User Manual
GFK-3184 Rev. B
January 2021

PACSafe™ Configurable Safety Controller User Manual

EMERSON™

Contents

1 About This Document

1.1 Important... Read This Before Proceeding!

It is the responsibility of the machine designer, controls engineer, machine builder, machine operator, and/or maintenance personnel or electrician to apply and maintain this device in full compliance with all applicable regulations and standards. The device can provide the required safeguarding function only if it is properly installed, properly operated, and properly maintained. This manual attempts to provide complete installation, operation, and maintenance instruction. *Reading the manual in its entirety is highly recommended to ensure proper understanding of the operation, installation, and maintenance.* Please direct any questions regarding the application or use of the device to Emerson.

For more information regarding U.S. and international institutions that provide safeguarding application and safeguarding device performance standards, see Standards and Regulations on p. 233.

WARNING:

- The user is responsible for following these instructions.
- **Failure to follow any of these responsibilities may potentially create a dangerous condition that could result in serious injury or death.**
- Carefully read, understand, and comply with all instructions for this device.
- Perform a risk assessment that includes the specific machine guarding application. Guidance on a compliant methodology can be found in ISO 12100 or ANSI B11.0.
- Determine what safeguarding devices and methods are appropriate per the results of the risk assessment and implement per all applicable local, state, and national codes and regulations. See ISO 13849-1, ANSI B11.19, and/or other appropriate standards.
- Verify that the entire safeguarding system (including input devices, control systems, and output devices) is properly configured and installed, operational, and working as intended for the application.
- Periodically re-verify, as needed, that the entire safeguarding system is working as intended for the application.

1.2 Warnings and Caution Notes as Used in this Publication

WARNING:

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

CAUTION:

Caution notices are used where equipment might be damaged if care is not taken.

Note: Notes merely call attention to information that is especially significant to understanding and operating the equipment.

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met during installation, operation, and maintenance. The information is supplied for informational purposes only, and Emerson makes no warranty as to the accuracy of the information included herein. Changes, modifications, and/or improvements to equipment and specifications are made periodically and these changes may or may not be reflected herein. It is understood that Emerson may make changes, modifications, or improvements to the equipment referenced herein or to the document itself at any time. This document is intended for trained personnel familiar with the Emerson products referenced herein.

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1.3 EU Declaration of Conformity (DoC)

Emerson 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 https://www.Emerson.com/Industrial-Automation-Controls/Support.

Product	Directive
PACSafe™ Configurable Safety Controller with Expansion & Display, PACSafe™ Configurable Safety Controller with Expansion, PACSafe™ Standalone Configurable Safety Controller with Display, PACSafe™ Standalone Configurable Safety Controller, PACSafe™ Input Modules, PACSafe™ Output Modules, PACSafe™ Relay Output Modules, and PACSafe™ Standalone Configurable Safety Controller with Relay Outputs	2006/42/EC and EMC Directive 2004/108/EC

Authorized Responsible Person Based in EU: Sher Boparai. Address: ICC Intelligent Platforms GmbH Memminger Str. 14 86159 Augsburg Germany

1.4 Revisions in this Manual

This revision of the manual includes the following changes:

Rev	Date	Description
B	Jan-2021	Updates to support links
A	Nov-2020	Initial release

2 Product Description

Safety control is a critical part of a safety system. Safety Controllers are systems that integrate with the rest of PACSafe controls, connecting seamlessly with the rest of Emerson PACSystems and PACMotion solutions.

PACSafe Safety Controllers are easy-to-use, configurable, and expandable modules (IC225SXE262 and IC225SXF262) designed to monitor multiple safety and non-safety input devices, providing safe stop and start functions for machines with hazardous motion. The Safety Controller can replace multiple safety relay modules in applications that include such safety input devices as E-stop buttons, interlocking gate switches, safety light curtains, two-hand controls, safety mats, and other safeguarding devices. The Safety Controller may also be used in place of larger and more complex safety PLCs with the use of additional input and/or output expansion modules.

The onboard interface:

- Provides access to fault diagnostics
- Allows reading and writing the configuration file from and to the IC225ACC001 drive
- PACSafe 262: Displays configuration summary, including terminal assignments and network settings

2.1 Naming Conventions in this Manual

The following naming conventions are used in this manual. For additional terms, see the Glossary.

Configurable Safety Controller	System that coordinates safety input and output devices, integrates with Emerson's PAC Machine Edition (PME) programming tool, and connects with the PACSystems portfolio.
Safety Controller	An abbreviated version referring to the entire PACSafe 262 Safety Controller system, as well as to the PACSafe 102, both of which are covered by this manual.
Expandable Safety Controller	Refers to expandable models.
Base Controller	Refers to the main module in the PACSafe 262 Safety Controller System.

The formal names of the PACSafe Safety Controller product line are:

- PACSafe™ Configurable Safety Controller with Expansion & Display
- PACSafe™ Configurable Safety Controller with Expansion
- PACSafe™ Standalone Configurable Safety Controller with Display
- PACSafe™ Standalone Configurable Safety Controller
- PACSafe™ Standalone Configurable Safety Controller with Relay Outputs
- PACSafe™ Input Modules
- PACSafe™ Output Modules
- PACSafe™ Relay Output Modules

2.2 Software

The PACSafe Studio Software is an application with real-time display and diagnostic tools that are used to:

- Design and edit configurations
- Test a configuration in Simulation Mode
- Write a configuration to the Safety Controller
- Read the current configuration from the Safety Controller
- Display real-time information, such as device statuses
- Display fault information

The Software uses icons and circuit symbols to assist in making appropriate input device and property selections. As the various device properties and I/O control relationships are established on the **Functional View** tab, the program automatically builds the corresponding wiring and ladder logic diagrams.

See Software Overview on p. 101 for details.

2.3 USB Connections

The micro USB port on the Base Controller and the PACSafe 102 is used to connect to a PC (via the IC225CBL001 cable) and the IC225ACC001 drive to read and write configurations created with the Software.

CAUTION:
- **Potential for Unintended Ground Return Path**
- A large current could damage the PC and/or the Safety Controller.
- The USB interface is implemented in an industry standard way and is not isolated from the 24 V return path.
- The USB cable makes it possible for the computer and Safety Controller to become part of an unintended ground return path for other connected equipment. A large current could damage the PC and/or the Safety Controller. To minimize this possibility, Emerson recommends that the USB cable is the only cable connected to the PC and the PC is placed on a non-conducting surface. This includes disconnecting the AC power supply from a laptop whenever possible.
- The USB interface is intended for downloading configurations and temporary monitoring or troubleshooting. It is not designed for continuous use as a maintenance port.

2.4 Ethernet Connections

Ethernet connections are made using an Ethernet cable connected from the Ethernet port of the Base Safety Controller or PACSafe 102 to a network switch or to the control or monitoring device. The Safety Controller supports either the standard or crossover-style cables. A shielded cable may be needed in high-noise environments.

2.5 Internal Logic

The Safety Controller's internal logic is designed so that a Safety Output can turn On only if all the controlling safety input device signals and the Safety Controller's self-check signals are in the Run state and report that there is no fault condition.

The PACSafe Studio Software uses both Logic and Safety Function blocks for simple and more advanced applications.

Logic Blocks are based on Boolean (True or False) logic laws. The following Logic Blocks are available:
- NOT
- AND
- OR
- NAND
- NOR
- XOR
- Flip Flop (Set priority and Reset priority)

See Logic Blocks on p. 106 for more information.

Function Blocks are pre-programmed blocks with built-in logic which provide various attribute selections to serve both common and complex application needs. The following Function Blocks are available:

- Bypass Block
- Delay Block
- Enabling Device Block
- Latch Reset Block
- Muting Block
- THC (Two-Hand Control) Block
- One Shot Block
- Press Control Block

See Function Blocks on p. 109 for more information.

2.6 Password Overview

A password is required to confirm and write the configuration to the Safety Controller and to access the Password Manager via the Software. See PACSafe 262 Password Manager on p. 117 and PACSafe 102 Password Manager on p. 118 for more information.

2.7 IC225ACC001 Drive and IC225ACC002 Programming Tool

Use the IC225ACC001 drive to store a **confirmed** configuration.

PACSafe 262: The configuration can be written directly by the Safety Controller, when the drive is plugged into the micro-USB port (see PACSafe 262 Configuration Mode on p. 158), or via the IC225ACC002 Programming Tool using only the Software without the need to plug in the Safety Controller.

Important: Verify that the configuration that is being imported to the Safety Controller is the correct configuration (via the Software or writing on the white label on the IC225ACC001 drive).

Click to access the programming tool options:

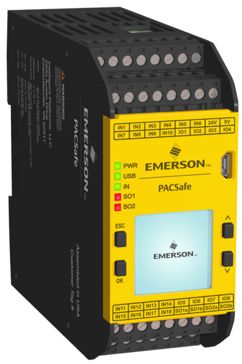
- **Read**—reads the current Safety Controller configuration from the IC225ACC001 drive and loads it to the Software
- **Write**—writes a confirmed configuration from the Software to the IC225ACC001 drive
- **Lock**—locks the IC225ACC001 drive preventing any configurations from being written to it (an empty drive cannot be locked)

Note: You will not be able to unlock the IC225ACC001 drive after it has been locked.

3 PACSafe 262 Overview

With the option to add up to eight I/O expansion modules, the PACSafe Expandable 262 Safety Controller has the capacity to adapt to a variety of machines, including large scale machines with multiple processes.

Figure 1. PACSafe 262 Safety Controller



- Program in minutes with intuitive, easy-to-use configuration software
- Up to eight expansion I/O modules can be added as automation requirements grow or change
- Choose from six expansion module models
- Expansion module models have a variety of safety inputs, solid-state safety outputs and safety relay outputs
- Innovative live display feature and diagnostics allow for active monitoring of I/O on a PC and assist in troubleshooting and commissioning
- Safety Controller and input modules allow safety inputs to be converted to status outputs for efficient terminal use
- Can be configured for up to 256 virtual status outputs
- Optional IC225ACC001 external drive for fast swap and quick configuration without a PC

3.1 PACSafe 262 Models

All Expandable and Non-Expandable Base modules have 18 Safety Inputs, 8 Convertible Safety I/Os, and 2 Solid-State Safety Output pairs. Up to eight expansion modules, in any combination of input and output modules, can be added to the expandable models of the Base Controller.

Table 1: Expandable Base Models

Model	Display
IC225SXE262	No
IC225SXF262	Yes

Table 2: Non-Expandable Base Models

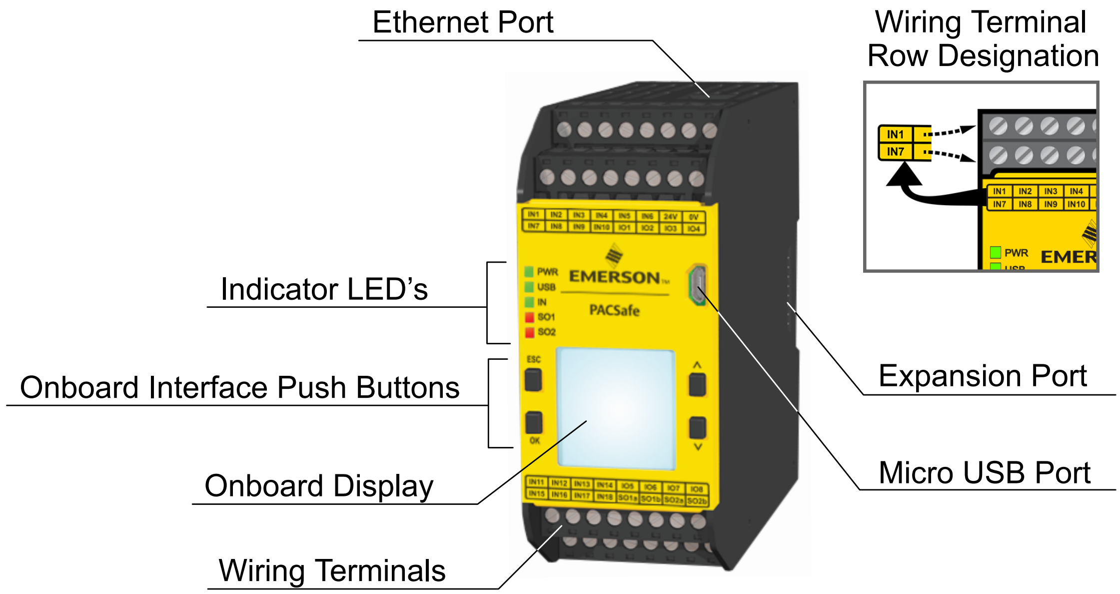
Model	Display
IC225SSE262	No
IC225SSF262	Yes

Table 3: I/O Expansion Modules

Model	Description
IC225SDD842	16-Channel Input Module—16 inputs (4 convertible)
IC225SDD841	8-Channel Input Module—8 inputs (2 convertible)
IC225SDL720	2-Pair Output Module—Dual-Channel Solid-State
IC225SDL740	4-Pair Output Module—Dual-Channel Solid-State
IC225SDL910	Single Relay, Dual Channel Output Module
IC225SDL920	Double Relay, Dual Channel Output Module

3.2 PACSafe 262 Features and Indicators

Figure 2. PACSafe 262 Features and Indicators



3.3 Input and Output Connections

3.3.1 PACSafe 262 Safety and Non-Safety Input Devices

The Base Controller has 26 input terminals that can be used to monitor either safety or non-safety devices; these devices may incorporate either solid-state or contact-based outputs. Some of the input terminals can be configured to either source 24 V DC for monitoring contacts or to signal the status of an input or an output. The function of each input circuit depends on the type of the device connected; this function is established during the controller configuration.

The Base Controller also supports non-safety virtual inputs.

The expansion modules IC225SDD841 and IC225SDD842 add additional inputs to the Safety Controller System.

Contact Emerson for additional information about connecting other devices not described in this manual. See the contact information at the end of this manual.

3.3.2 PACSafe 262 Safety Outputs

The Safety Outputs are designed to control Final Switching Devices (FSDs) and Machine Primary Control Elements (MPCEs) that are the last elements (in time) to control the dangerous motion. These control elements include relays, contactors, solenoid valves, motor controls, and other devices that typically incorporate force-guided (mechanically-linked) monitoring contacts, or electrical signals needed for external device monitoring (EDM).

