

Features

- Monitors one or two safety switches for a contact failure or wiring fault
- Two output switching channels for connection to controllable power interrupt circuits
- Auto reset or onboard manual reset
- Design complies with standards UL991, ISO 14119, and EN ISO 13849-1 (Safety Category 2, 3 or 4)
- For use in functional stop category 0 applications per NFPA 79 and IEC 60204-1
- 6 amp safety output contacts
- Removable terminal blocks
- If terminal blocks are swapped, Module remains functional with no loss of safety function
- 24 V AC/DC operation
- Single- or dual-channel input monitoring



GM-FA-10J Overview

The GM-FA-10J Gate Monitor Safety Module (the "Safety Module") is used to verify the proper operation of coded magnetic safety switches and positive-opening safety switches by monitoring a normally open (NO) and a normally closed (NC) contact from each switch. It can also be used to monitor and verify the correct state of two redundant current-sourcing PNP signals. (One PNP source must be Normally OFF and the other Normally Conducting for each input channel.) In a typical application, two safety switches (individually mounted) indicate the open or closed status of a gate, moveable guard, or barrier (all called "guards" throughout this document).

Two functions of the Safety Module are:

1. To monitor the contacts and wiring of safety switches for certain failures and to prevent them from re-starting if the switch or the module fails, and
2. To provide a reset routine after closing the guard and returning the inputs to their "closed" condition. This reset function may be required by machine safety standards.

The Safety Module monitors each switch for complementary switching; each channel must have one open (OFF) input and one closed (conducting) input at all times. These inputs must always be in opposite states and must switch state within 1 second of each other. Channel 1 has a "guard closed" condition when S11/S13 is closed and S11/S12 is open. Similarly, Channel 2 has a "guard closed" condition when S21/S23 is closed and S21/S22 is open (see ['Figure: Wiring to two 4-wire coded magnetic safety switches. Configured for single-channel monitoring of either one or two guards \(jumper S11/S13 or S21/S23 for single-channel\)'](#), this application is considered to meet or exceed requirements for Control Reliability and Safety Categories 3 and 4 per EN ISO 13849-1 on page 5 and ['Figure: Wiring to two positive-opening safety interlock switches. Configured for dual-channel monitoring of one guard, this application is considered to meet or exceed requirements for Control Reliability and Safety Categories 3 and 4 per EN ISO 13849-1, on page 5'](#)). The Safety Module also will detect and properly respond to a short circuit between the channels and a short circuit to other sources of power. The Safety Module will open the safety outputs within 35 milliseconds of the switching of either channel when the guard opens.

When the guard closes, debounce logic in the Safety Module's inputs increases the reliability and repeatability of successfully resetting the Safety Module and reduces the necessity of re-cycling the guard. This feature can result in increased efficiency of the machine, even if the guard is misaligned or vibration is present.

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

Contact: Safety Director, AMT – The Association for Manufacturing Technology, 7901 Jones Branch Drive, Suite 900, McLean, VA 22102-4206 USA, www.ambonline.org

NFPA 79 Electrical Standard for Industrial Machinery

Contact: National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471 USA, www.nfpa.org/

ANSIRIA R15.06 Safety Requirements for Industrial Robots and Robot Systems

Contact: Robotic Industries Association, 900 Victoria Way, Suite 140, Ann Arbor, MI 48108 USA, www.robotics.org

Applicable International Standards

ISO 12100 Safety of Machinery – General Principles for Design – Risk Assessment and Risk Reduction

EN 60204-1 Electrical Equipment of Machines Part 1: General Requirements

ISO 13849-1 Safety of Machinery – Safety-Related Parts of Control Systems – Part 1: General Principles for Design

EN 13855 (EN 999) The Positioning of Protective Equipment in Respect to Approach Speeds of Parts of the Human Body

ISO 14119 (EN 1088) Interlocking Devices Associated with Guards – Principles for Design and Selection

Also, request a type "C" standard for your specific machinery.

Contact IHS Markit (GlobalEngineering Documents) 15 Inverness Way East, Englewood, CO 80112 USA, <https://globalihs.com/>**Certificate of Adequacy**

This Safety Module datasheet (p/n 60998) satisfies the requirements of Machinery Directive 2006/42/EC, Section 1.7.4 — instructions.

Safety Circuit Integrity and EN ISO 13849-1 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 EN ISO 13849-1 Safety-Related Parts of a Control System.

Safety Circuit Integrity Levels

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 EN ISO 13849-1, which establishes five levels: Categories B, 1, 2, 3, and the most stringent, Category 4.

In the United States, the typical level of safety circuit integrity has been called control reliability. Control reliability typically incorporates redundant control and self-checking circuitry and has been loosely equated to EN ISO 13849-1 Categories 3 and 4 (see CSA Z432 and ANSI B11.TR4).

If the requirements described by EN ISO 13849-1 are to be implemented, a risk assessment must first be performed to determine the appropriate category, in order to ensure that the expected risk reduction is achieved. This risk assessment must also take into account national regulations, such as U.S. control reliability or European "C" level standards, to ensure that the minimum performance that has been mandated is complied with.

Fault Exclusion

An important concept within the category requirements of EN 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 EN ISO 13849-1/2 for further information.

Configuration

The Safety Module may be configured via DIP switches for dual-channel (redundant switches on a single guard), or single-channel operation (individual switches on two guards). In dual-channel operation, each channel (S11/S12/S13 and S21/S22/S23) must switch within 3-second simultaneity of the other when the guard closes. If not, the guard must be re-opened and closed until the timing requirement is met. When the guard opens, the two channels operate concurrently (both channels must switch but without the timing requirement).

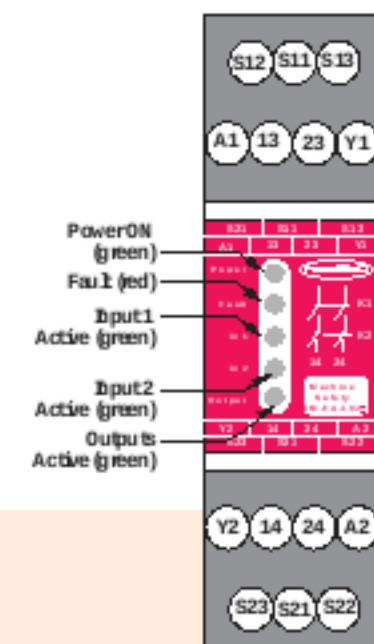
In single-channel operation, each channel operates individually, except to reset the device (in which case both guards must be closed). If only one switch is being monitored, the closed input of the unused channel must be jumpered (S11/S13 or S21/S23).

The reset function has two options, selected by DIP switch: Automatic reset or Monitored Manual reset. See ["Figure: Wiring to the guarded machine on page 6"](#) for configuration information.

The reset input also can be used for an External Device Monitoring (EDM) circuit. The EDM circuit consists of a normally closed, force-guided contact from each device being controlled by the Safety Module, followed in series with the Reset button (labeled) and time-limited attempt Y1 and Y2. See ["Figure: Alternate wiring for dual-channel monitoring of multiple guards on page 6"](#) for further information.

The output of the Safety Module consists of two redundant output switching channels, each of which is the series connection of two forced-guided relay contacts (K1 and K2 in ["Figure: Alternate wiring for dual-channel monitoring of multiple guards on page 6"](#)). Each of the switching outputs is rated for up to 250 V AC at up to 6 amps.

