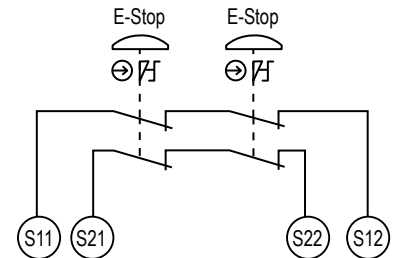


Figure 2. Series connection of multiple E-stop switches



Note: The minimum amount of time for the Module to detect a STOP condition is 15 milliseconds. This "recovery time" (OFF state) is required for the internal integrity tests to complete, allowing a reliable reset to occur. A lockout may occur if the Module is cycled too quickly. To clear the lockout, the inputs must be re-cycled, meeting the minimum recovery time requirements.

### Connection of Safety Switches

The Safety Module may be used to monitor safety interlocking switches that determine the position of a guard or gate. To achieve Category 4 operation per ISO 13849-1 (EN 954-1), two positive-opening safety switches must operate concurrently when the guard or gate is opened.

The Safety Module verifies concurrent opening of two contacts – one from each safety switch. Reset of the Safety Module is not possible if one switch fails to open or if a short circuit between the safety interlocking switches occurs.

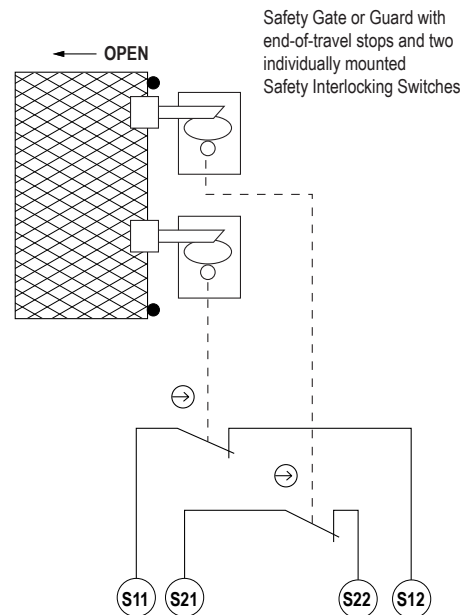


Figure 3. Wiring using contacts from two safety switches

### Connection of Reset Switch

The reset circuit switch can be any mechanical switch, such as a normally open momentary switch, or a two-position key switch. The reset switch must be capable of reliably switching 12 to 30 V dc at 20 to 50 milliamps. As shown in the hookup drawings, the reset switch connects between Safety Module terminals S33 and S34.

The reset switch must be located outside of – and not be accessible from – the area of dangerous motion, and must be positioned so that any area of dangerous motion may be observed by the switch operator during the reset procedure. See warning below.



**WARNING: Reset Switch Location**

All reset switches must be accessible only from outside, and in full view of, the hazardous area. Reset switches must also be out of reach from within the safeguarded space, and must be protected against unauthorized or inadvertent **operation** (for example, through the use of rings or guards). If any areas are not visible from the reset switch(es), additional means of safeguarding must be provided. Failure to do so may result in serious bodily injury or death.

## Automatic Reset Mode

The Safety Module may be configured (via hookup) for automatic reset. Leave terminals S33 and S34 open and install a jumper between terminals S32 and S35 (see hookups). The Safety Module will reset (and its outputs energize) as soon as the switch returns to its armed (closed-contact) position.

Automatic reset is useful for some automated processes. However, if **automatic** reset is used, it is necessary to provide a means of **preventing resumption** of hazardous machine **motion, until** an alternate reset procedure is performed. The alternate procedure must include a reset/restart switch, located outside the area of dangerous motion and positioned so that any area of dangerous motion may be observed by the switch operator during the reset procedure. See Warning.



**WARNING: Reset Routine Required**

U.S. and international standards require that a reset routine be performed **after** clearing the cause of a stop condition (for example, arming an E-stop button, closing an interlocked guard, etc.). Allowing the machine to restart without **actuating** the normal start command/device can create an unsafe **condition** which may result in serious injury or death.