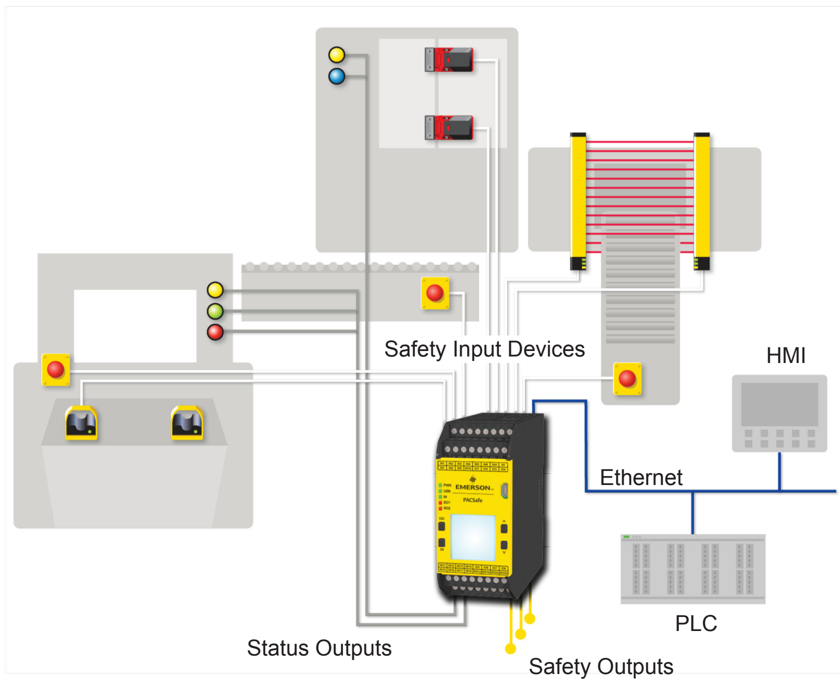
The Safety Controller has two independently controlled and redundant solid-state Safety Outputs (terminals SO1a & SO1b, and SO2a & SO2b). The Safety Controller's self-checking algorithm ensures that the outputs turn On and Off at the appropriate times, in response to the assigned input signals.

Each redundant solid-state Safety Output is designed to work either in pairs or as two individual outputs. When controlled in pairs, the Safety Outputs are suitable for Category 4 applications; when acting independently, they are suitable for applications up to Category 3 when appropriate fault exclusion has been employed (see *Single-channel Control* in Safety (Protective) Stop Circuits on p. 72 and Safety Circuit Integrity and ISO 13849-1 Safety Circuit Principles on p. 31). See Safety Outputs on p. 62 for more information about hookup, solid-state and safety relay outputs, external device monitoring, single/dual-channel Safety Stop Circuits, and configuring Safety Outputs.

Additional solid-state or safety relay outputs can be added to expandable models of the Base Controller by incorporating expansion output modules (IC225SDL720, IC225SDL740, IC225SDL910, and IC225SDL920). Up to eight expansion modules, in any combination of input or output modules, can be added.

The Safety Outputs can be controlled by input devices with both automatic and manual reset operation.

Figure 3. Safety Outputs (Example Application)



Functional Stops according to IEC 60204-1 and NFPA 79

The Safety Controller is capable of performing two functional stop types:

- Category 0: an uncontrolled stop with the immediate removal of power from the guarded machine
- Category 1: a controlled stop with a delay before power is removed from the guarded machine

Delayed stops can be used in applications where machines need power for a braking mechanism to stop the hazardous motion.

3.3.3 PACSafe 262 Status Outputs and Virtual Status Outputs

The Base Controller has eight convertible I/Os (labeled **IOx**) that can be used as Status Outputs which have the capability to send non-safety status signals to devices such as programmable logic controllers (PLCs) or indicator lights. In addition, any unused Safety Output terminals may be configured to perform a Status Output function with the benefit of higher current capacity (see PACSafe 262 Specifications on p. 19 for more information). For the solid-state safety outputs configured as status outputs, the safety test pulses stay enabled even when designated as a status output. The Status Output signal convention can be configured to be 24 V DC, 0 V DC, or cycling on and off. See Status Output Signal Conventions on p. 76 for information on the specific functions of a Status Output.

The Base Controller, using the Software, can be configured for up to 256 virtual status outputs. These outputs can communicate the same information as the status outputs over the network. See Virtual Status Outputs on p. 80 for more information.

WARNING:

- **Status Outputs and Virtual Status Outputs are not safety outputs and can fail in either the On or the Off state.**
- If a Status Output or a Virtual Status Output is used to control a safety-critical application, a failure to danger is possible and may lead to serious injury or death.
- Never use a Status Output or Virtual Status Output to control any safety-critical applications.

3.4 PACSafe 262 Automatic Terminal Optimization (ATO) Feature

Automatic Terminal Optimization (ATO) is a standard feature on all PACSafe 262 models. This feature automatically combines up to two I/O terminals for two devices that require +24 V test pulses from the Safety Controller. When applicable, the Software automatically does this for every pair of devices that are added, until I/O terminals are no longer available. Sharing is limited to two because the screw-type terminals are capable of accepting up to two wires.

If preferred, terminals may be manually reassigned in the device **Properties** window.

The following figures illustrate the PACSafe 262 ATO feature optimizing terminals for two gate switches. This results in a total terminal usage of six, versus eight if ATO is not utilized. The first gate switch (GS1) is added. This is a dual-channel, four-wire gate switch that requires two independent +24 V pulsed outputs from the Safety Controller. IO1 is assigned as +24 V test pulse 1 which runs through channel 1 of GS1 to IN1. IO2 is assigned as +24 V test pulse 2 which runs through channel 2 of GS1 to IN2. When the second gate switch GS2 is added, it also uses IO1 and IO2 but uses IN3 and IN4 to monitor its two channels.

Figure 4. GS1 and GS2 Sharing IO1 and IO2

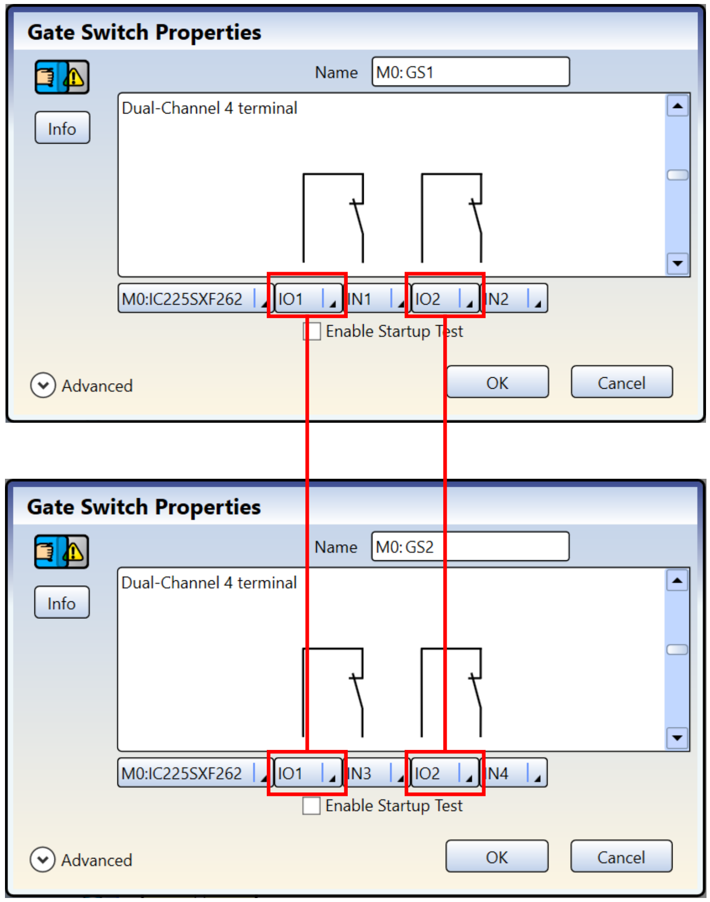
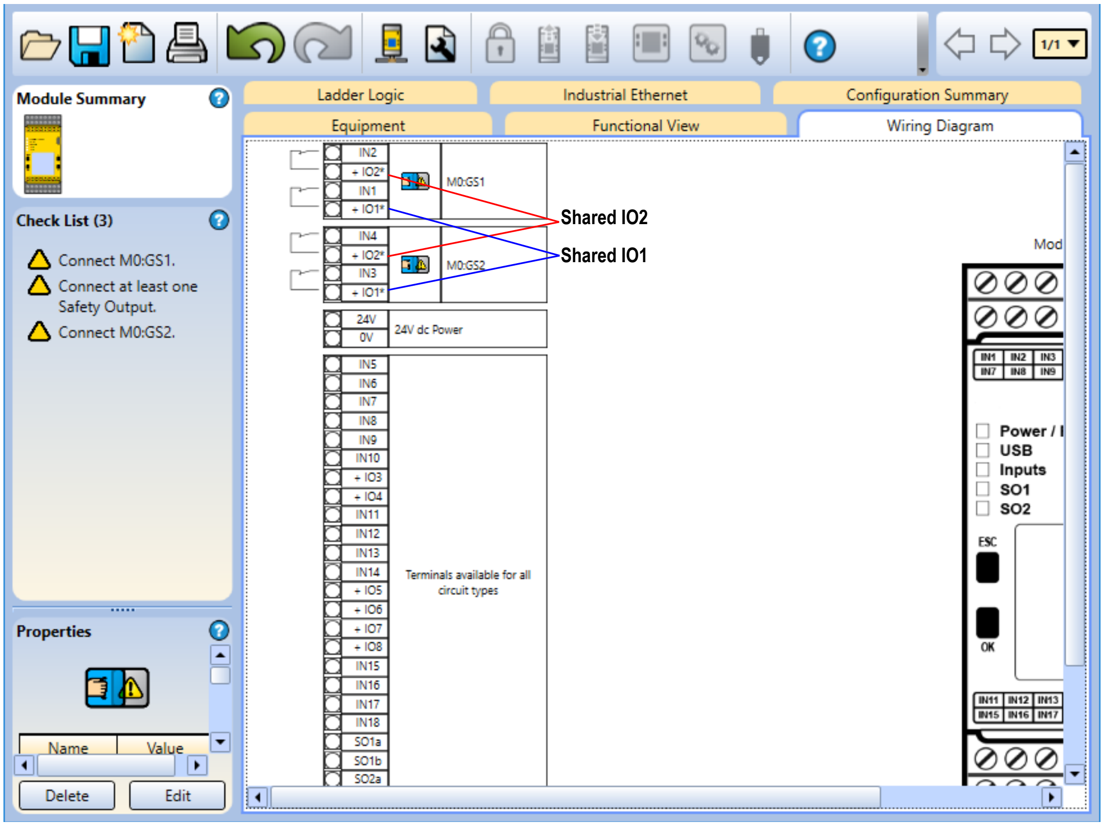
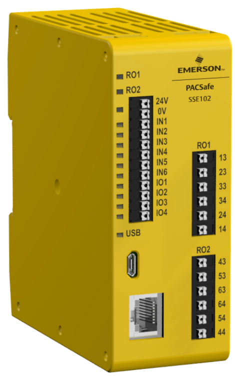


Figure 5. Wiring Diagram Tab View of Shared I/Os



4 PACSafe 102 Overview

Figure 6. PACSafe 102 Safety Controller



The PACSafe 102 configurable safety relay controller is an easy-to-use and cost-effective alternative to safety relay modules. It replaces the functionality and capability of two independent safety relay modules while offering the configurability, simplicity, and advanced diagnostics capabilities offered by the rest of the PACSafe Safety Controller line-up.

- Intuitive, icon-based programming with drag-and-drop PC configuration simplifies device setup and management
- Supports a wide range of safety devices, eliminating the need to buy and stock safety relay modules dedicated to specific safety devices
- Two six-amp safety relay outputs, each with three normally open (NO) sets of contacts
- Ten inputs, including four that can be used as non-safe outputs
- Automatic Terminal Optimization (ATO) can increase the inputs from 10 to up to 14
- Industrial Ethernet two-way communication
  - 256 virtual non-safe status outputs
  - 80 virtual non-safe inputs (reset, ON/OFF, cancel OFF-delay, mute enable)
- Optional IC225ACC001 external drive for fast swap and quick configuration without a PC (see PACSafe 102: Using the IC225ACC001 on p. 207)

4.1 PACSafe 102 Models

Model	Description
IC225SSE102	Configurable safety relay controller - 10 inputs (4 convertible), two 3-channel safety relay outputs, industrial ethernet

4.2 PACSafe 102 Features and Indicators

Connection points are push-in spring clamp connectors.

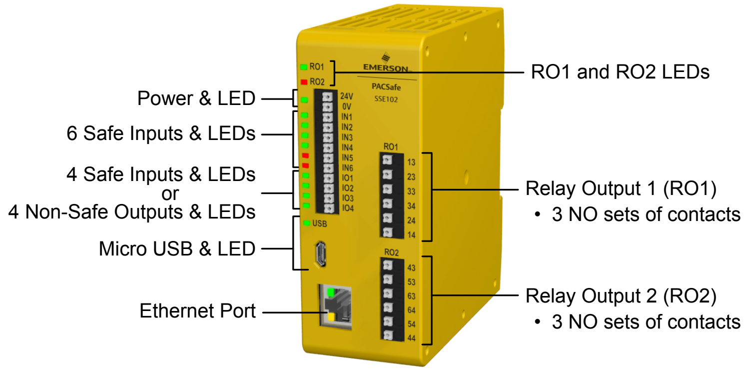
Wire Size: 24 to 14 AWG, 0.2 mm² to 2.08 mm²

Important: Clamp terminals are designed for one wire only. If more than one wire is connected to a terminal, a wire could loosen or become completely disconnected from the terminal, causing a short.

Use a stranded wire or a wire with an accompanying ferrule. Tinned wires are not recommended.

After inserting the wire into the terminal, tug the wire to make sure it is properly retained. If the wire is not retained, consider using a different wiring solution.