GM-FA-10J Features and Terminal Locations

**WARNING:**

- The hazard must be accessible only through the sensing field.
- Incorrect system installation could result in serious injury or death.
- The installation of the Safety Module must prevent any individual from reaching around, under, over or through the defined area and into the hazard without being detected.
- See OSHA CFR 1910.211, ANSI B11.19, and/or ISO 14119, ISO 14120 and ISO 13857 for information on determining safety distances and safe opening sizes for your guarding device. Mechanical barriers (for example, hard (fixed) guarding) or supplemental safeguarding options required to comply with these requirements.

WARNING:

- Determine the safety category.
- The design and installation of the safety devices and the means of interfacing of those devices could greatly affect the level of safety circuit integrity.
- Perform a risk assessment to determine the appropriate safety circuit integrity level or safety category, as described by ISO 13849-1, to ensure that the expected risk reduction is achieved and that all applicable regulations and standards are met.

Safety Interlock Switch Requirements

The following general requirements and considerations apply to the installation of interlocked guards and gates for the purpose of safeguarding. In addition, the user must refer to the relevant regulations to ensure compliance with all necessary requirements.

Hazards guarded by the interlocked guard must be prevented from operating until the guard is closed; a stop command must be issued to the guarded machine if the guard opens while the hazard is present. Closing the guard must not, by itself, initiate hazardous motion; a separate procedure must be required to initiate the motion. The safety interlock switches must not be used as a mechanical end-of-travel stop.

The guard must be located an adequate distance from the danger zone (so that the hazard has time to stop before the guard is opened sufficiently to provide access to the hazard), and it must open either laterally or away from the hazard, not into the safeguarded area. The guard also should not be able to close by itself and activate the interlocking circuitry. In addition, the installation must prevent personnel from reaching over, under, around, or through the guard to the hazard. Any openings in the guard must not allow access to the hazard (see OSHA 29 CFR 1910.217 Table O-18, ANSI B11.19, ISO 13857, EN ISO 14120 or the appropriate standard). The guard must be strong enough to contain hazards within the guarded area, which may be ejected, dropped, or emitted by the machine.

The safety interlock switches, actuators, sensors, and magnets must be designed and installed so that they cannot be easily defeated. They must be mounted securely so that their physical position cannot shift, using reliable fasteners that require a tool to remove them. Mounting slots in the housings are for initial adjustment; final cutting holes must be used for permanent location.



WARNING: If the application could result in a pass-through hazard (for example, open door guarding), either the safeguarding device or the guard in which it is located must cause a latched response following a stop command (for example, interruption of the sensing field of a light curtain, opening of an interlocked gate guard). The reset of this latched condition may only be achieved by actuating a reset switch that is separate from the normal sequence of machine cycle action. The switch must be positioned as described in this document.



WARNING:

- Perimeter guarding applications
- Failure to observe this warning could result in serious injury or death.
- Use lockout/tagout procedures per ANSI Z12.24-1, or use additional safeguarding as described by ANSI Z11.19 safety requirements or other applicable standards if a pass-through hazard cannot be isolated or reduced to an acceptable level of risk.

Coded Magnetic Safety Switches

In addition to positive-opening safety switches, coded magnetic switches used with the Safety Module must provide one normally closed contact and one normally open contact (typically a four-wire switch). The sensor and magnet must be mounted at a minimum distance of 15 mm (0.6 inches) from any magnetized or ferrous materials for proper operation. If either the sensor or magnet is mounted on a material that can be magnetized (a ferrous metal, such as iron), the switching distance will be affected. Although the sensor and magnet are coded to minimize the possibility of false actuation, they should not be used with known fields of high-level electronagnetic radiation.

Depending on the model of sensor and magnet used, the installation must be designed to provide the correct direction of approach. The speed of approach must be fast enough to meet the simultaneous monitoring period of 1.0 second, approximately equal to or greater than 0.1 m (4 inches) per second. If the simultaneity requirement is not met, the Safety Module can not be reset and will not close its safety output contacts.

Positive-Opening Interlocking Switches

Safety interlock switches used with the Safety Module must satisfy several requirements. Each switch must provide electrically isolated contacts: at minimum, one normally closed (N.C.) contact or normally conducting source and one normally open (N.O.) contact or normally OFF source to interface with the Module.

The contacts must be of "positive-opening" design, with one or more normally closed contacts rated for safety. Positive-opening operation causes the switch to be forced open, without the use of springs, when the switch actuator is disengaged or moved from its home position (see the Banner Catalog for examples). 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.

Switch Wiring for Typical Applications

Requirements vary widely for the level of control reliability or safety category (per EN ISO 13849) in the application of interlocked guards. Although Banner Engineering always recommends the highest level of safety in any application, it is the user's responsibility to safely install, operate, and maintain each safety system and comply with all relevant laws and regulations. The applications shown in [Figure:Wiring to two 4-wire coded magnetic safety switches. Configured for single-channel monitoring of either one or two guards \(jumper S11.613 or S21.623 for single channel\)](#), this application is considered to meet or exceed requirements for Control Reliability and Safety Categories 3 and 4 per EN ISO 13849-1, on page 5 through [Figure:Wiring to two complementary current-sourcing PNP devices. Configured for either single-channel or dual-channel monitoring, the level of safety \(Control Reliability or Safety Categories\) is dependent on the devices connected to the GM-FA-10J](#). on page 4 to meet or exceed the requirements for control reliability and Safety Category 3 or 4, per EN ISO 13849.

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 Safety 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 heat sources.

Electrical Installation

Each Safety Module is powered by 24 V AC/DC (at less than 150 mA). The Safety Module, in turn, supplies power to each switch.

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 35 milliseconds after a safety input opens. This classifies the Safety Module as a functional stop "Category 0" control, as defined by NFPA 79 and IEC/EN 60204-1.



WARNING:

- Risk of electric shock.
- Use extreme caution to avoid electrical shock. Serious injury or death could result.
- Always disconnect power for the safety system (for example, device module, interface, etc.) guarded machine, and/or their actuator being controlled before making any connections or replacing any component. Lockout/tagout procedures might be required. Refer to OSHA 29 CFR 1910.147, ANSI Z12.24-1, or the applicable standard for controlling hazardous energy.
- Make no more connections to the device or system than are described in this manual. Electrical installation and wiring must be made by a "Qualified Person" and must comply with the applicable electrical standards and wiring codes, such as the NEC (National Electrical Code), NFPA 79, or IEC 60204-1, and all applicable local standards and codes.

Connecting Power to the Safety Module

The Safety Module requires a 24 V AC/DC supply voltage (see [GM-FA-10J Specifications](#) on page 18). Use extreme caution when installing AC power. Use a minimum of 16 AWG to 18 AWG wire for power and output connections. Use a minimum of 20 AWG wire for all other terminal connections. A hand-operated supply disconnect and over-current protection (for example, a circuit breaker) must be provided per ANSI/NFPA 79 and IEC/EN 60204-1.