## Connection to the Machine to be Controlled

The machine hookup diagram shows a generic connection of the Safety Module's redundant output circuits to the master stop control elements (MSCs). An MSC is defined as an electrically powered device, external to the Safety Module, which stops the machinery being controlled by immediately removing electrical power to the machine and (when necessary) by applying braking to dangerous motion. This stopping action is accomplished by removing power to the actuator of either MSC.

## External Device Monitoring

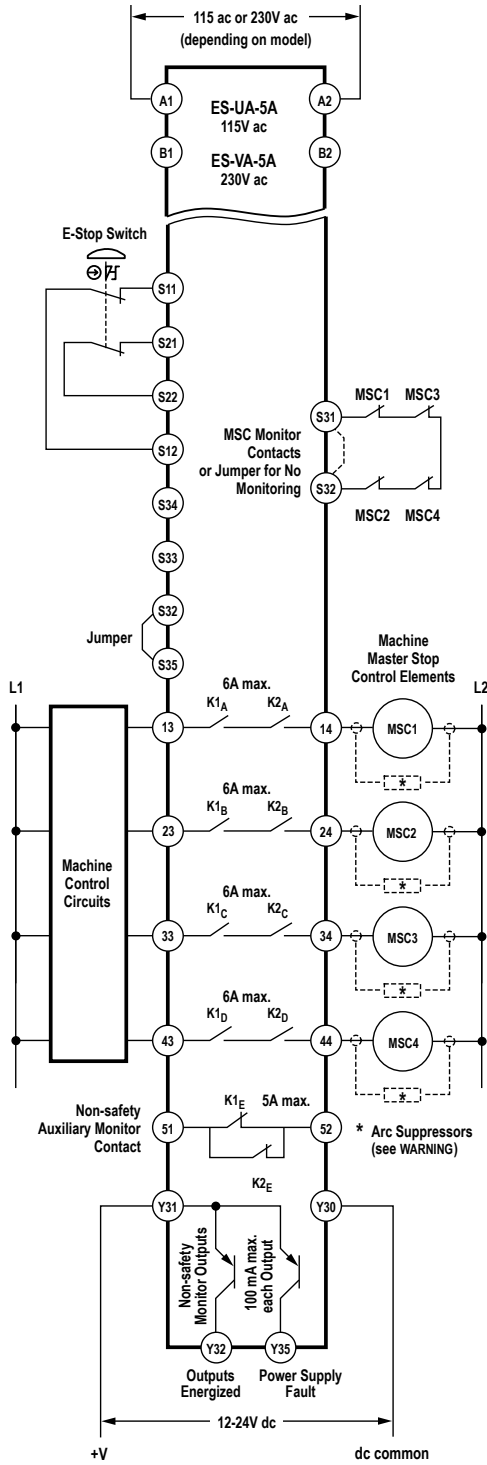
To satisfy the requirements of Control Reliability (OSHA and ANSI), Category 3 and 4 of ISO 13849-1 (EN 954-1), the Machine Primary Control Elements (MPCEs) must each offer a normally closed, forced-guided (mechanically linked) monitor contact. Connect one normally closed monitor contact from each Machine Primary Control Element as shown in the appropriate hookup drawing (circuit between terminals S31 and S32, jumper if no MSC contacts are monitored).

In operation, if one of the switching contacts of either MPCE fails in the energized condition, the associated monitor contact will remain open. Therefore, it will not be possible to reset the Primary Safety Device. If no MPCE-monitor contacts are monitored, it is the user's responsibility to ensure that any single failure will not result in a hazardous condition and will prevent a successive machine cycle.