Figure 7. Features and Indicators



4.3 Input and Output Connections

4.3.1 PACSafe 102 Safety and Non-Safety Input Devices

The PACSafe 102 has 10 input terminals that can be used to monitor either safety or non-safety devices; these devices may incorporate either solid-state or contact-based outputs.

Some of the input terminals can be configured to either source 24 V DC for monitoring contacts or to signal the status of an input or an output. The function of each input circuit depends on the type of the device connected; this function is established during the controller configuration.

4.3.2 PACSafe 102 Safety Relay Outputs

The PACSafe 102 has two, three-channel, normally open (NO), safety relay outputs.

The Safety Outputs are designed to control Final Switching Devices (FSDs) and Machine Primary Control Elements (MPCEs) that are the last elements (in time) to control the dangerous motion. These control elements include relays, contactors, solenoid valves, motor controls, and other devices that typically incorporate force-guided (mechanically-linked) monitoring contacts, or electrical signals needed for external device monitoring (EDM).

Functional Stops according to IEC 60204-1 and NFPA 79

The Safety Controller is capable of performing two functional stop types:

- Category 0: an uncontrolled stop with the immediate removal of power from the guarded machine
- Category 1: a controlled stop with a delay before power is removed from the guarded machine

Delayed stops can be used in applications where machines need power for a braking mechanism to stop the hazardous motion.

4.3.3 PACSafe 102 Status Outputs and Virtual Status Outputs

Using the Software, the PACSafe 102 can be configured for up to 256 virtual status outputs to communicate information over the network. These outputs have the capability to send non-safety status signals to devices such as programmable logic controllers (PLCs) or human-machine interfaces (HMIs). See Virtual Status Outputs on p. 80 for more information.

The PACSafe 102 has four convertible I/Os (labeled IOx) that can be used as Status Outputs to directly control indicator lights or be hard-wired inputs to PLCs. These outputs communicate the same information as the virtual status outputs.

WARNING:

- **Status Outputs and Virtual Status Outputs are not safety outputs and can fail in either the On or the Off state.**
- If a Status Output or a Virtual Status Output is used to control a safety-critical application, a failure to danger is possible and may lead to serious injury or death.
- Never use a Status Output or Virtual Status Output to control any safety-critical applications.

4.4 PACSafe 102 Automatic Terminal Optimization (ATO) Feature with External Terminal Blocks (ETB)

Automatic Terminal Optimization (ATO) Feature with External Terminal Blocks (ETB) is a standard feature on all PACSafe 102 models and is enabled by default.

The ATO feature can expand the 10 terminals on the PACSafe 102 to work with additional inputs by optimizing terminals and using ETBs. As devices are added, deleted, or edited, the Software automatically provides the optimum terminal assignment to minimize wiring and maximize terminal utilization.

ATO is a smart feature that provides all available device types and configuration options as a configuration is created. After all IN and I/O terminals are occupied and another device is added, ATO looks for devices that require +24 V test pulses from the Safety Controller. These devices are combined via an External Terminal Block (ETB) to free up an I/O terminal. Each ETB allows for up to three different devices to share a single I/O +24 V signal.

Disable ATO by editing the module properties of the PACSafe 102 in the Software, if preferred. ETBs will still be active, but you will be required to re-assign I/O terminals manually as needed to fully optimize terminal utilization.

5 Specifications and Requirements

5.1 PACSafe 262 Specifications

Base Controller and Expansion Modules

Mechanical Stress
Shock: 15 *g* for 11 ms, half-sine wave, 18 shocks total (per IEC 61131-2)
Vibration: 3.5 mm occasional / 1.75 mm continuous at 5 Hz to 9 Hz, 1.0 *g* occasional and 0.5 *g* continuous at 9 Hz to 150 Hz: all at 10 sweep cycles per axis (per IEC 61131-2)

Safety
Up to Category 4, PL e (EN ISO 13849)
Up to SIL CL 3 (IEC 62061, IEC 61508)

Product Performance Standards
See Standards and Regulations on p. 233 for a list of industry applicable U.S. and international standards

EMC
Meets or exceeds all EMC requirements in IEC 61131-2, IEC 62061 Annex E, Table E.1 (increased immunity levels), IEC 61326-1:2006, and IEC61326-3-1:2008

Operating Conditions
Temperature: 0 °C to +55 °C (+32 °F to +131 °F)
Storage Temperature: –30 °C to +65 °C (–22 °F to +149 °F)
Humidity: 90% at +50 °C maximum relative humidity (non-condensing)
Operating Altitude: 2000 m maximum (6562 ft maximum) per IEC 61010-1

Environmental Rating
NEMA 1 (IEC IP20), for use inside NEMA 3 (IEC IP54) or better enclosure

Removable Screw Terminals
Wire size: 24 to 12 AWG (0.2 to 3.31 mm²)
Wire strip length: 7 to 8 mm (0.275 in to 0.315 in)
Tightening torque: 0.565 N·m (5.0 in-lb)

Removable Clamp Terminals
Important: *Clamp terminals are designed for one wire only. If more than one wire is connected to a terminal, a wire could loosen or become completely disconnected from the terminal, causing a short. If more than one wire is required, a ferrule or an external terminal block should be used.*
Wire size: 24 to 16 AWG (0.20 to 1.31 mm²)
Wire strip length: 8.00 mm (0.315 in)

Important: The power supply must meet the requirements for extra low voltages with protective separation (SELV, PELV).

PACSafe 262 Base Safety Controller Modules

Power
24 V DC ± 20% (incl. ripple), 140 mA no load
Display models: add 20 mA
Expandable models: 3.6 A maximum bus load

Network Interface
Ethernet 10/100 Base-T/TX, RJ45 modular connector
Selectable auto-negotiate or manual rate and duplex
Auto MDI/MDIX (auto-cross)
Protocols: Modbus/TCP and PROFINET
Data: 256 virtual Status Outputs on Base Controllers; fault diagnostic codes and messages; access to fault log

Convertible I/O
Sourcing current: 80 mA maximum (overcurrent protected)

Automatic Terminal Optimization Feature
Up to two devices

Test Pulse
Width: 200 µs maximum
Rate: 200 ms typical

Output Protection
All solid-state outputs (safety and non-safety) are protected from shorts to 0 V or +24 V, including overcurrent conditions

Safety Ratings
PFH [1/h]: 1.05×10^{-9}
Proof Test Interval: 20 years

Certifications

CE, c UL us LISTED IND. CONT. EQ., UL LISTED Programmable Safety Controller 3NBN, PI CERTIFIED PROFIBUS • PROFINET

Safety Inputs (and Convertible I/O when used as inputs)
Input ON threshold: > 15 V DC (guaranteed on), 30 V DC max.
Input OFF threshold: < 5 V DC and < 2 mA, –3 V DC min.
Input ON current: 5 mA typical at 24 V DC, 50 mA peak contact cleaning current at 24 V DC
Input lead resistance: 300 Ω max. (150 Ω per lead)
Input requirements for a 4-wire Safety Mat:
· Max. capacity between plates: 0.22 µF
· Max. capacity between bottom plate and ground: 0.22 µF
· Max. resistance between the 2 input terminals of one plate: 20 Ω

Solid-State Safety Outputs
0.5 A max. at 24 V DC (1.0 V DC max. drop), 1 A max. inrush
Output OFF threshold: 1.7 V DC typical (2.0 V DC max.)
Output leakage current: 50 µA max. with open 0 V
Load: 0.1 µF max., 1 H max., 10 Ω max. per lead

Response and Recovery Times
Input to Output Response Time (Input Stop to Output Off): see the Configuration Summary in the Software, as it can vary
Input Recovery Time (Stop to Run): ON-Delay (if set) plus 250 ms typical (400 ms maximum)
Output xA to Output xB turn On differential (used as a pair, not split): 5 ms max.
Output X to Output Y turn on Differential (same input, same delay, any module): 3 scan times + 25 ms maximum
Virtual Input (Mute Enable and On/Off) Timing : RPI + 200 ms typical
Virtual Input (Manual Reset and Cancel Delay) Timing : see Virtual Non-Safety Input Devices on p. 58 for details

OFF-Delay Tolerance
The maximum is the response time given in the configuration summary plus 0.02%
The minimum is the configured OFF-Delay time minus 0.02% (assuming no power loss or faults)

ON-Delay Tolerance
The maximum is the configured ON-Delay plus 0.02% plus 250 ms typical (400 ms maximum)
The minimum is the configured ON-Delay minus 0.02%

IC225SDL720 and IC225SDL740 Solid-State Safety Output Modules

Solid-State Safety Outputs
IC225SDL720: 0.75 A maximum at 24 V DC (1.0 V DC maximum drop)
IC225SDL740: 0.5 A maximum at 24 V DC (1.0 V DC maximum drop)
Inrush: 2 A maximum
Output off threshold: 1.7 V DC typical (2.0 V DC maximum)
Output leakage current: 50 µA maximum with open 0 V
Load: 0.1 µF max., 1 H max., 10 Ω maximum per lead

Safety Ratings
PFH [1/h]: 5.8×10^{-10}
Proof Test Interval: 20 years

Certifications

CE, c UL us LISTED IND. CONT. EQ., UL LISTED Programmable Safety Controller 3NBN

External Power
IC225SDL720: 24 V DC ± 20% (including ripple); 0.075 A no-load, 3.075 A maximum load
IC225SDL740: 24 V DC ± 20% (including ripple); 0.1 A no-load, 4.1 A maximum load
Maximum Power-up Delay: 5 seconds after the Base Controller
Limited Isolation: ±30 V DC maximum referenced to 0 V on the Base Controller

Bus Power
0.02 A

Test Pulse
Width: 200 µs maximum
Rate: 200 ms typical

Output Protection
All solid-state outputs (safety and non-safety) are protected from shorts to 0 V or +24 V, including overcurrent conditions

IC225SDD841 and IC225SDD842 Safety Input Modules

Convertible I/O
Sourcing current: 80 mA maximum at 55 °C (131 °F) operating ambient temperature (overcurrent protected)

Bus Power
IC225SDD841: 0.07 A no load; 0.23 A maximum load
IC225SDD842: 0.09 A no load; 0.41 A maximum load

Safety Ratings
PFH [1/h]: 4×10^{-10}
Proof Test Interval: 20 years

Certifications

Safety Inputs (and Convertible I/O when used as inputs)
Input On threshold: > 15 V DC (guaranteed on), 30 V DC maximum
Input Off threshold: < 5 V DC and < 2 mA, –3 V DC minimum
Input On current: 5 mA typical at 24 V DC, 50 mA peak contact cleaning current at 24 V DC
Input lead resistance: 300 Ω max. (150 Ω per lead)
Input requirements for a 4-wire Safety Mat:
· Maximum capacity between plates: 0.22 µF
· Maximum capacity between bottom plate and ground: 0.22 µF
· Maximum resistance between the 2 input terminals of one plate: 20 Ω

Output Protection
The convertible inputs are protected from shorts to 0 V or +24 V, including overcurrent conditions

IC225SDL910 and IC225SDL920 Safety Relay Modules

Bus Power
IC225SDL910: 0.125 A (outputs On)
IC225SDL920: 0.15 A (outputs On)

Maximum Power
2000 VA, 240 W

Electrical Life
50,000 cycles at full resistive load

Overvoltage Category
III

Pollution Degree
2

Mechanical Life
40,000,000 cycles

Note: Transient suppression is recommended when switching inductive loads. Install suppressors across load. Never install suppressors across output contacts.

Safety Ratings
PFH [1/h]: 7.6×10^{-10}
Proof Test Interval: 20 years

B10d Values

Voltage	Current	B10d
230 V AC	3 A	300,000
230 V AC	1 A	750,000
24 V DC	≤ 2 A	1,500,000

Certifications

Contact Rating
UL/NEMA:
- **NO Contacts:** 6 A 250 V AC/24 V DC resistive; B300/ Q300 pilot duty
- **NC Contacts:** 2.5 A 150 V AC/24 V DC resistive; Q300 pilot duty

IEC 60947-5-1:
- **NO Contacts:** 6 A 250 V AC/DC continuous; AC 15: 3 A 250 V; DC13: 1 A 24 V/4 A 24 V 0.1 Hz
- **NC Contacts:** 2.5 A 150 V AC/DC continuous; AC 15: 1 A 150 V; DC13: 1 A 24 V/4 A 24 V 0.1 Hz

Contact Ratings to preserve 5 µm AgNi gold plating

	Minimum	Maximum
Voltage	100 mV AC/DC	60 V AC/DC
Current	1 mA	300 mA
Power	1 mW (1 mVA)	7 W (7 VA)

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.emerson.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

5.2 PACSafe 102 Specifications

Power
Voltage: 24 V DC ±20% (SELV)
Current:
240 mA maximum, no-load (relays on)
530 mA maximum, full-load (IO1 to IO4 used as auxiliary outputs)

Safety Inputs (and Convertible I/O when used as inputs)
Input ON threshold: > 15 V DC (guaranteed on), 30 V DC maximum
Input OFF threshold: < 5 V DC and < 2 mA, –3 V DC minimum
Input ON current: 5 mA typical at 24 V DC, 50 mA peak contact cleaning current at 24 V DC
Input lead resistance: 300 Ω maximum (150 Ω per lead)
Input requirements for a 4-wire Safety Mat:
· Maximum capacity between plates: 0.22 µF [1]
· Maximum capacity between bottom plate and ground: 0.22 µF [1]
· Maximum resistance between the 2 input terminals of one plate: 20 Ω

Response and Recovery Times
Input to Output Response Time (Input Stop to Output Off): see the Configuration Summary in the Software, as it can vary
Input Recovery Time (Stop to Run): ON-Delay (if set) plus 250 ms typical (400 ms maximum)
Virtual Input (Mute Enable and On/Off) Timing: RPI + 200 ms typical
Virtual Input (Manual Reset and Cancel Delay) Timing: see Virtual Non-Safety Input Devices on p. 58 for details

OFF-Delay Tolerance
The maximum is the response time given in the configuration summary plus 0.02%
The minimum is the configured OFF-delay time minus 0.02% (assuming no power loss or faults)

ON-Delay Tolerance
The maximum is the configured ON-delay plus 0.02% plus 250ms typical (400 ms maximum)
The minimum is the configured ON-delay minus 0.02%

Safety Outputs
3 NO sets of contacts for each output channel (RO1 and RO2). Each normally open output is a series connection of contacts from two forced-guided (mechanically linked) relays. RO1 consists of relays K1 and K2. RO2 consists of relays K3 and K4.