Monitoring Series-Connected Safety Switches

When monitoring two individually mounted safety switches (as shown in [Figure:Wiring to two 4-wire coded magnetic safety switches. Configured for single-channel monitoring of either one or two guards \(jumper S11.613 or S21.623 for single-channel\)](#), this application is considered to meet or exceed requirements for Control Reliability and Safety Categories 3 and 4 per EN ISO 13849-1, on page 5 through [Figure:Wiring to two complementary current-sourcing PNP devices. Configured for either single-channel or dual-channel monitoring, the level of safety \(Control Reliability or Safety Categories\) is dependent on the devices connected to the GM-FA-10J](#), on page 4), a faulty switch will be detected if it fails to switch as the guard opens. In this case, the Gate Monitor Module will de-energize its output relays and disable its reset function until the input requirements are met (i.e., the faulty switch is replaced). However, when a series of interlocking safety switches is monitored by a single Safety Module, the failure of one switch in the system may be masked or not detected at all (refer to [Figure:Alternate wiring for single-channel monitoring of multiple guards on page 5](#) and [Figure:Alternate wiring for dual-channel monitoring of multiple guards on page 6](#)).

¹¹A person who, by possession of a recognized degree or certificate of professional listing, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

Series-connected interlock switch circuits do not meet EN ISO 13849 Safety Category 4 and may not meet Control Reliability requirements because of the potential for inappropriate Gate Monitor reset or a loss of the safety stop signal. A multiple connection of this type should not be used in applications where loss of the safety stop signal or an inappropriate reset can lead potentially to serious injury or death. The following two scenarios assume two positive-opening safety switches on each guard:

- Masking of a failure.** If a guard is opened but a switch fails to open, the redundant safety switch will open and cause the Safety Module to de-energize its outputs. If the faulty guard is then closed, both Safety Module input channels are also close, but because one channel did not open, the Safety Module will not reset. However, if the faulty switch is not replaced and a second "good" guard is cycled (opening and then closing both of the Module's input channels), the Module considers the failure to be corrected. With the input requirements apparently satisfied, the Module allows a reset. This system is no longer redundant, if the second switch fails, may result in an unsafe condition (i.e., the accumulation of faults results in the loss of the safety function).
- Non-detection of a failure.** If a good guard is opened, the Safety Module de-energizes its outputs (a normal response). But if a faulty guard is then opened and closed before the good guard is re-closed, the failure on the faulty guard is not detected. This system is no longer redundant and may result in a loss of safety if the second safety switch fails to switch when needed.

The systems in either scenario do not inherently comply with the safety standard requirements of detecting single faults and preventing the next cycle. In multiple-guard systems using series-connected safety switches, it is important to periodically check the functional integrity of each interlocked guard individually. Operators, maintenance personnel, and others associated with the operation of the machine must be trained to recognize such failures and be instructed to correct them immediately.

Open and close each guard separately while verifying that the Gate Monitor outputs operate correctly throughout the check procedure. Follow each gate closure with a manual reset, if needed. If a contact set fails, the Safety Module will not enable its reset function. If the Safety Module does not reset, a switch may have failed; that switch must be immediately replaced.

This check must be performed and all faults must be cleared, at a minimum, during periodic checkouts. If the application can not exclude these types of failures and such a failure could result in serious injury or death, then the series connection of safety switches must not be used.

WARNING:

- Connect two or more devices to the same safety module controller in series.
- Connecting devices in parallel defeats the switch contacts monitoring ability of the module and creates an unsafe condition that could result in serious injury or death.
- Failure to test each device individually in this manner could result in undetected faults and create an unsafe condition that could result in serious injury or death.
- Connect the contacts of the corresponding pole of each switch in series. Never connect the contacts of multiple switches in parallel, individually activate (engage) each device, then release (disengage) and reset the safety module. This allows them only to check each switch and its wiring to detect faults. Perform this check during the prescribed checkouts.

Connecting to the Guarded Machine

The machine interface wiring diagram shows a generic connection of the Module's two redundant output circuits to machine primary control elements MPCE1 and MPCE2. A machine primary control element is an electrically powered device, external to the Module, which stops the guarded machinery by immediately removing electrical power to the machine and (when necessary) by applying braking to dangerous motion. The stop is accomplished by removing power to the actuator coil of either MPCE.

To satisfy the Safety Category 4 requirements of EN ISO 13849, each MPCE must offer a normally closed, forced-guided monitor contact. One normally closed monitor contact from each MPCE is wired in series to the Y1-Y2 feedback/reset input (see [Figure: Wiring to the guarded machine on page 6](#)). In operation, if one of the switching contacts of either MPCE fails in the shorted condition, the associated monitor contact will remain open, preventing the reset of the Module.

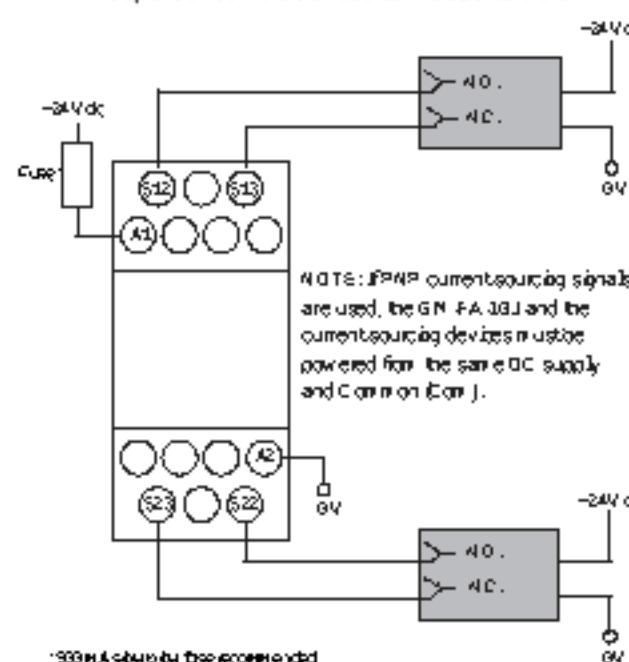
External Device Monitoring

To satisfy the requirements of Control Reliability (OSHA and ANSI) and Category 3 and 4 of EN ISO 13849-1, 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 master stop control element in series to Y1 and Y2 (see [Key definition for "Electrical Installation" not found in the DIA map](#)).

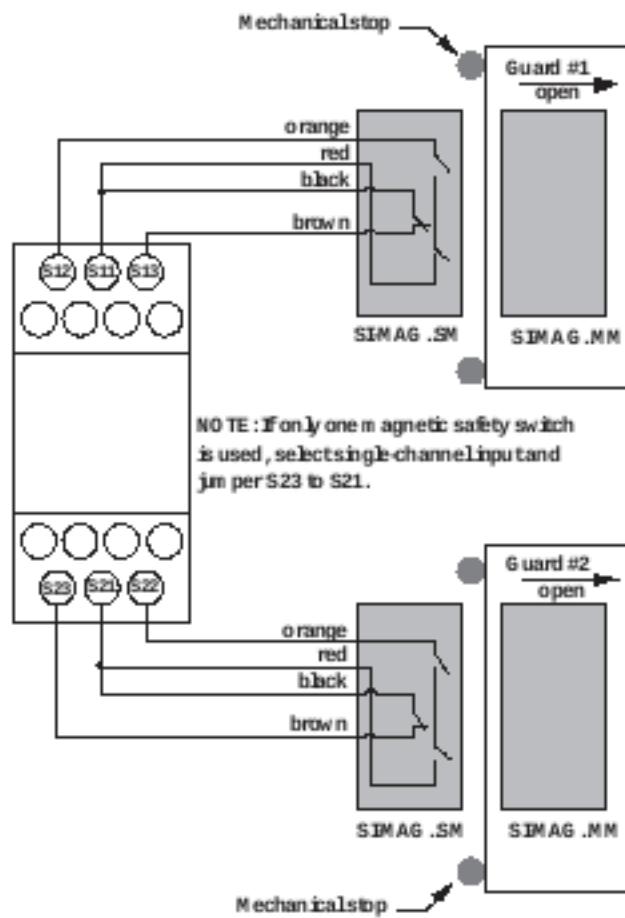
In operation, if one of the switching contacts of either MPCE fails in the energized condition, the associated monitor contact will remain open. Therefore, it will not be possible to reset the Safety Module. If no MPCE monitor contacts are monitored, a jumper must be installed between terminals Y1 and Y2 (dotted line), as shown in the hookup drawings. 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.