Wiring Drawings

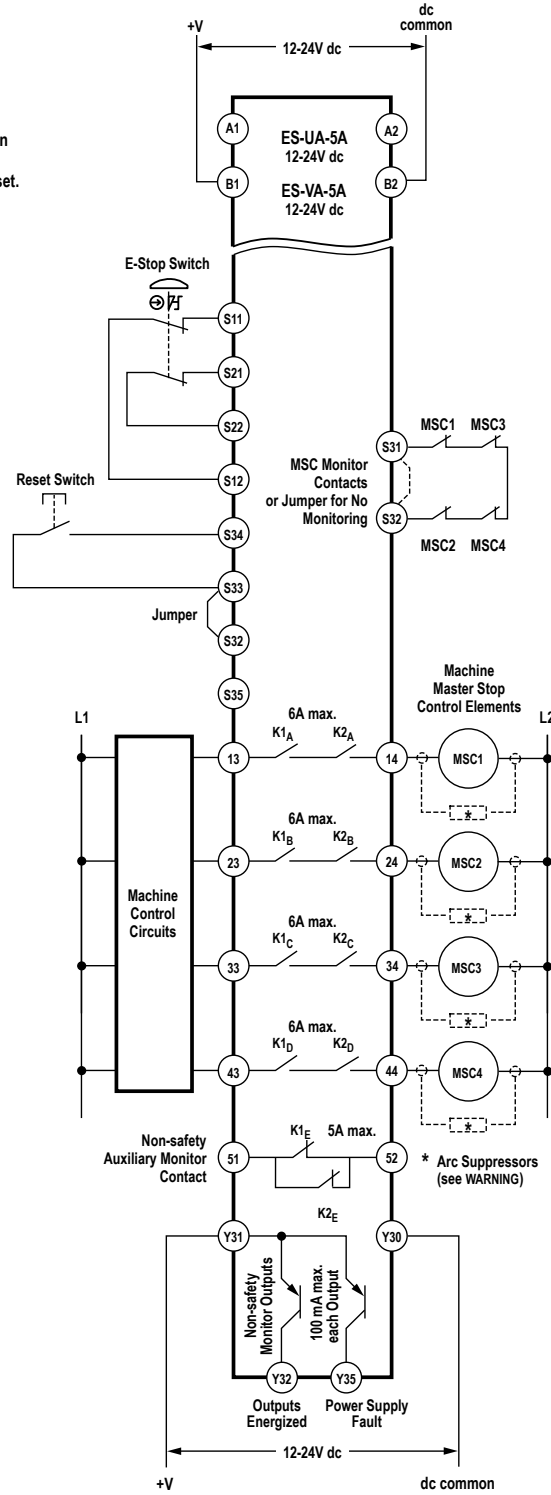
### Auto Reset

AC Power shown



### Manual Reset

DC Power shown



AC or DC power connections shown are valid for either auto or manual reset.