Convertible I/O
Sourcing current: 80 mA maximum (overcurrent protected)
Test Pulses: ~1 ms every 25 to 75 ms

Automatic Terminal Optimization Feature
Up to three devices connected with user-provided terminal blocks

Network Interface
Ethernet 10/100 Base-T/TX, RJ45 modular connector
Selectable auto negotiate or manual rate and duplex
Auto MDI/MDIX (auto cross)
Protocols: Modbus/TCP and PROFINET
Data: 256 virtual Status Outputs; fault diagnostic codes and messages; access to fault log

Operating Conditions
Temperature: 0 °C to +55 °C (+32 °F to +131 °F) (see Temperature Derating graph)
Storage Temperature: –30 °C to +65 °C (–22 °F to +149 °F)
Humidity: 90% at +50 °C maximum relative humidity (non-condensing)
Operating Altitude: 2000 m maximum (6562 ft maximum) per IEC 61010-1

Environmental Rating
NEMA 1 (IEC IP20), for use inside NEMA 3 (IEC IP54) or better enclosure

Mechanical Stress
Shock: 15 g for 11 ms, half-sine wave, 18 shocks total (per IEC 61131-2)
Vibration: 3.5 mm occasional / 1.75 mm continuous at 5 Hz to 9 Hz, 1.0 g occasional and 0.5 g continuous at 9 Hz to 150 Hz: all at 10 sweep cycles per axis (per IEC 61131-2)

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[1] If the safety mats share a convertible I/O, this is the total capacitance of all shared safety mats.

Contacts
AgNi + 0.2 µm gold

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 II (Category III, if appropriate overvoltage reduction is provided, as described in this document.)

Individual Contact Current Rating
Refer to the Temperature Derating graph when more than one contact output is used.

	Minimum	Maximum
Voltage	10 V AC/DC	250 V AC / 24 V DC
Current	10 mA AC/DC	6 A
Power	100 mW (100 mVA)	200 W (2000 VA)

Switching Capacity (IEC 60947-5-1)

AC 15	NO: 250 V AC, 3 A
DC 13	NO: 24 V DC, 2 A
DC 13 at 0.1 Hz	NO: 24 V DC, 4 A

EMC
Meets or exceeds all EMC requirements for immunity per IEC 61326-3-1:2012 and emissions per CISPR 11:2004 for Group 1, Class A equipment

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

Safety
Up to Category 4, PL e (EN ISO 13849)
Up to SIL CL 3 (IEC 62061, IEC 61508)

Safety Ratings
PFH [1/h]: 5.01×10^{-10}
Proof Test Interval: 20 years

Product Performance Standards
See Standards and Regulations on p. 233 for a list of industry applicable U.S. and international standards

Certifications

Mechanical Life
20,000,000 cycles

Electrical Life
50,000 cycles at full resistive load

UL Pilot Duty
B300 Q300

B10d Values

Voltage	Current	B10d
230 V AC	2 A	350,000
230 V AC	1 A	1,000,000
24 V DC	≤ 4 A	10,000,000

Push-in Spring Clamp Terminals
Wire Size: 24 to 14 AWG, 0.2 mm² to 2.08 mm²

Important: Clamp terminals are designed for one wire only. If more than one wire is connected to a terminal, a wire could loosen or become completely disconnected from the terminal, causing a short.

Use a stranded wire or a wire with an accompanying ferrule. Tinned wires are not recommended.

After inserting the wire into the terminal, tug the wire to make sure it is properly retained. If the wire is not retained, consider using a different wiring solution.

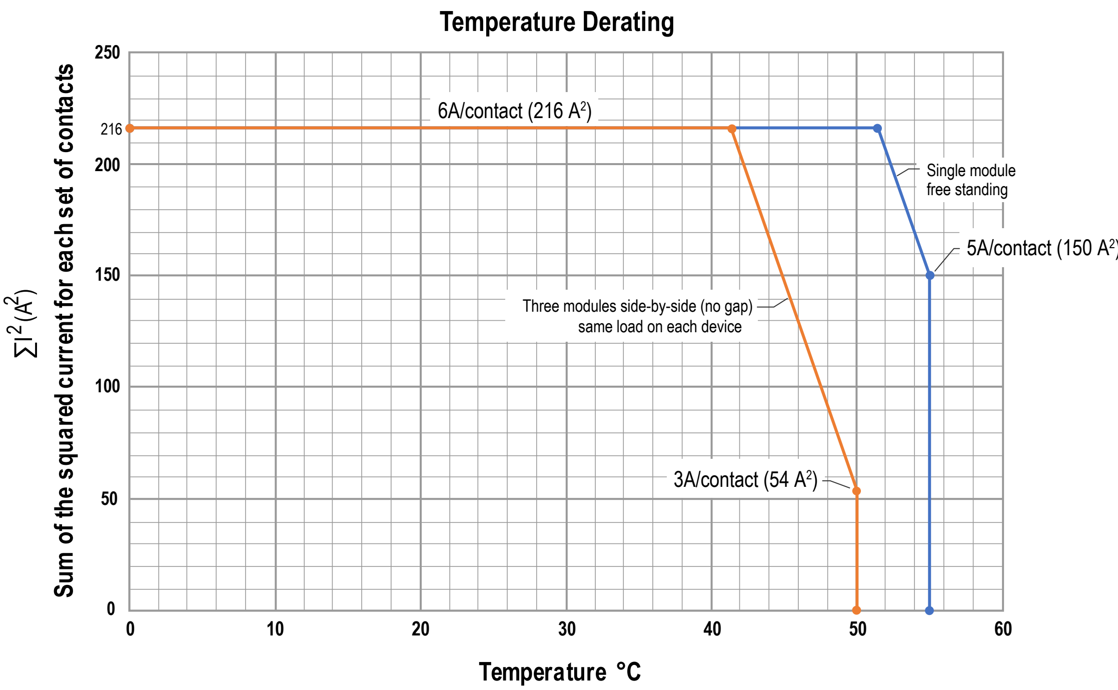
Required Overcurrent Protection

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.emerson.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

Figure 8. PACSafe 102 Temperature Derating



Example Temperature Derating Calculations	
Single Unit, Free Standing	Three Modules
$\sum I^2 = I_1{}^2 + I_2{}^2 + I_3{}^2 + I_4{}^2 + I_5{}^2 + I_6{}^2$	$\sum I^2 = I_1{}^2 + I_2{}^2 + I_3{}^2 + I_4{}^2 + I_5{}^2 + I_6{}^2$ (all six modules)
I_1 = 4 A (normally open output RO1 channel 1)	I_1 = 4 A
I_2 = 4 A (normally open output RO1 channel 2)	I_2 = 4 A
I_3 = 4 A (normally open output RO1 channel 3)	I_3 = 4 A
I_4 = 4 A (normally open output RO2 channel 4)	I_4 = 4 A
I_5 = 4 A (normally open output RO2 channel 5)	I_5 = 4 A
I_6 = 4 A (normally open output RO2 channel 6)	I_6 = 4 A
$\sum I^2 = 4^2 + 4^2 + 4^2 + 4^2 + 4^2 + 4^2 = 96\ A^2$	$\sum I^2 = 4^2 + 4^2 + 4^2 + 4^2 + 4^2 + 4^2 = 96\ A^2$
T_{max} = 55 °C	T_{max} = 46 °C

5.3 Dimensions

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

Figure 9. PACSafe 262 Base Module Dimensions

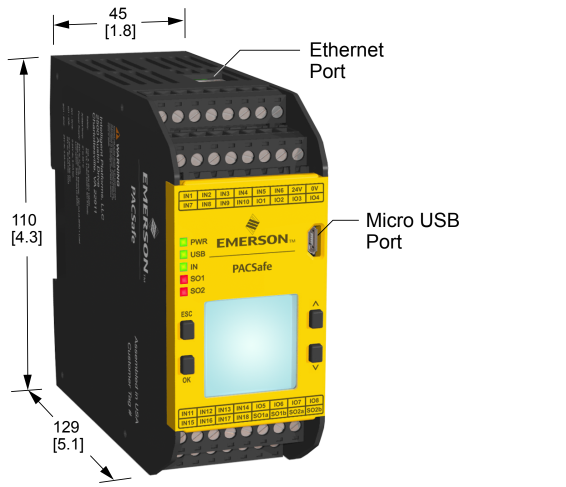


Figure 10. Expansion Module Dimensions

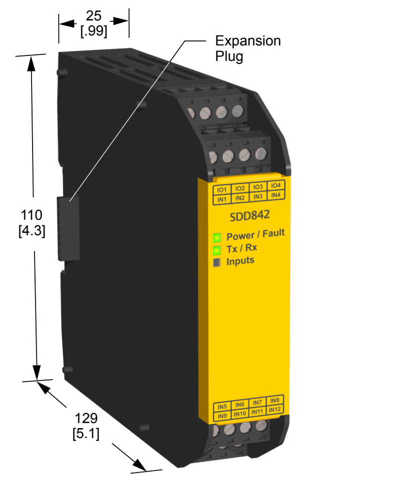
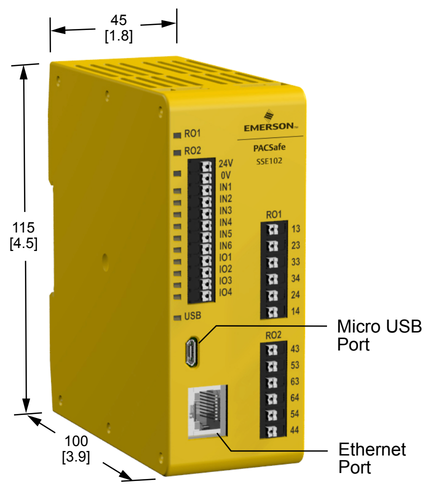


Figure 11. PACSafe 102 Dimensions



5.4 PC Requirements

Important: Administrative rights are required to install the Safety Controller drivers (needed for communication with the controller).

Operating system: Windows 10[2]

System type: 32-bit, 64-bit

[2] Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries.

Hard drive space:	80 MB (plus up to 280 MB for Microsoft .NET 4.0, if not already installed)
Memory (RAM):	512 MB minimum, 1 GB+ recommended
Processor:	1 GHz minimum, 2 GHz+ recommended
Screen resolution:	1024 × 768 full color minimum, 1650 × 1050 full color recommended
Third-party software:	Microsoft .NET 4.0 (included with installer), PDF Viewer (such as Adobe Acrobat)
USB port:	USB 2.0 (not required to build configurations)

6 System Installation

6.1 Installing the Software

Important: Administrative rights are required to install the Safety Controller drivers (needed for communication with the controller).

1. Download the latest version of the software from https://emerson-mas.force.com/communities/en_US/Download/PACSafe-Configuration-Tools .
2. Navigate to and open the downloaded file.
3. Click **Next** to begin the installation process.
4. Confirm the software destination and availability for users and click **Next**.
5. Click **Install** to install the software.
6. Depending on your system settings, a popup window may appear prompting to allow PACSafe Studio to make changes to your computer. Click **Yes**.
7. Click **Finish** to exit the installer.

Open **PACSafe Studio** from the **Desktop** or the **Start Menu**.

6.2 Installing the Safety Controller

Do not exceed the operating specifications for reliable operation. The enclosure must provide adequate heat dissipation so that the air closely surrounding the Safety Controller does not exceed its maximum operating temperature (see Specifications and Requirements on p. 19).

Important: Mount the Safety Controller in a location that is free from large shocks and high-amplitude vibration.

Important:
- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

6.2.1 Mounting Instructions

The Safety Controller mounts to a standard 35 mm DIN-rail track. It must be installed inside an enclosure rated NEMA 3 (IEC IP54) or better. It should be mounted to a vertical surface with the vent openings at the bottom and the top to allow for natural convection cooling.

Follow the mounting instructions to avoid damage to the Safety Controller.

To **mount** the PACSafe modules:

1. Tilt the top of the module slightly backward and place it on the DIN rail.
2. Straighten the module against the rail.
3. Lower the module onto the rail.

To **remove** the PACSafe modules:

1. Push up on the bottom of the module.
2. Tilt the top of the module slightly forward.
3. Lower the module after the top rigid clip is clear of the DIN rail.

Note: To remove an expansion module, pull apart other modules on each side of the desired module to free bus connectors.

7 Installation Considerations

7.1 Appropriate Application

The correct application of the Safety Controller depends on the type of machine and the safeguards that are to be interfaced with the Safety Controller. **If there is any concern about whether or not your machinery is compatible with this Safety Controller, contact Emerson.** See the contact information at the end of this manual.

Read this Section Carefully Before Installing the System.

The Safety Controller is a control device that is intended to be used in conjunction with a machine safeguarding device. Its ability to perform this function depends upon the appropriateness of the application and upon the Safety Controller's proper mechanical and electrical installation and interfacing with the machine to be guarded.

If all mounting, installation, interfacing, and checkout procedures are not followed properly, the Safety Controller cannot provide the protection for which it was designed. The user is responsible for satisfying all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this control system in any particular application. Make sure that all safety requirements have been met and that all technical installation and maintenance instructions contained in this document are followed.

WARNING:

- **Not a stand-alone safeguarding device**
- Failure to properly safeguard hazards according to a risk assessment, local regulations, and applicable standards might lead to serious injury or death.
- This Emerson device is considered complementary equipment that is used to augment safeguarding that limits or eliminates an individual's exposure to a hazard without action by the individual or others.