Connecting Safety Switches

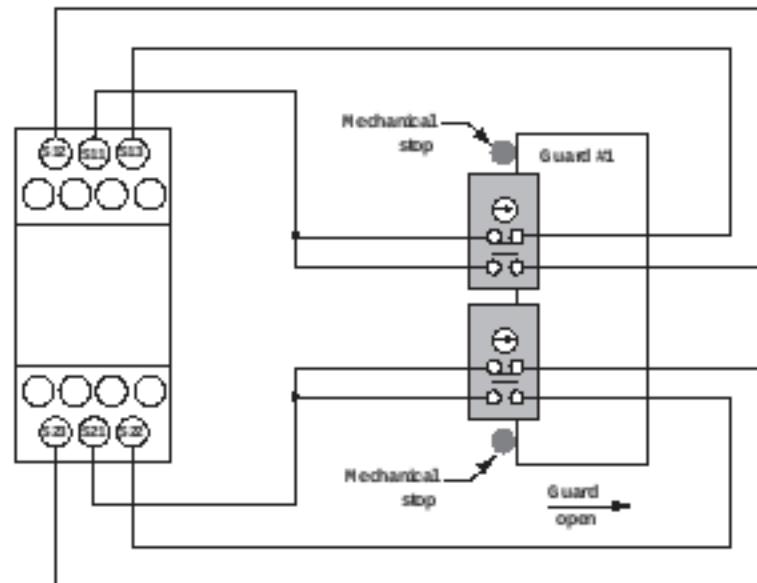
Wiring to two complementary current-sourcing PNP devices. Configured for either single-channel or dual-channel monitoring, the level of safety (Control Reliability or Safety Categories) is dependent on the devices connected to the GM-FA-10J.



Wiring to two 4-wire coded magnetic safety switches. Configured for single-channel monitoring of either one or two guards (jumper S11/S13 or S21/S23 for single-channel), this application is considered to meet exceeded requirements for Control Reliability and Safety Categories 3 and 4 per EN 60 12849-1.



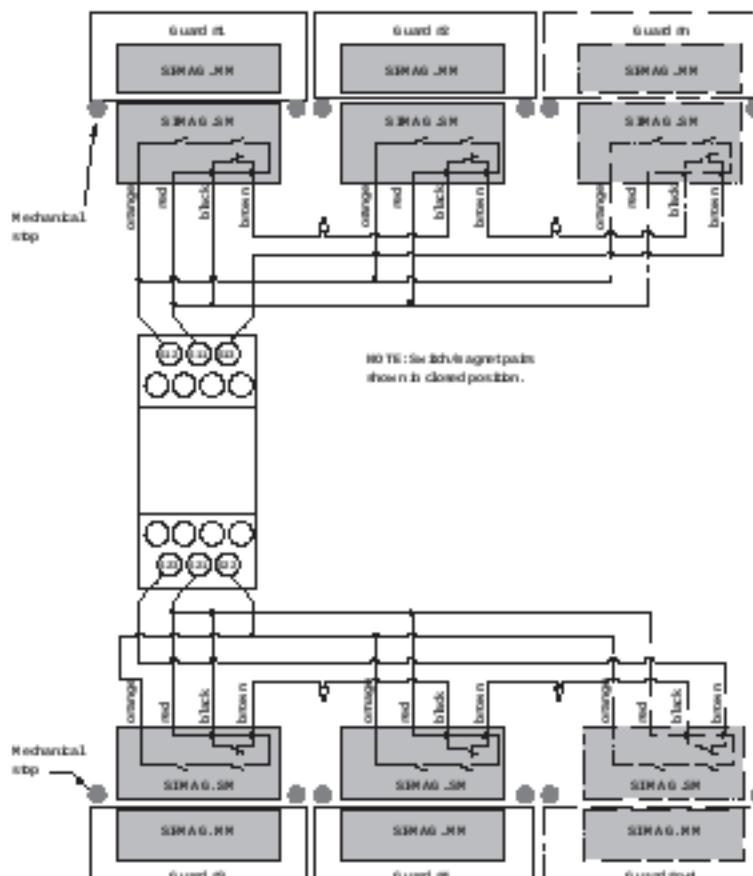
Wiring to two positive-opening safety interlock switches. Configured for dual-channel monitoring of one guard, this application is considered to meet exceeded requirements for Control Reliability and Safety Categories 3 and 4 per EN 60 12849-1.



IMPORTANT: If the model number of the magnetic switch does not include a letter between the SIMAG and the number, the orange wire is shown white and the red wire is gray (kitemark code).

Single-Channel Monitoring

Alternating wiring for single-channel monitoring of multiple guards



Configured for single-channel monitoring of multiple guards with single switches at each guard (see Warning). Up to 10 Banner magnetic switches may be connected to each channel in this series/parallel method.



WARNING: Note Safety Category 4 Application. When monitoring multiple guards with a series connection of multiple safety interlock switches, a single failure can be masked or undetected still. When such a configuration is used, procedures must be performed regularly to verify proper operation of each switch. See "Monitoring Series-Connected Safety Switches" for more information.

(If other than Banner magnetic switches are used, a total resistance of 2700 ohms between S11/S13, S11/S12, S21/S22, and S21/S23 must not be exceeded.)

IMPORTANT: If the model number of the magnetic switch does not include a letter between the SIMAG and the number, the orange wire is shown white and the red wire is gray (kitemark code).

IMPORTANT: The single- and dual-channel monitoring is referring to the module's inputs/channel to the generic safety circuits. Each input/channel has a built-in monitoring the changes of two input contacts and can be used in circuits rated to the highest levels of safety.

Dual Channel Monitoring

Configured for dual channel monitoring of multiple guards with two safety switches mounted individually on each guard (see Warning).