Figure 4. Wiring for 2-Channel E-Stop Applications

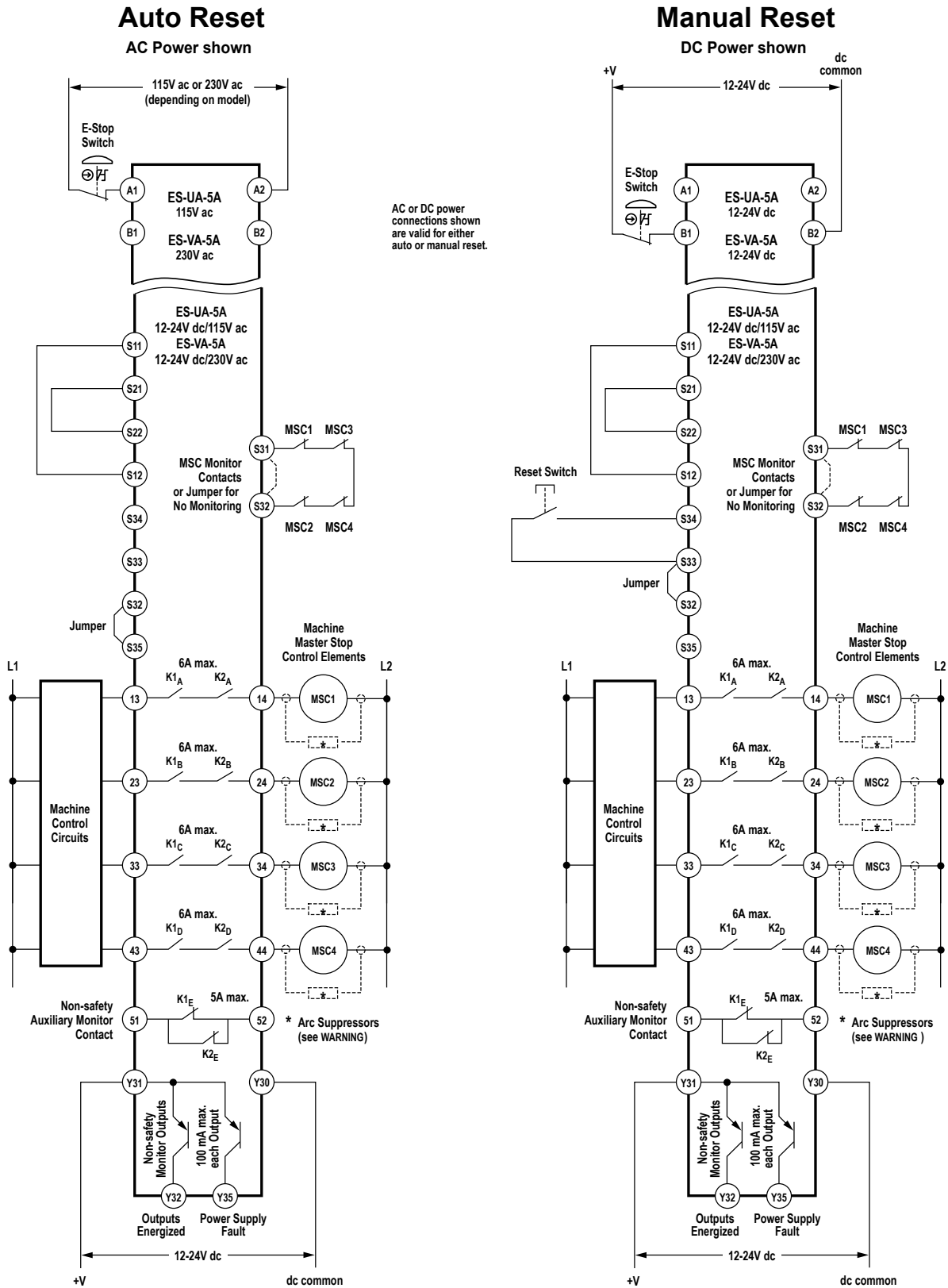


Figure 5. Wiring for 1-Channel E-Stop Applications

### Overvoltage Category II and III Installations (EN 50178 and IEC 60664-1)

The Safety Module is rated for Overvoltage Category III when voltages of 1 V to 150 V ac/dc are applied to the output relay contacts. It is rated for Overvoltage Category II when voltages of 151 V to 250 V ac/dc are applied to the output relay contacts and no additional precautions are taken to attenuate possible overvoltage situations in the supply voltage. The Module can be used in an Overvoltage



Category III environment (with voltages of 151 V to 250 V ac/dc) if care is taken either to reduce the level of electrical disturbances seen by the Module to Overvoltage Category II levels by installing surge suppressor devices (for example, arc suppressors), or to install extra external insulation in order to isolate both the Safety Module and the user from the higher voltage levels of a Category III environment.

For Overvoltage Category III **installations** with applied voltages from 151 V to 250 V ac/dc applied to the output contact(s): the Safety Module may be used under the conditions of a higher overvoltage category where appropriate overvoltage reduction is provided.