WARNING:

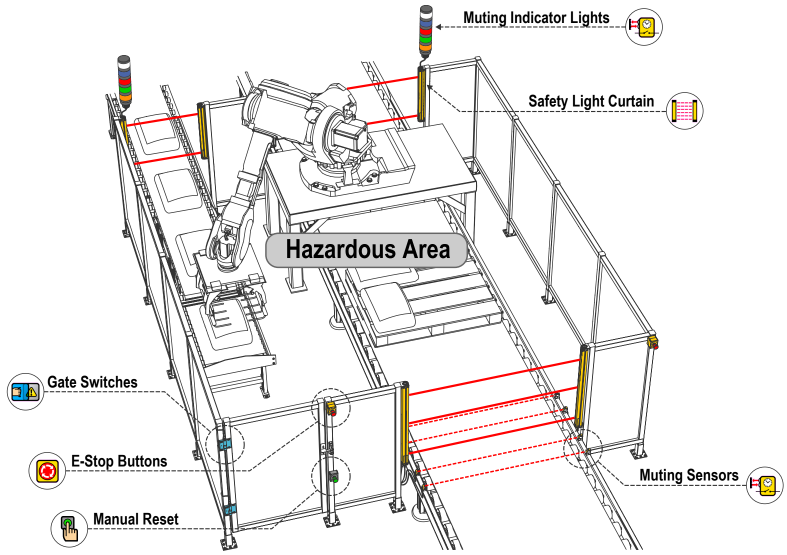
- **User Is Responsible for Safe Application of this device**
- The application examples described in this document depict generalized guarding situations. Every guarding application has a unique set of requirements.
- Make sure that all safety requirements are met and that all installation instructions are followed. Direct any questions regarding safeguarding to Emerson at the number or addresses listed this document.

7.2 PACSafe 262 Applications

The Safety Controller can be used wherever safety modules are used. The Safety Controller is well suited to address many types of applications, including, but not limited to:

- Two-hand control with mute function
- Robot weld/processing cells with dual-zone muting
- Material-handling operations that require multiple inputs and bypass functions
- Manually loaded rotary loading stations
- Multiple two-hand-control station applications
- Lean manufacturing stations
- Dynamic monitoring of single- or dual-solenoid valves or press safety valves

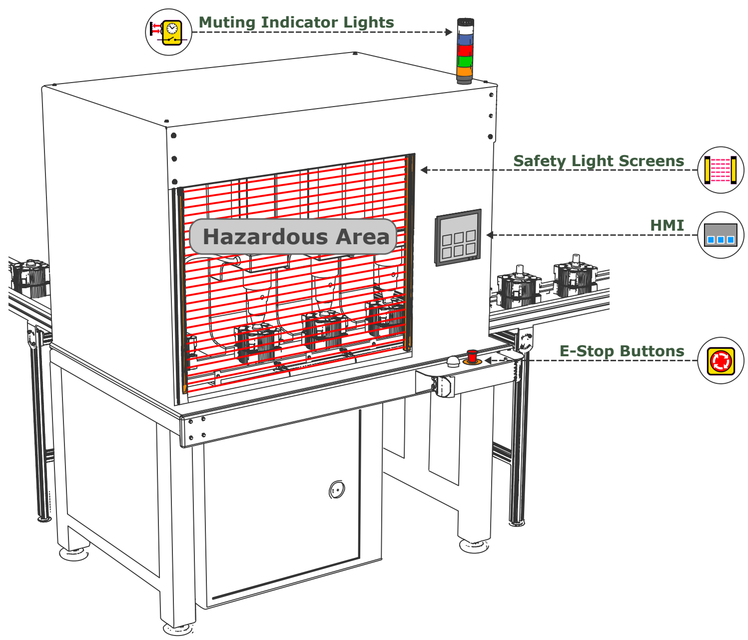
Figure 12. Sample Application - Robotic Cell



7.3 PACSafe 102 Applications

The PACSafe 102 Safety Controller is ideal for a small to medium size machine that would typically use two independent safety relay modules.

Figure 13. PACSafe 102 Sample Application



7.4 Safety Input Devices

The Safety Controller monitors the state of the safety input devices that are connected to it. In general, when all of the input devices that have been configured to control a particular Safety Output are in the Run state, the Safety Output turns or remains On. When one or more of the safety input devices change from Run state to Stop state, the Safety Output turns Off. A few special safety input device functions can, under predefined circumstances, temporarily suspend the safety input stop signal to keep the Safety Output On, for example, muting or bypassing.

The Safety Controller can detect input faults with certain input circuits that would otherwise result in a loss of the control of the safety function. When such faults are detected, the Safety Controller turns the associated outputs Off until the faults are cleared. The function blocks used in the configuration impact the safety outputs. It is necessary to carefully review the configuration if the input device faults occur.

Methods to eliminate or minimize the possibility of these faults include, but are not limited to:

- Physically separating the interconnecting control wires from each other and from secondary sources of power
- Routing interconnecting control wires in separate conduit, runs, or channels
- Locating all control elements (Safety Controller, interface modules, FSDs, and MPCEs) within one control panel, adjacent to each other, and directly connected with short wires
- 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 or direct-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
- Training the operators, maintenance personnel, and others involved with operating the machine and the safeguarding to recognize and immediately correct all failures

Note: Follow the device manufacturer's installation, operation, and maintenance instructions and all relevant regulations. If there are any questions about the device(s) that are connected to the Safety Controller, contact Emerson for assistance. See the contact information at the end of this manual.

Figure 14. PACSafe 262 Terminal Locations

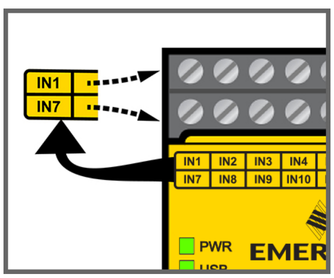
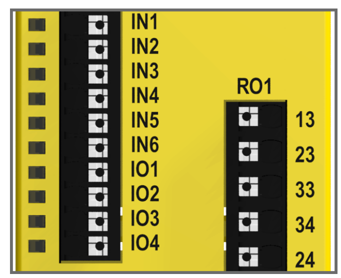


Figure 15. PACSafe 102 Terminal Locations



WARNING:

- Input Device and Safety Integrity
- Failure to follow these instructions could result in serious injury or death.
- The Safety Controller can monitor many different safety input devices. The user must conduct a Risk Assessment of the guarding application to determine what Safety Integrity Level needs to be reached to know how to properly connect the input devices to the Safety Controller.
- The user must also eliminate or minimize possible input signal faults/ failures that may result in the loss of the safety functions.

7.4.1 Safety Circuit Integrity and ISO 13849-1 Safety Circuit Principles

Safety circuits involve the safety-related functions of a machine that minimize the level of risk of harm. 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

Safety circuits in International and European standards have been segmented into Categories and Performance Levels, depending on their ability to maintain their integrity in the event of a failure and the statistical likelihood of that failure. ISO 13849-1 details safety circuit integrity by describing circuit architecture/structure (Categories) and the required performance level (PL) of safety functions under foreseeable conditions.

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 ISO 13849-1 Category 3 or 4 and/or Performance Level “d” or “e” (see ANSI B11.19).

Perform a risk assessment to ensure appropriate application, interfacing/hookup, and risk reduction (see ANSI B11.0 or ISO 12100). The risk assessment must be performed to determine the appropriate safety circuit integrity in order to ensure that the expected risk reduction is achieved. This risk assessment must take into account all local regulations and relevant standards, such as U.S. Control Reliability or European "C" level standards.

The Safety Controller inputs can support up to Category 4 PL e (ISO 13849-1) and Safety Integrity Level 3 (IEC 61508 and IEC 62061) interfacing/hookup. The actual safety circuit integrity level is dependent on the configuration, proper installation of external circuitry, and the type and installation of the safety input devices. The user is responsible for the determination of the overall safety rating(s) and full compliance with all applicable regulations and standards.

The following sections deal only with Category 2, Category 3, and Category 4 applications, as described in ISO 13849-1. The input device circuits shown in the table below are commonly used in safeguarding applications, though other solutions are possible depending on fault exclusion and the risk assessment. The table below shows the input device circuits and the safety category level that is possible if all of the fault detection and fault exclusion requirements are met.

⚠ 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.

⚠ WARNING:

- **For input devices with dual contact inputs using two or three terminals, detecting a short between two input channels (contact inputs, but not complementary contacts) is not possible if the two contacts are closed.**
- Failure to follow these instructions could result in serious injury or death.
- A short can be detected when the input is in the Stop state for at least two (2) seconds (see the **INx & IOx input terminals** Tip in Safety Input Device Options on p. 35).

WARNING:

- Category 2 or 3 Input Shorts
- It is not possible to detect a short between two input channels (contact inputs, but not complementary contacts) if they are supplied through the same source (for example, the same terminal from the Safety Controller in a dual-channel, 3-terminal wiring, or from an external 24 V supply) and the two contacts are closed.
- Such a short can be detected only when both contacts are open and the short is present for at least two (2) seconds.

Fault Exclusion

An important concept within the requirements of ISO 13849-1 is the probability of the occurrence of a failure, which can be reduced using a technique termed "fault exclusion." The rationale assumes that the possibility of certain well-defined failure(s) can be reduced via design, installation, or technical improbability to a point where the resulting fault(s) can be, for the most part, disregarded—that is, "excluded" in the evaluation.

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. Fault exclusion allows the designer to design out the possibility of various failures and justify it through the risk assessment process to meet the requirements of ISO 13849-1/-2.

Requirements vary widely for the level of safety circuit integrity in safety applications (that is, Control Reliability or Category/Performance Level) per ISO 13849-1. It is the responsibility of the user to safely install, operate, and maintain each safety system and comply with all relevant laws and regulations.

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.

7.4.2 Safety Input Device Properties

The Safety Controller is configured via the Software to accommodate many types of safety input devices. See Adding Inputs and Status Outputs on p. 81 for more information on input device configuration.

Reset Logic: Manual or Automatic Reset

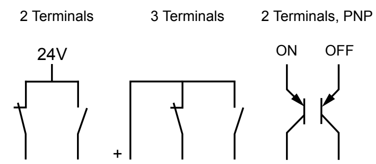
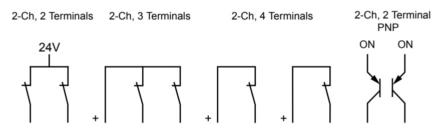
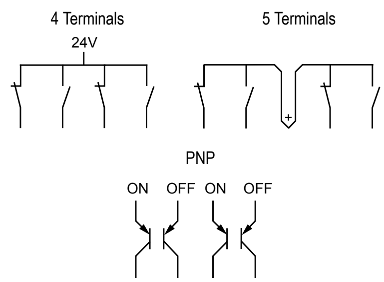
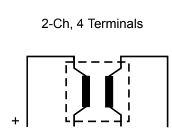
A manual reset may be required for safety input devices by using a Latch Reset Block or configuring a safety output for a latch reset before the safety output(s) they control are permitted to turn back On. This is sometimes referred to as “latch” mode because the safety output “latches” to the Off state until a reset is performed. If a safety input device is configured for automatic reset or “trip” mode, the safety output(s) it controls will turn back On when the input device changes to the Run state (provided that all other controlling inputs are also in the Run state).

Connecting the Input Devices

The Safety Controller needs to know what device signal lines are connected to which wiring terminals so that it can apply the proper signal monitoring methods, Run and Stop conventions, and timing and fault rules. The terminals are assigned automatically during the configuration process and can be changed manually using the Software.

Signal Change-of-State Types

Two change-of-state (COS) types can be used when monitoring dual-channel safety input device signals: Simultaneous or Concurrent.

<table>
<tr><th rowspan="2">Input Circuit</th><th colspan="2">Input Signal COS Timing Rules</th></tr>
<tr><th>Stop State—SO turns Off when [3]:</th><th>Run State—SO turns On when [4]:</th></tr>
<tr><td>Dual-Channel A and B Complementary

</td><td rowspan="2">At least 1 channel (A or B) input is in the Stop state.</td><td rowspan="2">Simultaneous: A and B are both in the Stop state and then both switch to the Run state within 3 seconds before outputs turn On.
Concurrent: A and B concurrently switch to the Stop state, then both switch to the Run state with no simultaneity to turn outputs On.</td></tr>
<tr><td>Dual-Channel A and B

</td></tr>
<tr><td>2X Complementary A and B

</td><td>At least 1 channel (A or B) within a pair of contacts is in the Stop state.</td><td>Simultaneous: A and B are concurrently in the Stop state, then the contacts within a channel switch to the Run state within 400 ms (150 ms for two-hand control), both channels are in the Run state within 3 seconds (0.5 seconds for two-hand control).
Concurrent: A and B are concurrently in the Stop state. Contacts within a single-channel switch to the Run state within 3 seconds. There is no simultaneity requirement between the switching of channel A and channel B.</td></tr>
<tr><td>4-Wire Safety Mat

</td><td>One of the following conditions is met:
Input channels are shorted together (normal operation)
At least one of the wires is disconnected
One of the normally low channels is detected high
One of the normally high channels is detected low</td><td>Each channel detects its own pulses.</td></tr>
</table>

[3] Safety Outputs turn Off when one of the controlling inputs is in the Stop state.
[4] Safety Outputs turn On only when all of the controlling inputs are in the Run state and after a manual reset is performed (if any safety inputs are configured for Manual reset and were in their Stop state).

Signal Debounce Times

Closed-to-Open Debounce Time (from 6 ms to 1000 ms in 1 ms intervals, except 6 ms to 1500 ms for mute sensors). The closed-to-open debounce time is the time limit required for the input signal to transition from the high (24 V DC) state to the steady low (0 V DC) state. This time limit may need to be increased in cases where high-magnitude device vibration, impact shock, or switch noise conditions result in a need for longer signal transition times. If the debounce time is set too short under these harsh conditions, the system may detect a signal disparity fault and lock out. The default setting is 6 ms.

> ⚠ **CAUTION: Debounce and Response—Any changes in the debounce times may affect the Safety Output response (turn OFF) time.** This value is computed and displayed for each Safety Output when a configuration is created.

Open-to-Closed Debounce Time (from 10 ms to 1000 ms in 1 ms intervals, except 10 ms to 1500 ms for mute sensors). The open-to-closed debounce time is the time limit required for the input signal to transition from the low (0 V DC) state to the steady high (24 V DC) state. This time limit may need to be increased in cases where high magnitude device vibration, impact shock, or switch noise conditions result in a need for longer signal transition times. If the debounce time is set too short under these harsh conditions, the system may detect a signal disparity fault and lock out. The default setting is 50 ms.