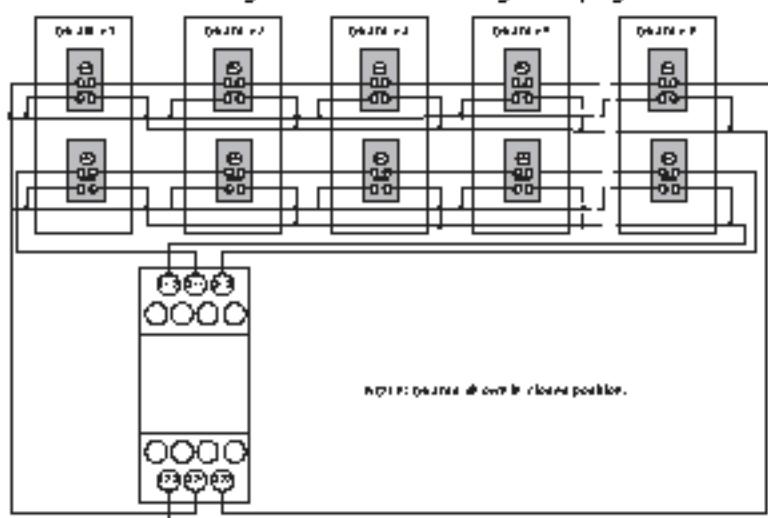
The number of mechanical switches is limited by the maximum resistance of 270 ohm between S11/S13, S11/S12, S21/S22 and S21/S23. The total resistance is calculated by adding the resistance of all guard switch contacts and the resistance of the cables that connect the switches and the switches to the module.



WARNING: Note Safety Category 4 Application. When monitoring multiple guards with a series connection of multiple safety interlock switches, a single failure may be masked or undetected at all.

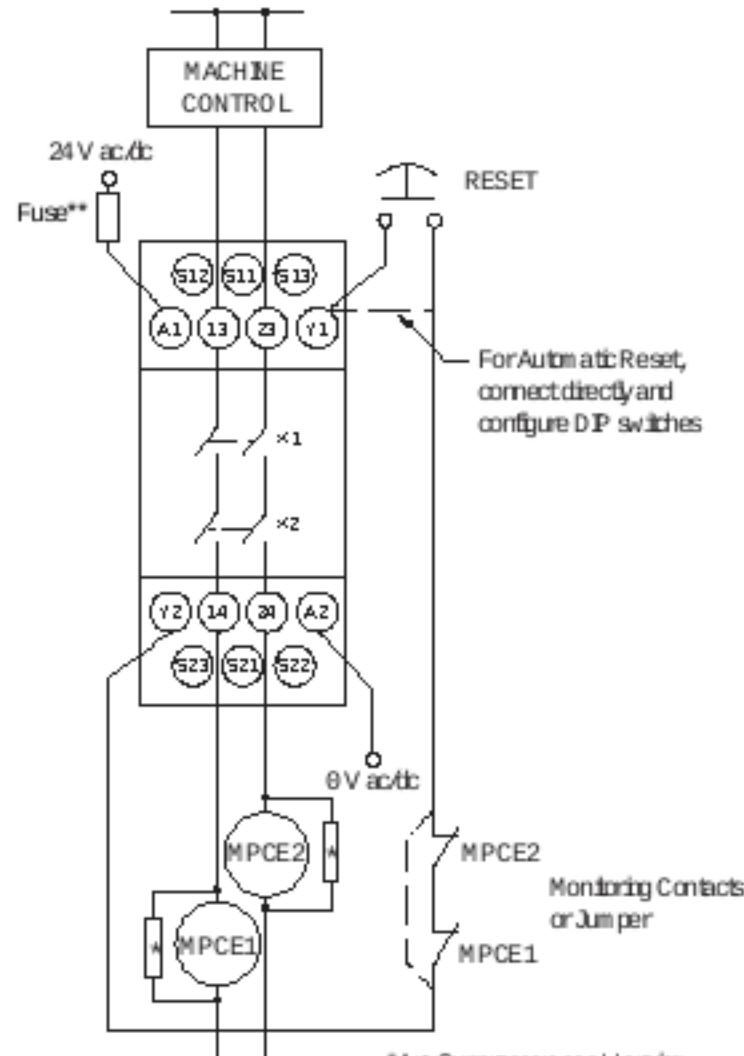
When such a configuration is used, procedures must be performed regularly to verify proper operation of each switch. See "Monitoring Series-Connected Safety Switches" for more information.

Alternate wiring for dual channel monitoring of multiple guards



WARNING: Interfacing MPCEs. NEVER wire an intermediate device(s) (e.g., PLC, PES, PC) between the Safety Module outputs and their active primary control element (MPCE) switches. In such an arrangement, in the event of a failure there is the loss of the safety function word, OR in such a manner that the safety function can be suspended, overridden, or defeated, unless accompanied with an even greater degree of safety. Whenever fixed guided mechanical linked relays are used as intermediate switching devices, a normally closed fixed guided monitor contact on each relay must be added to the series feedback loop between Safety Module terminals Y1 and Y2.

Wiring to the guarded machine

**WARNING:**

- Properly install arc transient suppressors.
- Failure to follow these instructions could result in serious injury or death.
- Install arc suppressors as shown across the coils of the active primary control elements. Do not install suppressors directly across the output contacts of the safety or interface module. In such a configuration, it is possible for suppressors to fail as a short circuit.

**500 mA slow blow fuse recommended

*Arc Suppressor, see Warning

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

The Safety Module is rated for overvoltage Category II when voltages of 1V to 150V AC/DC are applied to the output relay contacts. It is rated for overvoltage Category II when voltages of 151V to 250V 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 Safety Module can be used in an overvoltage Category III environment (with voltages of 151V to 250V AC/DC) if care is taken either to reduce the level of electrical disturbances seen by the Safety 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 151V to 250V 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.

GM FA-10J Configuration

WARNING:

- Reset routine required
- Failure to prevent the machine from restarting without actuating the normal start-up switch device can create an unsafe condition that could result in serious injury or death.
- Do not allow the machine to restart without actuating the normal start-up switch device. Perform the reset routine after clearing the cause of a stop condition, as required by U.S. and international standards.

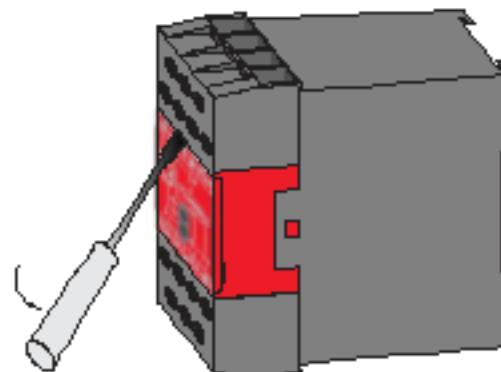
WARNING:

- Inadequate switches
- Failure to correctly install reset switches could result in serious injury or death.
- Install reset switches so that they are accessible only from outside and in full view of the safeguarded space. Reset switches can only be accessible from within the safeguarded space. Protect reset switches against unauthorized or inadvertent operation (for example, through the use of rings or guards). If there are any hazardous areas before reset switches, provide additional safeguarding.

To remove a terminal block, insert a small flat-blade screwdriver into the slot at the center of the block as shown (may be covered by label). As typically mounted on a DIN rail, to remove the top block, rotate the screwdriver downwards (towards the module) and pry to loosen. The terminal block will slide outwards (towards you) as it loosens. To remove the lower block, rotate the screwdriver upwards (towards the module) and pry to loosen.