Appropriate methods include:

- An overvoltage protective device
- A transformer with isolated windings
- A distribution system with multiple branch circuits (capable of diverting energy of surges)
- A capacitance capable of absorbing energy of surges
- A resistance or similar damping device capable of dissipating the energy of surges

When switching inductive ac loads, it is good practice to protect the Safety Module outputs by installing appropriately-sized arc suppressors. However, if arc suppressors are used, they must be installed across the load being switched (for example, across the coils of external safety relays), and never across the Safety Module's output contacts (see WARNING, Arc Suppressors).

## Auxiliary Monitor Contact/Solid-State Monitor Outputs **Connection**

The action of the auxiliary monitor contact, terminals 51-52, inversely "follows" the action of the safety outputs. Two additional solid-state monitor outputs (at terminals Y32 and Y35) each are capable of switching up to 100 mA at 12- 24V dc. The output at terminal Y32 follows the action of the output circuits (K1 and K2); the output at terminal Y35 opens (low signal) when there is a loss of power or a fault is detected. These outputs are to be used only for nonsafety **functions** (typically, to communicate the status of the Safety Module to a programmable logic controller). See the appropriate figure for wiring information.



### WARNING: Wiring of Arc Suppressors

If arc suppressors are used, they **MUST** be installed as shown across the actuator coil of the stop control elements (MSCs or MPCEs). **NEVER** install suppressors directly across the output contacts of the Safety Device or Module. It is possible for suppressors to fail as a short circuit. If installed directly across the output contacts, a short-circuited suppressor creates an unsafe **condition** which may result in serious injury or death.



### WARNING: Interfacing MSCs

Do not wire an intermediate device(s) (for example, PLC, PES, PC) between the Safety Module outputs and the Master Stop Control Element it switches in such a manner that in the event of a failure there is a loss of the safety stop command, or in such a manner that the safety function can be suspended, overridden, or defeated, unless accomplished with the same or greater degree of safety.

Whenever forced-guided, mechanically linked relays are added as intermediate switching devices, a normally closed (N.C.) forced-guided monitor contact from each relay must be added to the series feedback loop between Safety Module terminals S31 and S32.

## Initial Checkout Procedure



### CAUTION: Disconnect Power Prior to Checkout

Before performing the **initial** checkout procedure, make certain all power is disconnected from the machine to be controlled.

Dangerous voltages may be present along the Safety Module wiring barriers whenever power to the machine control elements is On. Exercise extreme **caution** whenever machine control power is or may be present. Always disconnect power to the machine control elements before opening the enclosure housing of the Safety Module.

1. Remove power from the machine primary control elements.
2. Ensure the safety device is in a STOP or "open-contact" state (for example, actuate the E-stop switch to open its contacts).
3. Apply power to the Safety Module at terminals A1 and A2 or B1 and B2. Verify that only the Input Power indicator is ON. If either input channel 1 or input channel 2 indicators are ON at this point, disconnect the input power and check all wiring. Return to step 2 after the cause of the problem has been corrected.
4. Reset or otherwise cause the safety device to reach an ON or "closed-contact" state (for example, arm the E-stop switch to close its contacts).
5. Manual Reset mode: Ch1 and Ch2 indicators should be flashing. Close and reopen the Reset switch.
6. Verify that the Ch1 and Ch2 indicators both come ON. If only one indicator comes ON or if any indicator is flashing, refer to the Troubleshooting section for more information. Return to step 2 after correcting the problem.
7. Cause the safety device to generate a STOP or "open-contact" state (for example, actuate the E-stop switch to open its contacts). The Ch1 and Ch2 indicators should turn OFF simultaneously. If either indicator remains ON, disconnect the input power and check all wiring. Return to step 2 after the cause of the problem has been corrected. Refer to the Troubleshooting section for more information.
8. If more than one safety device is series-connected to the Safety Module, run the above checkout procedure individually for EACH device.

- Close and secure the enclosure in which the Safety Module is mounted. Apply power to the machine control elements and perform the Periodic Checkout Procedure.