7.5 Safety Input Device Options

Figure 16. Input Device Circuit—Safety Category Guide

General Circuit Symbols		Circuits shown in Run State						Circuits shown in Stop State	
		ES	GS	OS	RP	PS	SM	THC	ED
1 & 2 Terminal Single-Channel (see note 1)	24V	Cat 2	Cat 2	Cat 2	Cat 2	Cat 2			
2 & 3 Terminal Dual-Channel (see note 2)	24V	Cat 3	Cat 3	Cat 3	Cat 3	Cat 3		Type IIIa Cat 1 Type IIIb Cat 3	Cat 3
2 Terminal Dual-Channel PNP w/ integral monitoring (see note 3)	ON ON	Cat 4	Cat 4	Cat 4	Cat 4	Cat 4		Type IIIa Cat 1	Cat 4
3 & 4 Terminal Dual-Channel (see notes 2 & 4)		Cat 4	Cat 4	Cat 4	Cat 4	Cat 4		Type IIIa Cat 1 Type IIIb Cat 3	Cat 4
2 & 3 Terminal Dual-Channel Complementary	24V		Cat 4	Cat 4	Cat 4	Cat 4			Cat 4
2 Terminal Dual-Channel Complementary PNP	ON OFF		Cat 4	Cat 4	Cat 4	Cat 4			Cat 4
4 & 5 Terminal Dual-Channel Complementary	24V		Cat 4					Type IIIc Cat 4	Cat 4
4 Terminal Dual-Channel Complementary PNP	ON OFF ON OFF		Cat 4					Type IIIc Cat 4	Cat 4
4 Terminal Safety Mat							Cat 3		

Note:

1. Circuit typically meets up to ISO 13849-1 Category 2 if input devices are safety rated and fault exclusion wiring practices prevent a) shorts across the contacts or solid-state devices and b) shorts to other power sources.
2. Circuit typically meets up to ISO 13849-1 Category 3 if input devices are safety rated (see **Tip: INx & IOx input terminals**, following).
   The 2 Terminal circuit detects a single-channel short to other power sources when the contacts open and close again (concurrency fault).
   The 3 Terminal circuit detects a short to other power sources whether the contacts are open or closed.
3. Circuit meets up to ISO 13849-1 Category 4 if input devices are safety rated and provide internal monitoring of the PNP outputs to detect a) shorts across channels and b) shorts to other power sources.
4. Circuit meets up to ISO 13849-1 Category 4 if input devices are safety rated (see **Tip: INx & IOx input terminals** above). These circuits can detect both shorts to other power sources and shorts between channels.

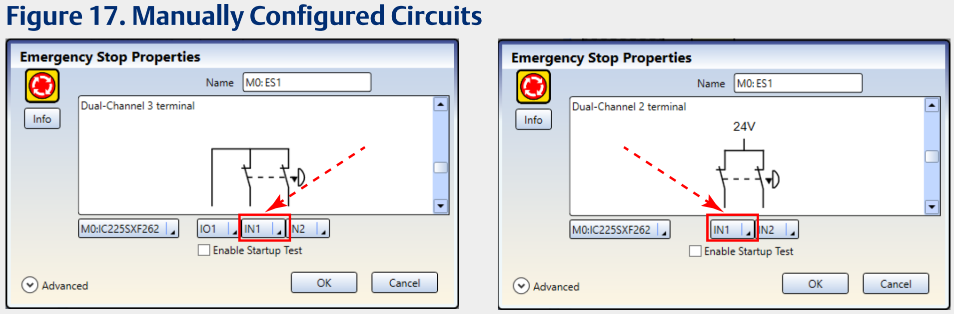
CAUTION:

- **Incomplete installation information**
- Many installation considerations necessary to properly apply these devices are not covered by this document.
- Refer to the appropriate device installation instructions to ensure the safe application of the device.

WARNING: This table lists the highest safety categories possible for common safety-rated input device circuits. If the additional requirements stated in the following notes are not possible due to safety device or installation limitations, or if, for example, the Safety Controller's IOx input terminals are all in use, then the highest safety category may not be possible.

Tip: INx & IOx input terminals, these circuits can be manually configured to meet Category 4 circuit requirements by changing the first (left most) standard input terminal (INx) to any available convertible terminal (IOx) as shown below. These circuits will detect shorts to other power sources and between channels when the input has been in the Stop state for at least 2 seconds.

Figure 17. Manually Configured Circuits



7.5.1 Safety Circuit Integrity Levels

The application requirements for safeguarding devices vary for the level of control reliability or safety category per ISO 13849-1. The user is responsible to safely install, operate, and maintain each safety system and comply with all relevant laws and regulations.

The safety performance (integrity) must reduce the risk from identified hazards as determined by the machine's risk assessment. See Safety Circuit Integrity and ISO 13849-1 Safety Circuit Principles on p. 31 for guidance.

7.5.2 Emergency Stop Push Buttons

The Safety Controller safety inputs may be used to monitor Emergency Stop (E-stop) push buttons.

WARNING:
- **Do not mute or bypass any emergency stop device**
- Muting or bypassing the safety outputs renders the emergency stop function ineffective.
- ANSI B11.19, NFPA 79 and IEC/EN 60204-1 require that the emergency stop function remains active at all times.

WARNING: The Safety Controller Emergency Stop configuration prevents muting or bypassing of the E-stop input(s). However, the user still must ensure that the E-stop device remains active at all times.

WARNING:
- **Reset routine required**
- Failure to prevent the machine from restarting without actuating the normal start command/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 command/device. Perform the reset routine after clearing the cause of a stop condition, as required by U.S. and international standards.

In addition to the requirements stated in this section, the design and installation of the Emergency Stop device must comply with NFPA 79 or ISO 13850. The stop function must be either a functional stop Category 0 or a Category 1 (see NFPA79).

Emergency Stop Push Button Requirements

The E-stop switch must provide one or two contacts for safety which are closed when the switch is armed. When 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. A mechanical force applied to such a button (or switch) is transmitted directly to the contacts, forcing them to open. This ensures that the switch contacts open whenever the switch is activated.

Standards NFPA 79, ANSI B11.19, IEC/EN 60204-1, and ISO 13850 specify additional emergency stop switch device requirements, including the following:
- Emergency Stop push buttons must be located at each operator control station and at other operating stations where emergency shutdown is required
- Stop and Emergency Stop push buttons must be continuously operable and readily accessible from all control and operating stations where located. **Do not mute or bypass any E-stop button**
- Actuators of emergency stop devices must be colored red. The background immediately around the device actuator must be colored yellow. The actuator of a push-button-operated device must be of the palm or mushroom-head type
- The emergency stop actuator must be a self-latching type

Note: Some applications may have additional requirements; the user is responsible to comply with all relevant regulations.

7.5.3 Rope (Cable) Pull

Rope (cable) pull emergency stop switches use steel wire rope; they provide emergency stop actuation continuously over a distance, such as along a conveyor.

Rope pull emergency stop switches have many of the same requirements as Emergency Stop push buttons, such as positive (direct) opening operation, as described by IEC 60947-5-1. See Emergency Stop Push Buttons on p. 37 for additional information.

In emergency stop applications, the rope pull switches must have the capability not only to react to a pull in any direction, but also to a slack or a break of the rope. Emergency stop rope pull switches also need to provide a latching function that requires a manual reset after actuation.

Rope (Cable) Pull Installation Guidelines

NFPA 79, ANSI B11.19, IEC/EN 60204-1, and ISO 13850 specify emergency stop requirements for rope (cable) pull installations, including the following:

- Rope (cable) pulls must be located where emergency shutdown is required
- Rope (cable) pulls must be continuously operable, easily visible, and readily accessible; do not mute or bypass
- Rope (cable) pulls must provide constant tension of the rope (cable) pull
- Rope (cable) pulls, as well as any flags or markers, must be colored red
- Rope (cable) pulls must have the capability to react to a force in any direction
- The switch must:
    - Have a self-latching function that requires a manual reset after actuation
    - Have a direct opening operation
    - Detect a slack condition or a break of the rope (cable)

Additional installation guidelines:

- The wire rope (cable) should be easily accessible, red in color for E-Stop functions, and visible along its entire length. Markers or flags may be fixed on the rope (cable) to increase its visibility
- Mounting points, including support points, must be rigid and allow sufficient space around the rope (cable) to allow easy access
- The rope (cable) should be free of friction at all supports. Pulleys are recommended. Lubrication may be necessary. Contamination of the system, such as dirt, metal chips or swarf, etc., must be prevented from adversely affecting operation
- Use only pulleys (not eye bolts) when routing the rope (cable) around a corner or whenever direction changes, even slightly
- Never run rope (cable) through conduit or other tubing
- Never attach weights to the rope (cable)
- A tensioning spring is recommended to ensure compliance with direction-independent actuation of the wire rope (cable) and must be installed on the load-bearing structure (machine frame, wall, etc.)
- Temperature affects rope (cable) tension. The wire rope (cable) expands (lengthens) when temperature increases, and contracts (shrinks) when temperature decreases. Significant temperature variations require frequent checks of the tension adjustment

> **WARNING:** Failure to follow the installation guidelines and procedures may result in the ineffectiveness or non-operation of the Rope (Cable) Pull system and create an unsafe condition resulting in a serious injury or death.

7.5.4 Enabling Device

An enabling device is a manually operated control which, when continuously actuated, allows a machine cycle to be initiated in conjunction with a start control. Standards that cover the design and application of enabling devices include: ISO 12100-1/-2, IEC 60204-1, NFPA 79, ANSI/RIA R15.06, and ANSI B11.19.

The enabling device actively controls the suspension of a Stop signal during a portion of a machine operation where a hazard may occur. The enabling device permits a hazardous portion of the machine to run, but must not start it. An enabling device can control one or more safety outputs. When the enable signal switches from the Stop state to the Run state, the Safety Controller enters the Enable mode. A separate machine command signal from another device is needed to start the hazardous motion. **This enabling device must have ultimate hazard turn Off or Stop authority.**

7.5.5 Protective (Safety) Stop

A Protective (Safety) Stop is designed for the connection of miscellaneous devices that could include safeguarding (protective) devices and complementary equipment. This stop function is a type of interruption of operation that allows an orderly cessation of motion for safeguarding purposes. The function can be reset or activated either automatically or manually.

Protective (Safety) Stop Requirements

The required safety circuit integrity level is determined by a risk assessment and indicates the level of control performance that is acceptable, for example, category 4, Control Reliability (see Safety Circuit Integrity and ISO 13849-1 Safety Circuit Principles on p. 31). The protective stop circuit must control the safeguarded hazard by causing a stop of the hazardous situation(s), and removing power from the machine actuators within the safety function response time. This functional stop typically meets category 0 or 1 as described by NFPA 79 and IEC60204-1.

7.5.6 Interlocked Guard or Gate

The Safety Controller safety inputs may be used to monitor electrically interlocked guards or gates.

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 or 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 29CFR1910.217 Table O-10, ANSI B11.19, ISO 13857, ISO14120/EN953 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 only; final mounting holes must be used for permanent location.

WARNING: If the application could result in a pass-through hazard (for example, perimeter guarding), either the safeguarding device or the guarded machine's MSCs/MPCEs must cause a Latched response following a Stop command (for example, interruption of the sensing field of a light curtain, or 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 means of machine cycle initiation. 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 Z244.1, or use additional safeguarding as described by ANSI B11.19 safety requirements or other applicable standards if a passthrough hazard cannot be eliminated or reduced to an acceptable level of risk.

7.5.7 Optical Sensor

The Safety Controller safety inputs may be used to monitor optical-based devices that use light as a means of detection.

Optical Sensor Requirements

When used as safeguarding devices, optical sensors are described by IEC61496-1/-2/-3 as Active Opto-electronic Protective Devices (AOPD) and Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR).

AOPDs include safety light curtains and safety grids and points (multiple-/single-beam devices). These devices generally meet Type 2 or Type 4 design requirements. A Type 2 device is allowed to be used in a Category 2 application, per ISO 13849-1, and a Type 4 device can be used in a Category 4 application.

AOPDDRs include area or laser scanners. The primary designation for these devices is a Type 3, for use in up to Category 3 applications.

Optical safety devices must be placed at an appropriate safety distance (minimum distance), according to the application standards. Refer to the applicable standards and to manufacturer documentation specific to your device for the appropriate calculations. The response time of the Safety Controller outputs to each safety input is provided on the **Configuration Summary** tab in the Software.

If the application includes a pass-through hazard (a person could pass through the optical device beams and stand undetected on the hazard side), other safeguarding may be required, and manual reset should be selected (see Manual Reset Input on p. 56).

WARNING: If the application could result in a pass-through hazard (for example, perimeter guarding), either the safeguarding device or the guarded machine's MSCs/MPCEs must cause a Latched response following a Stop command (for example, interruption of the sensing field of a light curtain, or 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 means of machine cycle initiation. The switch must be positioned as described in this document.

7.5.8 Two-Hand Control

The Safety Controller may be used as an initiation device for most powered machinery when machine cycling is controlled by a machine operator.

The Two-Hand Control (THC) actuators must be positioned so that hazardous motion is completed or stopped before the operator can release one or both of the buttons and reach the hazard (see Two-Hand Control Safety Distance (Minimum Distance) on p. 42).

The Safety Controller safety inputs used to monitor the actuation of the hand controls for two-hand control comply with the functionality of Type III requirements of IEC 60204-1 and ISO 13851 and the requirements of NFPA 79 and ANSI B11.19 for two-hand control, which include:

- Simultaneous actuation by both hands within a 500 ms time frame
- When this time limit is exceeded, both hand controls must be released before operation is initiated
- Continuous actuation during a hazardous condition
- Cessation of the hazardous condition if either hand control is released
- Release and re-actuation of both hand controls to re-initiate the hazardous motion or condition (anti-tie down)
- The appropriate performance level of the safety-related function (Control Reliability, Category/Performance level, or appropriate regulation and standard, or Safety Integration Level) as determined by a risk assessment

WARNING:

- **Use adequate point-of-operation guarding**
- Failure to properly guard hazardous machinery can result in a dangerous condition that could lead to serious injury or death.
- When properly installed, a two-hand control safety device provides protection only for the hands of the machine operator. It might be necessary to install additional safeguarding, such as safety light curtains, additional two-hand controls, and/or hard guards, to protect all individuals from hazardous machinery.