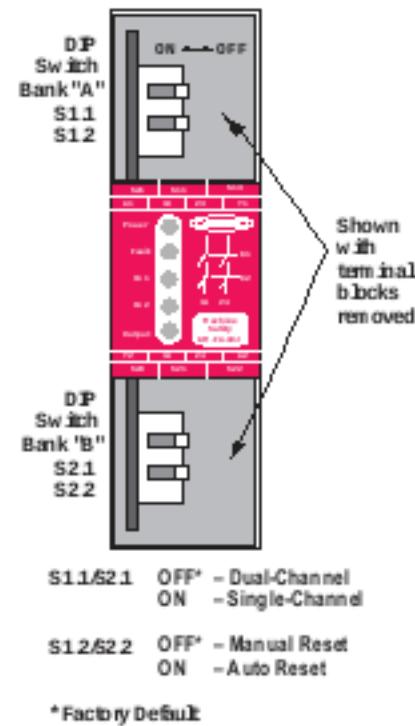
When reinserting the block, take care to slide the dovetail on the terminal block into the slot on the frame.

Remove from terminal blocks



ManualReset and ResetSwitch Connection

DIP switch configuration settings for reset mode and single-/dual-channel operation



NOTE: Corresponding DIP switches in Banks A and B must be set identically.

Automatic Reset Mode

To configure the Module for Automatic Reset, set switches S1.2 and S2.2 in Banks A and B to ON. If no MPEC contacts are monitored, install a jumper between terminals Y1 and Y2 (see [Figure: Wiring to the guarded machine on page 6](#)). The Safety Module will reset (and its outputs will energize) as soon as the guards return to their closed position.

Automatic Reset is useful for some automated processes. However, if Automatic Reset is used, an alternate means must be provided to prevent resumption of hazardous machine motion until an alternate reset procedure is performed. The alternate means must include a Reset switch, located outside the area of dangerous motion, and positioned so that the switch operator can see all areas of dangerous motion during the reset procedure.

Single-Channel or Dual-Channel Input

The Safety Module may be configured for single-channel or dual-channel operation by setting DIP switches S1.1 and S2.1 in Banks A and B. In single-channel operation (S1.1 and S2.1 – ON), the input channels function independently. The two guards can be monitored individually, but both channels must be in the closed position for the SafetyModule to be reset.

In dual-channel operation (S1.1 and S2.1 – OFF) the input channels must function together. Both channels must switch within a 3-second simultaneity of the other when the guard closes. If not, the guard must be re-opened and closed until the timing requirement is met. When the guard opens, the channels function concurrently (both must open, but without the timing requirement).

In either configuration, the “closed” inputs of each channel must be closed before the SafetyModule can be reset (continuity S1.1 to S1.3 and S2.1 to S2.3). If in single-channel mode and monitoring only one switch, a jumper must be installed at the unused input (e.g., S2.1 to S2.3; see [“Figure: Wiring to two 4-wire coded magnetic safety switches. Configured for single-channel monitoring of either one or two guards \(jumper per S1.1/S1.3 or S2.1/S2.3 for single-channel\)”](#)). This application is considered to meet or exceed requirements for ControlReliability and SafetyCategories 3 and 4 per EN ISO 13849-1 on page 5).

Troubleshooting

Initial Checkout Procedure

CAUTION:

- Disconnect power prior to checkout.
- Dangerous voltages might be present along the module wiring barriers whenever power to the machine control elements is on.
- Before performing the initial checkout procedure, disconnect power from the entire machine to be controlled. Exercise extreme caution whenever machine control power is on or might be present. Always disconnect power to the machine control elements before opening the enclosure housing of the module.

WARNING:

- Test multiple safety devices individually.
- Failure to test each safety device individually could result in undetected faults and create an unsafe condition that could result in serious injury or death.
- When two or more safety devices are used, individually activate each device causing a stop or open contact condition, then reset them to safety mode (using an autoreset mode). This allows the monitoring circuits to check each device and know how to detect faults.

- Remove power from the machine control elements (MPCEs).
- Close all monitored guards. If the Module is wired to single-channel input, the second input (S2.1/S2.3 or S1.1/S1.3) must be jumpered if unused.
- Apply input power (only) to the Gate Monitor Module terminals A1 and A2 (see [“Figure: Wiring to the guarded machine on page 6”](#)). The following LEDs should come ON: Power, Input1, Input2. If the PowerLED comes ON, but either or both InputLEDs are not ON, disconnect input power and check the wiring of the connected switch(es) and/or the jumper. Check if the jumper is installed correctly on the unused input. Return to step 2 after the cause of the problem has been corrected.
- Step 4 varies, depending on how the module is configured.

Option	Description
If the Module is set to single-channel operation	After the Power, Input1, and Input2 LEDs all are ON, open and close all connected guards one at a time. When each individual guard opens, the corresponding InputLED must turn OFF, and when the guard closes its LED must come ON again.
If the Module is set to dual-channel operation	After the Power, Input1, and Input2 LEDs all are ON, open the guard; both switches must open within 3 seconds, and both InputLEDs must turn OFF. If the red FaultLED comes ON, simultaneously between the switches or within one switch (between its NO and NC contacts) was noted. Check all wiring and the switches.
If the Module is set to Auto Reset	(Y1/Y2 closed and DIP switches set to Auto Reset), the outputLED will come ON as soon as both InputLEDs are ON (output contacts 13/14 and 23/24 close).
If the Module is set to Manual/Monitored Reset	The OutputLED should come ON only if Input1 and 2 LEDs are ON and the Resetbutton connected to Y1 and Y2 went from open to closed and back to open position.

- Repeat step 4 individually for each guard that is being monitored.

- Close the guard. Apply power to the machine control elements and perform the [“Periodic Checks”](#) on page 8.

NOTE Make sure that both Input1 and 2 LEDs are ON only when ALL connected guards are closed. If the guards are closed and the InputLEDs are OFF, the guard switches may be wired incorrectly, which could reset the Module inappropriately (safety output contacts close as soon as one of the connected guards opens).

Do not continue operation until all checks are completed and all problems are corrected. See [“Do Not Use Machine Until System is Working Properly”](#) warning, and [“Repairs”](#) on page 12 and [“Troubleshooting”](#) on page 9 for further information.

Periodic Checks

Banner Engineering highly recommends performing the periodic checks as described. However, a qualified person (or team) should evaluate these generic recommendations considering their specific application and determine the appropriate frequency of checkouts. This will generally be determined by a risk assessment, such as the one contained in ANSI B11.0. The result of the risk assessment will drive the frequency and content of the periodic checkout procedures and must be followed.

WARNING:

- Do not use the system until the checkouts are verified.
- Attempts to use the guarded/controlled machine before these checks are verified could result in serious injury or death.
- If all these checks cannot be verified, do not attempt to use the safety system that includes the Banner Engineering Cap device and the guarded/controlled machine until the defect or problem has been corrected.

A Designated Person is identified in writing by the employer as being appropriately trained to perform a specified checkout procedure. A Qualified Person possesses a recognized degree or certificate or has extensive knowledge, training, and experience to be able to solve problems relating to safety switch installation.

At each shiftchange or machine setup, a Designated Person should perform the following checks on all safety switches:

- Verify the switch, sensor, actuator, or magnet are not broken or damaged.
- Check for good alignment between the switch and actuator or sensor and magnet.
- Confirm the switches are not being used as an end-of-travel stop.
- Correct any loosened mounting hardware.
- Verify it is not possible to reach any hazard point through an opened guard (or any opening) before hazardous machine motion stops completely.
- Open and close each guard separately while verifying that the Gate Monitor outputs operate correctly throughout the check procedure. Follow each gate closure with a manual reset, if needed. If a contact set fails, the Safety Module will not enable its reset function. If the Safety Module does not reset, a switch may have failed; that switch must be immediately replaced.
- In addition, a Qualified Person should perform the following on a periodic schedule (determined by the user, based upon the severity of the environment and the frequency of switch actuations):
 - Inspect the electrical wiring for continuity and damage.
 - Confirm that the wiring conforms to the instructions given in this installation manual.