**WARNING: Multiple Safety Devices**

When two or more safety devices are used, each device must be individually actuated, causing a Stop or open-contact **condition**, then reset/rearmed and the Safety Module reset (if using manual reset mode). This allows the monitoring circuits to check each device and its wiring to detect faults. Failure to test each device individually in this manner may result in undetected faults and create an unsafe **condition** which may result in serious injury or death.

## Repairs

Contact Banner Engineering for troubleshooting of this device. Do not **attempt** any repairs to this Banner device; it contains no **field-replaceable** parts or components. If the device, device part, or device component is determined to be defective by a Banner Applications Engineer, they will advise you of Banner's RMA (Return Merchandise Authorization) procedure.



**Important:** If instructed to return the device, pack it with care. Damage that occurs in return shipping is not covered by warranty.



**CAUTION: Abuse of Module After Failure**

If an internal fault has occurred and the Module will not reset, do not tap, strike, or otherwise **attempt** to correct the fault by a physical impact to the housing. An internal relay may have failed in such a manner that its replacement is required.

If the Module is not immediately replaced or repaired, **multiple** simultaneous failures may accumulate such that the safety **function** can not be guaranteed.

## Specifications

**Supply Voltage and Current**

- AI-A2: 115 V ac (model ES-UA-5A) or 230 V ac (model ES-VA-5A) ±15% , 50/60 Hz
- BI-B2: 11 V dc to 27.6 V dc
- Power consumption: approx. 4 W/7 VA

The Safety Module should be connected only to a SELV (safety extra-low voltage, for circuits without earth ground) or a PELV (protected extra-low voltage, for circuits with earth ground) power supply.

**Supply Protection Circuitry**

Protected against transient voltages and reverse polarity

**Overvoltage Category**

Output relay contact voltage of 1 V to 150 V ac/dc: category III  
 Output relay contact voltage of 151 V to 250 V ac/dc: category III, if appropriate overvoltage reduction is provided (see Overvoltage Category III Installations).

**Pollution Degree**

2

**Required Overcurrent Protection**



**WARNING:** Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

Overcurrent protection is required to be provided by end product application per the supplied table.

Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.

Supply wiring leads < 24 AWG shall not be spliced.

For additional product support, go to [www.bannerengineering.com](http://www.bannerengineering.com).

Supply Wiring (AWG)	Required Overcurrent Protection (Amps)
20	5.0
22	3.0
24	2.0
26	1.0
28	0.8
30	0.5

### Relay Outputs

**Relay Outputs**

4 normally open (N.O.) output channels and 1 normally closed (N.C.) auxiliary output  
 Contacts: AgNi, 5 µm gold-plated



Each normally open output channel is a series connection of contacts from two forced-guided (mechanically linked) relays, K1-K2. The normally closed Aux. output channel is a parallel connection of contacts from two forced-guided relays, K1-K2.


Relay Outputs

**Low Current Rating:** The 5 µm gold-plated contacts allow the switching of low current/low voltage. In these low-power applications, multiple contacts can also be switched in series (for example, “dry switching”). To preserve the gold plating on the contacts, do not exceed the following max. values at any time:

	Min.	Max.
Voltage	1 V ac/dc	60 V
Current	5 mA ac/dc	300 mA
Power	5 mW (5 mVA)	7 W (7 VA)

**High Current Rating:** If higher loads must be switched through one or more of the contacts, the minimum and maximum values of the contact(s) changes to:

	Minimum	Maximum
 IND. CONT. EQ. 447Y	Voltage	N.O. Safety Contacts (13-14, 23-24, 33-34, 43-44): 250 V ac / 24 V dc, 6 A resistive
	Current	B300, Q300 (UL508)
	Power	N.C. Auxiliary Contact (51-52): 250 V ac/ 24 V dc, 5 A resistive
 IND. CONT. EQ. 447Y		B300, Q300 (UL508)

	Minimum	Maximum — IEC60947-5-1
	Voltage	N.O. Safety Contacts:
	Current	AC-1: 250 V ac, 6 A; DC-1: 24 V dc, 6 A
	Power	AC-15: 230 V ac, 3 A; DC-13: 24 V dc, 4 A
		N.C. Auxiliary Contact:
		AC-1: 250 V ac, 5 A; DC-1: 24 V dc, 5 A
		AC-15: 230 V ac, 2 A; DC-13: 24 V dc, 4 A

Mechanical Life

> 50,000,000 operations



Note: Transient suppression is recommended when switching inductive loads. Install suppressors across load. Never install suppressors across output contacts (see Warning, Wiring of Arc Suppressors).