CAUTION:

- **Avoid installing hand controls in contaminated environments**—Severe contamination or other environmental influences could cause a slow response or false on condition of mechanical or ergonomic buttons.
- A slow response or false on condition could result in exposure to a hazard.
- The environment in which hand controls are installed must not adversely affect the means of actuation.

The level of safety achieved (for example, ISO 13849-1 Category) depends in part on the circuit type selected.

Consider the following when installing hand controls:

- Failure modes, such as a short circuit, a broken spring, or a mechanical seizure, that may result in not detecting the release of a hand control
- Severe contamination or other environmental influences that may cause a slow response when released or false ON condition of the hand control(s), for example, sticking of a mechanical linkage
- Protection from accidental or unintended operation, for example, mounting position, rings, guards, or shields
- Minimizing the possibility of defeat, for example, hand controls must be far enough apart so that they cannot be operated by the use of one arm—typically, not less than 550 mm (21.7 in) in a straight line, per ISO 13851
- The functional reliability and installation of external logic devices
- Proper electrical installation per NEC and NFPA 79 or IEC 60204

> CAUTION:
> - **Install hand controls to prevent accidental actuation**
> - It is not possible to completely protect the two-hand control system from defeat.
> - OSHA regulations require the user to arrange and protect hand controls to minimize possibility of defeat or accidental actuation.

> CAUTION:
> - **Machine control must provide anti-repeat control**
> - U.S. and International standards for single-stroke or single-cycle machines require that the machine control provides appropriate anti-repeat control.
> - This Emerson device can assist in accomplishing anti-repeat control, but a risk assessment must be performed to determine the suitability of such use.

Two-Hand Control Safety Distance (Minimum Distance)

The hand controls operator must not be able to reach the hazardous area with a hand or any other body part before the machine motion ceases. Use the formula below to calculate the safety distance (minimum distance).

> WARNING:
> - **Mount hand controls at a safe distance from moving machine parts**
> - Failure to establish and maintain the safety distance (minimum distance) could result in serious injury or death.
> - Mount hand controls as determined by the applicable standard. The operator or other non-qualified persons must not be able to relocate the hand controls.

U.S. Applications

The Safety Distance formula, as provided in ANSI B11.19:

Part-Revolution Clutch Machinery (the machine and its controls allow the machine to stop motion during the hazardous portion of the machine cycle)

$$D_s = K \times (T_s + T_r) + D_{pf}$$

For Full-Revolution Clutch Machinery (the machine and its controls are designed to complete a full machine cycle)

$$D_s = K \times (T_m + T_r + T_h)$$

D_s
: the Safety Distance (in inches)

K
: the OSHA/ANSI recommended hand-speed constant (in inches per second), in most cases is calculated at 63 in/s, but may vary between 63 in/s to 100 in/s based on the application circumstances;

: not a conclusive determination; consider all factors, including the physical ability of the operator, when determining the value of K to be used.

T_h
: the response time of the slowest hand control from the time when a hand disengages that control until the switch opens;

: T_h is usually insignificant for purely mechanical switches. However, T_h should be considered for safety distance calculation when using electronic or electromechanical (powered) hand controls.

T_m

the maximum time (in seconds) the machine takes to cease all motion after it has been tripped. For full revolution clutch presses with only one engaging point, T_m is equal to the time necessary for one and one-half revolutions of the crankshaft. For full revolution clutch presses with more than one engaging point, T_m is calculated as follows:

$$T_m = (1/2 + 1/N) \times T_{cy}$$

N = number of clutch engaging points per revolution

T_{cy} = time (in seconds) necessary to complete one revolution of the crankshaft

T_r

the response time of the Safety Controller as measured from the time a stop signal from either hand control is received. The Safety Controller response time is obtained from the **Configuration Summary** tab in the Software.

T_s

the overall stop time of the machine (in seconds) from the initial stop signal to the final ceasing of all motion, including stop times of all relevant control elements and measured at maximum machine velocity.

T_s is usually measured by a stop-time measuring device. If the specified machine stop time is used, add at least 20% as a safety factor to account for brake system deterioration. If the stop-time of the two redundant machine control elements is unequal, the slower of the two times must be used for calculating the separation distance.

European Applications

The Minimum Distance Formula, as provided in EN 13855:

$$S = (K \times T) + C$$

S

the Minimum Distance (in millimeters)

K

the EN 13855 recommended hand-speed constant (in millimeters per second), in most cases is calculated at 1600 mm/s, but may vary between 1600 mm/s to 2500 mm/s based on the application circumstances;

not a conclusive determination; consider all factors, including the physical ability of the operator, when determining the value of K to be used.

T

the overall machine stopping response time (in seconds), from the physical initiation of the safety device to the final ceasing of all motion.

C

the added distance due to the depth penetration factor equals 250 mm, per EN 13855. The EN 13855 **C** factor may be reduced to 0 if the risk of encroachment is eliminated, but the safety distance must always be 100 mm or greater.

7.5.9 Safety Mat

The Safety Controller may be used to monitor pressure-sensitive safety mats and safety edges.

The purpose of the Safety Mat input of the Safety Controller is to verify the proper operation of 4-wire, presence-sensing safety mats. Multiple mats may be connected in series to one Safety Controller, 150 ohms maximum per input (see Safety Mat Hookup Options on p. 47).

> **Important:** The Safety Controller is not designed to monitor 2-wire mats, bumpers, or edges (with or without sensing resistors).

The Safety Controller monitors the contacts (contact plates) and the wiring of one or more safety mat(s) for failures and prevents the machine from restarting if a failure is detected. A reset routine after the operator steps off the safety mat may be provided by the Safety Controller, or, if the Safety Controller is used in auto-reset mode, the reset function must be provided by the machine control system. This prevents the controlled machinery from restarting automatically after the mat is cleared.

WARNING:

- Application of Safety Mats
- Failure to follow these instructions could result in serious injury or death.
- Safety Mat application requirements vary for the level of control reliability or category and performance level as described by ISO 13849-1 and ISO 13856. Although Emerson always recommends the highest level of safety in any application, the user is responsible to safely install, operate, and maintain each safety system per the manufacturer's recommendations and comply with all relevant laws and regulations.
- Do not use safety mats as a tripping device to initiate machine motion (such as in a presence-sensing device initiation application), because of the possibility of unexpected start or re-start of the machine cycle resulting from failure(s) within the mat and the interconnect cabling.
- Do not use a safety mat to enable or provide the means to allow the machine control to start hazardous motion by simply standing on the safety mat (for example, at a control station). This type of application uses reverse/negative logic and certain failures (for example, loss of power to the Module) can result in a false enable signal.

Safety Mat Requirements

The following are minimum requirements for the design, construction, and installation of four-wire safety mat sensor(s) to be interfaced with the Safety Controller. These requirements are a summary of standards ISO 13856-1, ANSI/RIA R15.06 and ANSI B11.19. The user must review and comply with all applicable regulations and standards.

Safety Mat System Design and Construction

The safety mat system sensor, Safety Controller, and any additional devices must have a response time that is fast enough to reduce the possibility of an individual stepping lightly and quickly over the mat’s sensing surface (less than 100 to 200 ms, depending on the relevant standard).

For a safety mat system, the minimum object sensitivity of the sensor must detect, at a minimum, a 30 kg (66 lb) weight on an 80 mm (3.15 in) diameter circular disk test piece anywhere on the mat’s sensing surface, including joints and junctions. The effective sensing surface or area must be identifiable and can comprise one or more sensors. The safety mat supplier should state this minimum weight and diameter as the minimum object sensitivity of the sensor.

User adjustments to actuating force and response time are not allowed (ISO 13856-1). The sensor should be manufactured to prevent any reasonably foreseeable failures, such as oxidation of the contact elements which could cause a loss in sensitivity.

The environmental rating of the sensor must meet a minimum of IP54. When the sensor is specified for immersion in water, the sensor’s minimum enclosure level must be IP67. The interconnect cabling may require special attention. A wicking action may result in the ingress of liquid into the mat, possibly causing a loss of sensor sensitivity. The termination of the interconnect cabling may need to be located in an enclosure that has an appropriate environmental rating.

The sensor must not be adversely affected by the environmental conditions for which the system is intended. The effects of liquids and other substances on the sensor must be taken into account. For example, long-term exposure to some liquids can cause degradation or swelling of the sensor’s housing material, resulting in an unsafe condition.

The sensor’s top surface should be a lifetime non-slip design, or otherwise minimize the possibility of slipping under the expected operating conditions.

The four-wire connection between the interconnect cables and the sensor must withstand dragging or carrying the sensor by its cable without failing in an unsafe manner, such as broken connections due to sharp or steady pulls, or continuous flexing. If such connection is not available, an alternative method must be employed to avoid such failure, for example, a cable which disconnects without damage and results in a safe situation.

Safety Mat Installation

The mounting surface quality and preparation for the safety mat must meet the requirements stated by the manufacturer of the sensor. Irregularities in the mounting surfaces may impair the function of the sensor and should be reduced to an acceptable minimum. The mounting surface should be level and clean. Avoid the collection of fluids under or around the sensor. Prevent the risk of failure due to a build-up of dirt, turning chips, or other material under the sensor(s) or the associated hardware. Special consideration should be given to joints between the sensors to ensure that foreign material does not migrate under or into the sensor.

Any damage (cuts, tears, wear, or punctures) to the outer insulating jacket of the interconnect cable or to any part of the exterior of the safety mat must be immediately repaired or replaced. Ingress of material (including dirt particles, insects, fluid, moisture, or turning-chips), which may be present near the mat, may cause the sensor to corrode or to lose its sensitivity.

Routinely inspect and test each safety mat according to the manufacturer's recommendations. Do not exceed operational specifications, such as the maximum number of switching operations.

Securely mount each safety mat to prevent inadvertent movement (creeping) or unauthorized removal. Methods include, but are not limited to, secured edging or trim, tamper-resistant or one-way fasteners, and recessed flooring or mounting surface, in addition to the size and weight of large mats.

Each safety mat must be installed to minimize tripping hazards, particularly towards the machine hazard. A tripping hazard may exist when the difference in height of an adjacent horizontal surface is 4 mm (1/8 in) or more. Minimize tripping hazards at joints, junctions, and edges, and when additional coverings are used. Methods include a ground-flush installation of the mat, or a ramp that does not exceed 20° from horizontal. Use contrasting colors or markings to identify ramps and edges.

Position and size the safety mat system so that persons cannot enter the hazardous area without being detected, and cannot reach the hazard before the hazardous conditions have ceased. Additional guards or safeguarding devices may be required to ensure that exposure to the hazard(s) is not possible by reaching over, under, or around the device's sensing surface.

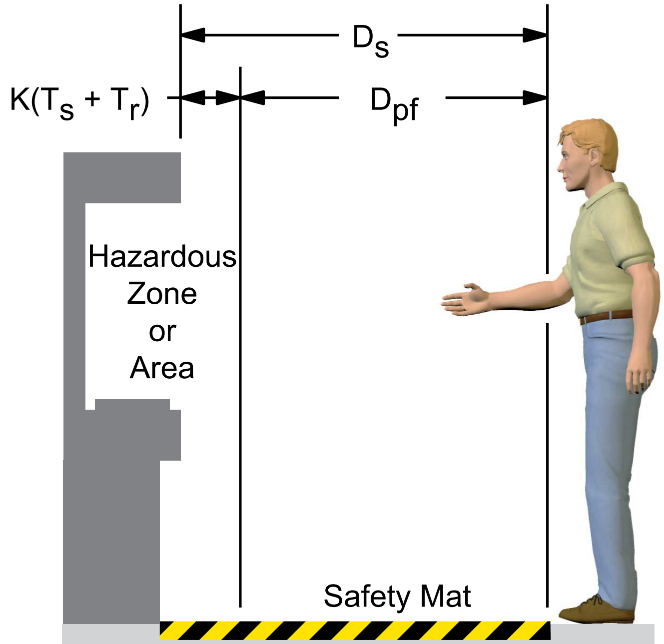
A safety mat installation must take into account the possibility of easily stepping over the sensing surface and not being detected. ANSI and international standards require a minimum depth of field of the sensor surface (the smallest distance between the edge of the mat and hazard) to be from 750 mm to 1200 mm (30 in to 48 in), depending on the application and the relevant standard. The possibility of stepping on machine supports or other physical objects to bypass or climb over the sensor also must be prevented.

Safety Mat Safety Distance (Minimum Distance)

As a stand-alone safeguard, the safety mat must be installed at a safety distance (minimum distance) so that the exterior edge of the sensing surface is at or beyond that distance, unless it is solely used to prevent start/restart, or solely used for clearance safeguarding (see ANSI B11.19, ANSI/RIA R15.06, and ISO 13855).

The safety distance (minimum distance) required for an application depends on several factors, including the speed of the hand (or individual), the total system stopping time (which includes several response time components), and the depth penetration factor. Refer to the relevant standard to determine the appropriate distance or means to ensure that individuals cannot be exposed to the hazard(s).

Figure 18. Determining safety distance for the safety mat



U.S. Applications

The Safety Distance formula, as provided in ANSI B11.19:

$$D_s = K \times (T_s + T_r) + D_{pf}$$

D_s
: the Safety Distance (in inches)

T_r
: the response time of the Safety Controller as measured from the time a stop signal from either hand control. The Safety Controller response time is obtained from the **Configuration Summary** tab in the Software.

K
: the OSHA/ANSI recommended hand-speed constant (in inches per second), in most cases is calculated at 63 in/s, but may vary between 63 in/s to 100 in/s based on the application circumstances;

  not a conclusive determination; consider all factors, including the physical ability of the operator, when determining the value of K to be used.

T_s
: the overall stop time of the machine (in seconds) from the initial stop signal to the final ceasing of all motion, including stop times of all relevant control elements and measured at maximum machine velocity.