Do not continue operation until all checks are completed and all problems are corrected. See "Repairs" on page 12 and "Troubleshooting" on page 8 for further information.

Troubleshooting

Model GM-FA-10J Gate Monitoring Safety Module provides five LED indicators.

LED	Condition	Meaning
Power (green)	ON	Power is connected to terminals A1/A2.
	OFF	No power or low power to terminals A1/A2, or internal power supply failure.
Fault (red)	ON	External fault or configuration fault. The corresponding Function LED will flash to indicate the area where the fault has been detected. See "Clearing Faults" on page 9 for probable cause.
	Flashing	Internal fault. See "Repairs" on page 12.
Input1 (green)	ON	Guard 1 is closed and the inputs of Channel 1 are satisfied.
	OFF	Guard 1 is open or the inputs of Channel 1 are not satisfied.
Input2 (green)	ON	Guard 2 is closed and the inputs of Channel 2 are satisfied.
	OFF	Guard 2 is open or the inputs of Channel 2 are not satisfied.
Output (green)	ON	Both internal relays X1 and X2 are energized (13/14 and 23/24 are closed).
	OFF	Both internal relays X1 and X2 are de-energized (13/14 and 23/24 are opened).
	Flashing	Reset requested. Cycle the Reset input (button) (open, closed, open) to enter RUN mode.
	Flashing (along with the Fault LED ON)	See "Clearing Faults" on page 9 for probable cause.

Clearing Faults

To clear a fault condition, first correct the problem and then cycle the input channels to the module (open and close the guards). When the Fault LED lights, the corresponding Function LED will flash to indicate the problem. If the Fault LED is flashing, refer to "Repairs" on page 12.

Input1:S12/S13

Input2:S22/S23

LEDs					Fault, Probable Cause, and Procedures
Power	Fault	Input1	Input2	Output	
On	On	Flashing	On/Off	Off	INPUT CHANNEL 1 FAULT (S11/S12/S13) <ul style="list-style-type: none"> a. S13 open (guard closed) b. S12 open (guard open) c. S11 open (guard is open or closed) d. Short between S11 and S12
On	On	On/Off	Flashing	Off	INPUT CHANNEL 2 FAULT (S21/S22/S23) <ul style="list-style-type: none"> a. S23 open (guard closed) b. S22 open (guard open) c. S21 open (guard is open or closed) d. Short between S21 and S22
On	On	Flashing	Flashing	Off	SHORT BETWEEN INPUT CHANNELS <ul style="list-style-type: none"> a. Short between S11 and S21
On	On	On/Off	On/Off	Off	SIMULTANEOUS FAULT <ul style="list-style-type: none"> a. Dual channels simultaneously > 3 seconds (configured for dual channel operation) b. Channels simultaneously > 1 second (NO AC did not switch within 1 second) See "Configuration" on page 2 for description of complementary switching and dual channel operation.
Flashing	Flashing	Off	Off	Off	O/P SWITCH ERROR <ul style="list-style-type: none"> a. O/P switch settings are incorrect: Bank A does not switch Bank B See "GM-FA-10J Configuration" on page 1 for O/P switch configuration.
On	On	On	On	Flashing	OPEN RESET FAULT <ul style="list-style-type: none"> a. Y1/Y2 open when configured for Auto Reset See "GM-FA-10J Configuration" on page 1 for Manual/Auto Reset information.

Continued on page 13

Continued from page 9

LEDs					Fault, Probability Cause, and Procedures
Power	Fault	Input1	Input2	Output	
On	Flashing	Off	Off	Off	INTERNAL FAULT (See "Repairs" on page 12) a. Incorrect check sum b. Internal relay failure (e.g., welded contact due to inductive load arcing.) c. Low input power d. Other internal fault

GM-FA-10J Specifications

Supply Voltage and Current

24 V DC ±10% at 150 mA (SELV rated supply according to EN EC 62368, NEC Class 2)
24 V AC ±10% at 150 mA, 50-60 Hz ±5% (NEC Class 2-rated transformer)
Power consumption: approx. 3 mA / 3 W
To comply with UL and CSA standards, the isolated secondary power supply circuit must be installed in an appropriate enclosure to limit the overvoltage to 0.8 kV. The use of a 900 mA, slow blow fuse in series with the +24 V AC/DC is highly recommended. The GM-FA-10J does not contain an internal fuse.

Supply Protection Circuitry

Protected against transient voltages and reverse polarity

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

Output Configuration

Contacts: AgNi, 5 µm gold-plated
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 (e.g., "dry switching").
To preserve the gold plating on the contacts, do not exceed the following max. values at any time:
Max. voltage: 14 V AC/DC; Max. voltage: 38 V
Max. current: 5 mA AAC/DC; Max. current: 383 mA
Max. power: 5 mW (5 mVA); Max. power: 1 W (1 VA)

High Current Rating

Higher loads can be switched through one or all of the contacts, the minimum and maximum values of the contacts (changes to:
UL Listed: Nominally voltage: 15 V AC/DC; Nominal current: 38 mA AAC/DC; Nominally power: 0.45 W (0.45 VA); Max: 250 V AC / 24 V DC, 5 A, resistive - IEC 62368-1: AC 15 : 250 V ac, 3 A; DC 13 : 24 V dc, 2 A

Electrical Life (switching cycles of the output contacts, resistive load)

150,000 cycles at 230 V AC
1,000,000 cycles at 230 V AC
2,000,000 cycles at 120 V AC
5,000,000 cycles at 120 V AC

Safety Monitoring

2 Channel operation: 3 seconds
1 Channel operation: infinite

Input Requirements

Each switch or sensor must have a normally closed contact and a normally open contact capable of switching 20 to 50 mA at 15 to 38 V dc.
Reset switch: 20 mA at 12 V DC, hard contact only
Max. external resistance between terminals 511-512, 511-513, 521-522 and 521-523: 2 kΩ (max. 5 sec.).

Overvoltage Category

Output relay contact voltage of 14 V to 158 V AC/DC: Category III
Output relay contact voltage of 151 V to 233 V AC/DC: Category II
Category III: Appropriate overvoltage reduction is provided, as described in [Overvoltage Cat. II and III](#)

Pollution Degree

2

Status Indicators

One red LED: Fault (see ["Troubleshooting" on page 8](#))
Four green LEDs: Power – power is supplied to Safety Module;
Channel 1 – inputs satisfied (guard closed); Channel 2 – inputs satisfied (guard closed); Output – K1 and K2 energized, safety outputs closed

Construction

Polyacetal housing, Rated EC P23

Mounting

Mounts to standard DIN or 1/2" rail track. Safety modules must be installed inside an enclosure rated IEC 60A-3 (IEC P54), or better.

Mechanical Life

≥ 50,000,000 operations

Output Response Time

35 ms max.

Required Document Protection



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

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

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

Supplying leads < 24 AWG shall not be soldered.

For additional product support, go to [www.bannerengineering.com](#).