Electrical Life

150,000 cycles at 1500 VA  
 1,000,000 cycles at 450 VA  
 2,000,000 cycles at 250 VA  
 5,000,000 cycles at 125 VA

Solid-State Outputs

Two non-safety solid-state dc outputs  
 Output circuits require application of +12 to 24 V dc ± 15% at terminal Y31; dc common at Y30.  
 Max. switching current: 100 mA at 12 to 24 V dc

Both outputs are protected against short circuits.

Output at Y32 monitors state of outputs – conducts (output high) when both K1 and K2 are energized.

Output at Y35 conducts (output high) when in normal operation (no lockout).

Output Response Time

35 ms max. (25 ms typical)

I/O

General

Input Requirements

E-stop switch: must have normally closed contacts each capable of switching 20 to 50 mA at 12 to 30 V dc; and must be open longer than 15 ms for a valid stop command.  
 Maximum input resistance 250 ohms per channel at 24 V dc supply voltage.  
 Maximum input resistance 25 ohms per channel at 12 V dc supply voltage.  
 Reset switch: must have one normally open contact capable of switching 20 to 50 mA at 12 to 30 V dc.

OFF-State Recovery Time

350 ms maximum

Indicators

3 green LED indicators: Power ON , Channel 1, Channel 2  
 1 red LED indicator: indicates a fault condition (see Troubleshooting)

Construction

Polycarbonate housing. Rated NEMA 1, IEC IP20

Mounting

Mounts to standard 35 mm DIN rail track. Safety Module must be installed inside an enclosure rated NEMA 3 (IEC IP54), or better.

**Operating Conditions**

**Vibration Resistance**

10 to 60 Hz at 0.35 mm peak displacement per UL 991  
60 to 150 Hz at 5 g max.

**Environment**

Temperature: 0 °C to +50 °C (+32 °F to +122 °F), (surrounding air)  
90% at +50 °C maximum relative humidity (non-condensing)

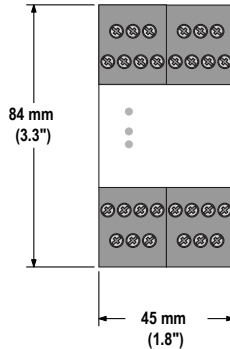
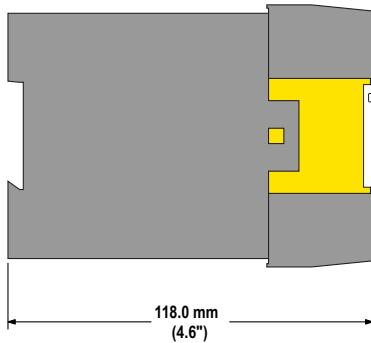
**Standards and Certifications**

**Design Standards**

Cat. 4 PL e per EN ISO 13849-1; SIL 3 per IEC 61508 and IEC 62061



**Dimensions**



All measurements are listed in millimeters [inches], unless noted otherwise.

**Troubleshooting**

Module will not reset

Indicator Status	Possible Causes and <b>Solutions</b>
Power LED ON Fault LED OFF Ch1 LED Flashing Ch2 LED Flashing	Waiting for manual reset: <ul style="list-style-type: none"> <li>EDM monitoring contacts are not closed. Check MSCs.</li> <li>Check jumper at S32-S35 (auto reset) or S32-S33 (manual reset).</li> <li>Check reset button connection.</li> </ul>

No Fault Indicated

Indicator Status	Possible Causes and <b>Solutions</b>
Power LED ON Fault LED OFF Ch1 LED OFF Ch2 LED OFF	E-stop button open: <ul style="list-style-type: none"> <li>Connector loose.</li> <li>Re-arm E-stop button.</li> </ul>
Power LED ON Fault LED OFF Ch1 LED OFF Ch2 LED ON	Ch.1 open; Ch. 2 closed: <ul style="list-style-type: none"> <li>Check wiring to S11-S12.</li> <li>Check switch.</li> <li>Check connectors are properly seated.</li> </ul>

Indicator Status	Possible Causes and <b>Solutions</b>
Power LED ON Fault LED OFF Ch1 LED ON Ch2 LED OFF	Ch.1 closed; Ch. 2 open: <ul style="list-style-type: none"> <li>• Check wiring to S21-S22.</li> <li>• Check switch.</li> <li>• Check connectors are properly seated.</li> </ul>

Fault

Indicator Status	Possible Causes and <b>Solutions</b>
Power LED ON Fault LED ON* Ch1 and Ch2 LED flashing alternately	Input concurrency fault: Both inputs did not open concurrently. Both inputs are now closed. <ul style="list-style-type: none"> <li>• Check switches/wiring at both inputs.</li> <li>• Open both inputs to clear the fault.</li> </ul>
Power LED ON Fault LED ON* Ch1 LED OFF Ch2 LED Flashing	Input concurrency fault: Ch1 opened and closed and is now open while Ch2 remained closed. <ul style="list-style-type: none"> <li>• Check switches/wiring at both inputs.</li> <li>• Open both inputs to clear the fault.</li> </ul>
Power LED ON Fault LED ON* Ch1 LED Flashing Ch2 LED OFF	Input concurrency fault: Ch1 remained closed while Ch2 opened and closed and is now open. <ul style="list-style-type: none"> <li>• Check switches/wiring at both inputs.</li> <li>• Open both inputs to clear the fault.</li> </ul>
Power LED ON Fault LED ON* Ch1 LED ON Ch2 LED ON	Possible input fault: Ch1 and Ch 2 are closed and are (or were) shorted together. <ul style="list-style-type: none"> <li>• Check wiring at both inputs.</li> <li>• Open both inputs to clear the fault.</li> </ul> Possible internal fault: Return to factory for repair or replacement
All LEDs Off	Possible fault in machine control or wiring to module: <ul style="list-style-type: none"> <li>• Check input power connections or external fuses.</li> <li>• Check connectors are properly seated.</li> </ul>
Dim LEDs	Dim Power LED: <ul style="list-style-type: none"> <li>• Check power supply capacity and load.</li> </ul> Other LEDs dim: <ul style="list-style-type: none"> <li>• May glow during power-up (normal).</li> <li>• Check power supply load and capacity.</li> </ul>
* Fault LED Flickers	This is normal while the Fault LED is ON.

MSCs Do Not Energize

Indicator Status	Possible Causes and <b>Solutions</b>
Power LED ON Fault LED OFF Ch1 LED ON Ch2 LED ON	Possible fault in machine control or an open circuit between machine control and MSCs: <ul style="list-style-type: none"> <li>• Check continuity of safety outputs (e.g. between terminals 13 and 14).</li> <li>• Check control wires and connectors.</li> <li>• Check MSCs.</li> </ul>

## EU Declaration of Conformity (DoC)

Banner Engineering Corp. herewith declares that the ES-UA-5A and ES-VA-5A Emergency Stop Modules for industrial control is in conformity with the provisions of the Machinery Directive 2006/42/EC and all essential health and safety requirements have been met.

Representative in EU: Peter Mertens, Managing Director Banner Engineering Europe. Address: Park Lane, Culliganlaan 2F, 1831 Diegem, Belgium.

## Banner Engineering Corp. Limited Warranty

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