Supply V Kv-ing PKC 2	Required Document Protection PK	Supply V Kv-ing PKC 2	Required Document Protection PK
20	50	20	10
22	30	20	08
24	10	20	06

Safe Values

Voltage V	Current A	RMS
230 V	2	60.00
230 V	1	60.00
230 V	0.5	1,000.00
240 V	≤ 2 A	6,000.00

Certifications



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1931 Oegem, BELGIUM

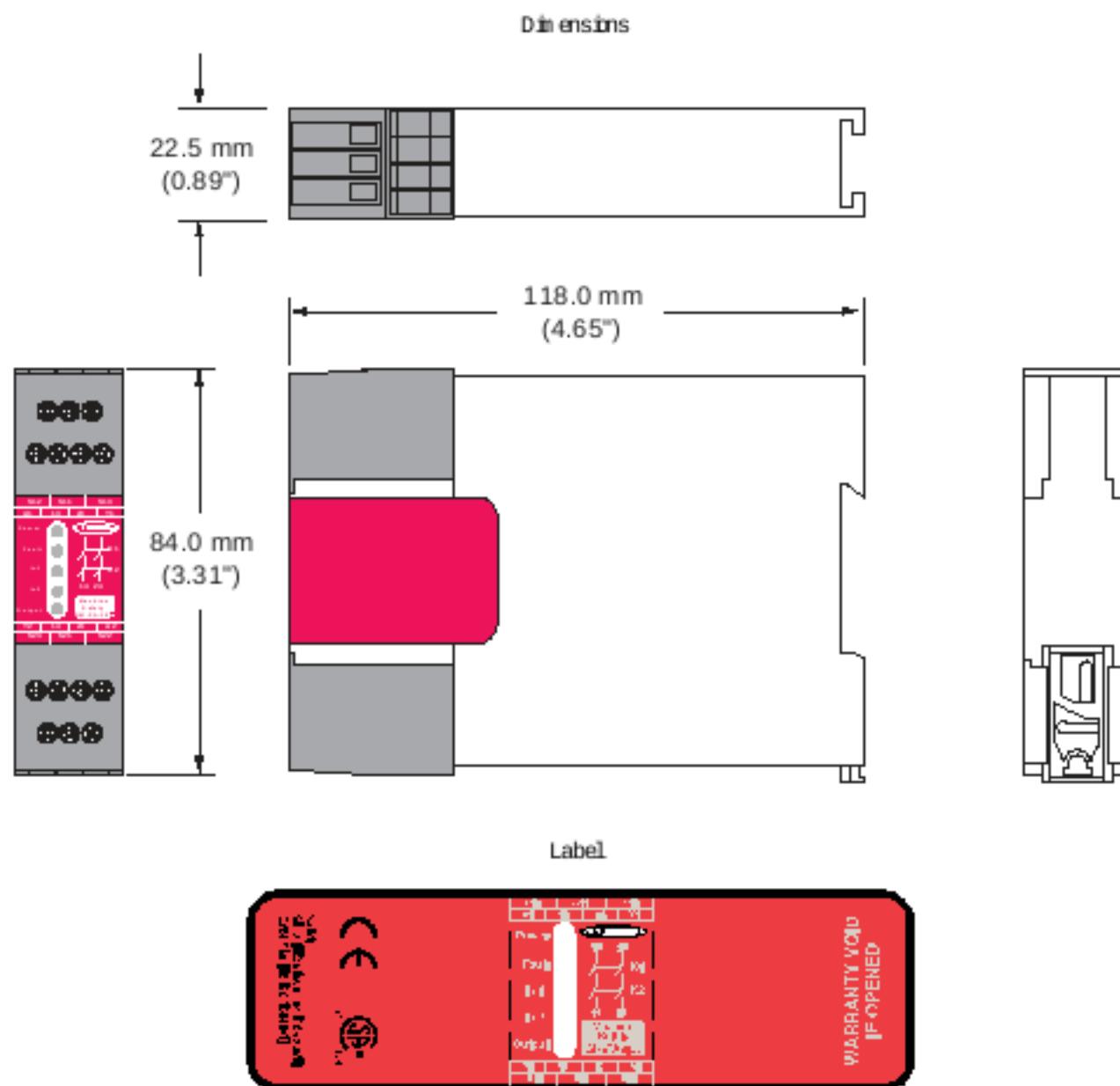


Turck Banner LTD, Blenheim House
Blenheim Court,
Wickford, Essex SS11 8YT
GREAT BRITAIN



IMPORTANT: Transient suppression is recommended when switching inductive loads. Install suppressors across load. Never install suppressors across output contacts (see Warning in [Overvoltage Cat. II and III](#)).

GM-FA-10J Dimensions



Related Products

SIMAG Models

MagnetSensor Pair	MagnetSensor		Coded Magnet
	Model	Connection	
	SIMAGB1SM	3m cable with flying leads	SIMAGB1NN (Switching distance: 4 mm to 14 mm) OR SIMAGB1NN 90° (90° orientation) (Switching distance: 4 mm to 14 mm) OR SIMAGB1NNHF (Switching distance: 8 mm to 16 mm)
	SIMAGB1SMCO	3m cable with flying leads: cable composite	
	SIMAGB1SMQD	4-pin M8 QD connector	
	SIMAGB1SMCOQD	4-pin M8 QD connector: connector composite	
	SIMAGB2SM	3m cable with flying leads	SIMAGB2NN (Switching distance: 3 mm to 14 mm)
	SIMAGB2SMQD	4-pin M8 QD connector	
	SIMAGB3SM	3m cable with flying leads	SIMAGB3NN (Switching distance: 5 mm to 14 mm)
	SIMAGB3SMQD	4-pin M12 QD connector	

The magnet sensors listed have a 3 m (10 ft) cable. To order 9 m (30 ft) cables models, add w/90 to the model number (e.g. SIMAGB1SM w/90). (Older models without the B, are non-UL approved models. These older models do NOT work with SIMAG B models.)

A basic SIMAG system requires an SIM AG sensor, coded magnet, cable (for QD versions), and a safety monitoring device.

NOTE: This manual applies to the older genetic series, specifically banner models that do not contain the "G" in model name.

Product Support and Maintenance

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.

Obtain assistance with product repairs by contacting your local Banner Engineering Corp. distributor or by calling Banner directly at (763) 544-3164. Access literature translated into your native language on the Banner website at www.bannerengineering.com or contact Banner directly at (763) 544-3164.

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

WARNING:

- Do not abuse the 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 with a physical impact to the housing.
- Failure to follow these instructions could result in serious injury or death.
- An internal relay may have failed in such a manner that its replacement is required. If this occurs, it must be replaced immediately or repaired multiple simultaneous failures might occur due to the safety function cannot be guaranteed.

EU/UK Declaration of Conformity (DoC)

Banner Engineering Corp. herewith declares that these products are in conformity with the provisions of the listed directives and all essential health and safety requirements have been met. For the complete DoC, please go to www.bannerengineering.com.

Product	Directive
GM-FA-10J Gate Monitoring Safety Module	EU : 2006/42/EC
	UKCA : Machinery (Safety) Regulation 2008

Representative in EU: Spiros Lachanidis, Managing Director, Banner Engineering BV Park Lane | Culliganlaan 2F bus 3 | 1831 Diegem, BELGIUM

Representative in UK: Tony Coghlan, Managing Director, Turck Banner LTD Blenheim House | Blenheim Court | Wickford, Essex SS11 8YT | Great Britain

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