  T_s is usually measured by a stop-time measuring device. If the specified machine stop time is used, add at least 20% as a safety factor to account for brake system deterioration. If the stop-time of the two redundant machine control elements is unequal, the slower of the two times must be used for calculating the separation distance.

D_{pf}
: the added distance due to the penetration depth factor

  equals 48 in, per ANSI B11.19

European Applications

The Minimum Distance Formula, as provided in EN 13855:

```
S = (K x T) + C
```

S
: the Minimum Distance (in millimeters)

K
: the EN 13855 recommended hand-speed constant (in millimeters per second), in most cases is calculated at 1600 mm/s, but may vary between 1600 mm/s to 2500 mm/s based on the application circumstances;

not a conclusive determination; consider all factors, including the physical ability of the operator, when determining the value of K to be used.

T
: the overall machine stopping response time (in seconds), from the physical initiation of the safety device to the final ceasing of all motion.

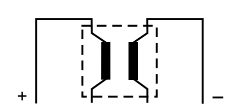
C
: the added distance due to the depth penetration factor equals 1200 mm, per EN 13855.

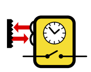
Safety Mat Hookup Options

Pressure-sensitive mats and pressure-sensitive floors must meet the requirements of the category for which they are specified and marked. These categories are defined in ISO 13849-1.

The safety mat, its Safety Controller, and any output signal switching devices must meet, at a minimum, the Category 1 safety requirements. See ISO 13856-1 and ISO 13849-1 for relevant requirement details.

The Safety Controller is designed to monitor 4-wire safety mats and is not compatible with two-wire devices (mats, sensing edges, or any other devices with two wires and a sensing resistor).

4-Wire	
This circuit typically meets ISO 13849-1 Category 2 or Category 3 requirements depending on the safety rating and installation of the mat(s). The Safety Controller enters a Lockout mode when an open wire, a short to 0 V, or a short to another source of power is detected.	

7.5.10  Muting Sensor

Safety device muting is an automatically controlled suspension of one or more safety input stop signals during a portion of a machine operation when no immediate hazard is present or when access to the hazard is safeguarded. Muting sensors can be mapped to one or more of the following safety input devices:

- Safety gate (interlocking) switches
- Optical sensors
- Two-hand controls
- Safety mats
- Protective stops

US and International standards require the user to arrange, install, and operate the safety system so that personnel are protected and the possibility of defeating the safeguard is minimized.

Examples of Muting Sensors and Switches

WARNING:

- Avoid hazardous installations
- Improper adjustment or positioning could result in serious injury or death.
- Properly adjust or position the two or four independent position switches so that they close only after the hazard no longer exists and open again when the cycle is complete or the hazard is again present.
- The user is responsible for satisfying all local, state, and national laws, rules, codes, and regulations relating to the use of safety equipment in any particular application. Ensure that all appropriate agency requirements have been met and that all installation and maintenance instructions contained in the appropriate manuals are followed.

Photoelectric Sensors (Opposed Mode)

Opposed-mode sensors should be configured for dark operate (DO) and have open (non-conducting) output contacts in a power Off condition. Both the emitter and receiver from each pair should be powered from the same source to reduce the possibility of common mode failures.

Photoelectric Sensors (Polarized Retroreflective Mode)

The user must ensure that false proxying (activation due to shiny or reflective surfaces) is not possible. Sensors with linear polarization can greatly reduce or eliminate this effect.

Use a sensor configured for light operate (LO or NO) if initiating a mute when the retroreflective target or tape is detected (home position). Use a sensor configured for dark operate (DO or NC) when a blocked beam path initiates the muted condition (entry/exit). Both situations must have open (non-conducting) output contacts in a power Off condition.

Positive-Opening Safety Switches

Two (or four) independent switches, each with a minimum of one closed safety contact to initiate the mute cycle, are typically used. An application using a single switch with a single actuator and two closed contacts may result in an unsafe situation.

Inductive Proximity Sensors

Typically, inductive proximity sensors are used to initiate a muted cycle when a metal surface is detected. Do not use two-wire sensors due to excessive leakage current causing false On conditions. Use only three- or four-wire sensors that have discrete PNP or hard-contact outputs that are separate from the input power.

Mute Device Requirements

The muting devices must, at a minimum, comply with the following requirements:

1. There must be a minimum of two independent hard-wired muting devices.
2. The muting devices must have one of the following: normally open contacts, PNP outputs (both of which must fulfill the input requirements listed in the Specifications and Requirements on p. 19), or a complementary switching action. At least one of these contacts must close when the switch is actuated, and must open (or not conduct) when the switch is not actuated or is in a power-off state.
3. The activation of the inputs to the muting function must come from separate sources. These sources must be mounted separately to prevent an unsafe muting condition resulting from misadjustment, misalignment, or a single common mode failure, such as physical damage to the mounting surface. Only one of these sources may pass through, or be affected by, a PLC or a similar device.
4. The muting devices must be installed so that they cannot be easily defeated or bypassed.

5. The muting devices must be mounted so that their physical position and alignment cannot be easily changed.
6. It must not be possible for environmental conditions, such as extreme airborne contamination, to initiate a mute condition.
7. The muting devices must not be set to use any delay or other timing functions unless such functions are accomplished so that no single component failure prevents the removal of the hazard, subsequent machine cycles are prevented until the failure is corrected, and no hazard is created by extending the muted period.

7.5.11 Bypass Switch

The safety device bypass is a manually activated and temporary suspension of one or more safety input stop signals, under supervisory control, when no immediate hazard is present. It is typically accomplished by selecting a bypass mode of operation using a key switch to facilitate machine setup, web alignment/adjustments, robot teach, and process troubleshooting.

Bypass switches can be mapped to one or more of the following safety input devices:

- Safety gate (interlocking) switches
- Optical sensors
- Two-Hand Controls
- Safety mats
- Protective stop

Requirements of Bypassing Safeguards

Requirements to bypass a safeguarding device include[5]:

- The bypass function must be temporary
- The means of selecting or enabling the bypass must be capable of being supervised
- Automatic machine operation must be prevented by limiting range of motion, speed, or power (use inch, jog, or slow-speed modes). Bypass mode must not be used for production
- Supplemental safeguarding must be provided. Personnel must not be exposed to hazards
- The means of bypassing must be within full view of the safeguard to be bypassed
- Initiation of motion should only be through a hold-to-run type of control
- All emergency stops must remain active
- The means of bypassing must be employed at the same level of reliability as the safeguard
- Visual indication that the safeguarding device has been bypassed must be provided and be readily observable from the location of the safeguard
- Personnel must be trained in the use of the safeguard and in the use of the bypass
- Risk assessment and risk reduction (per the relevant standard) must be accomplished
- The reset, actuation, clearing, or enabling of the safeguarding device must not initiate hazardous motion or create a hazardous situation

Bypassing a safeguarding device should not be confused with *muting*, which is a temporary, automatic suspension of the safeguarding function of a safeguarding device during a non-hazardous portion of the machine cycle. Muting allows for material to be manually or automatically fed into a machine or process without issuing a stop command. Another term commonly confused with bypassing is *blanking*, which desensitizes a portion of the sensing field of an optical safeguarding device, such as disabling one or more beams of a safety light curtain so that a specific beam break is ignored.

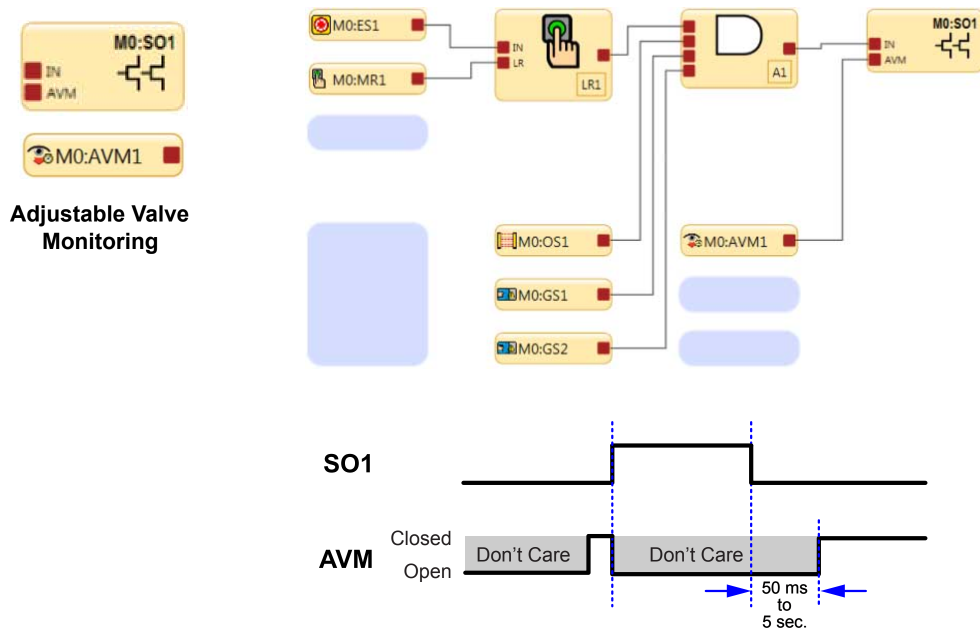
7.5.12 Adjustable Valve Monitoring (AVM) Function

The Adjustable Valve (Device) Monitoring (AVM) function is similar in function to One-Channel External Device Monitoring (1-channel EDM, see External Device Monitoring (EDM) on p. 69). The

[5] This summary was compiled from sources including NFPA79, ANSI/RIA R15.06, ISO 13849-1, IEC60204-1, and ANSI B11.19. The user is responsible to verify safeguards required by these specs and all other relevant laws and regulations.

AVM function monitors the state of the device(s) that are controlled by the safety output to which the function is mapped. When the safety output turns OFF, the AVM input must be high/On (+24 V DC applied) before the AVM timer expires or a lockout will occur. The AVM input must also be high/ON when the safety output attempts to turn ON or a lockout will occur.

Figure 19. Timing logic—AVM Function



Adjustable Valve Monitoring AVM is a way to check the operation of dual-channel valves. The force guided NC monitoring contacts of the valves are used as an input to detect a "stuck on" fault condition and will prevent the Safety Controller outputs from turning On.

Note: 50 ms to 5 s time period is adjustable in 50 ms intervals (default is 50 ms).

The Adjustable Valve (Device) Monitoring function is useful for dynamically monitoring devices under the control of the safety output that may become slow, stick, or fail in an energized state or position, and whose operation needs to be verified after a Stop signal occurs. Example applications include single- or dual-solenoid valves controlling clutch/brake mechanisms, and position sensors that monitor the home position of a linear actuator.

Synchronization or checking a maximum differential timing between two or more devices, such as dual valves, may be achieved by mapping multiple AVM functions to one safety output and configuring the AVM timer to the same values. Any number of AVM inputs can be mapped to one safety output. An input signal can be generated by a hard/relay contact or a solid-state PNP output.

WARNING:

- Adjustable Valve Monitoring (AVM) Operation
- When the AVM function is used, the Safety Output(s) will not turn ON until the AVM input is satisfied. This could result in an ON-delay up to the configured AVM monitoring time.
- It is the user's responsibility to ensure the AVM monitoring time is properly configured for the application and to instruct all individuals associated with the machine about the possibility of the ON-Delay effect, which may not be readily apparent to the machine operator or to other personnel.

7.5.13 PACSafe 262: Cycle Initiation for Press Control Function Block

A single, momentary actuator may be used as an initiation device for small hydraulic/pneumatic presses when used with the Press Control Function Block when configured for Single Actuator Control. This is an initiation input to start the press cycle. When Single Actuator Control is selected, the operator can start the cycle with this input, and then release and perform other tasks.

CAUTION: Other means must be provided to ensure that operators are protected from the hazards because their hands do not have to engage the button during the entire movement of the press.

Access to the hazard must be protected using means other than a hold-to-run button, for example, light curtains, gates, etc. These safety devices must also be connected to inputs on the Press Control function block.

The Cycle Initiation input can be connected to the GO node of the Press Control Function Block or the IN node of a Bypass block that is connected to the GO node of the Press Control Function Block.

The Cycle Initiation device must be mounted at a location that complies with the following warning.

WARNING:

- Install cycle initiation devices properly
- Failure to properly install cycle initiation devices could result in serious injury or death.
- Install cycle initiation devices so that they are accessible only from outside, and in full view of, the safeguarded space. Cycle initiation devices cannot be accessible from within the safeguarded space. Protect cycle initiation devices against unauthorized or inadvertent operation (for example, through the use of rings or guards). If there are any hazardous areas that are not visible from the cycle initiation devices, provide additional safeguarding.

7.5.14 SQS PACSafe 262: Press Control Sequential Stop (SQS) Function

The Press Control Sequential Stop (SQS) input provides a signal to the press control system that the press ram has reached a position such that there is no longer a crushing hazard (less than a 6 mm (0.25 in) gap). The downward motion of the press ram stops at this point. The operator can remove their hands from the two-hand control to ensure the work piece is in the correct position (the Mutable Safety input is muted at this time). After the operator ensures the work piece is in the correct position, they engage the Foot Pedal input to finish the down stroke.

Note: The above is one method of controlling the Press Control process. There are three allowable processes:

1. Two-Hand Control input (TC1) turns on the GO input to drive the ram to the SQS point. Release TC1 and engage the FP1 to turn on the Ft Pedal input to drive the ram to the Bottom of Stroke (BOS), release Foot Pedal input (FP1) and engage TC1 to raise the ram.
2. FP1 turns on the GO input to drive the ram to the SQS point, Release FP1. Re-engaging FP1 drives the ram to the BOS point, and then back up to the Top of Stroke (TOS) point. (The Ft Pedal input will disappear when FP1 is connected to the GO node).
3. TC1 turns on the GO input to drive the ram to the SQS point, release TC1. Re-engaging TC1 drives the ram to the BOS point, and then back up to the TOS point. (To set the system up for this method, do NOT select the Ft Pedal node in the Press Control Inputs function block.)

The Sequential Stop input can directly mute the Mutable Safety input or it can work in unison with the Press Control Mute Sensor input to mute the Mutable Safety input of the press control system (for Press Control Mute Sensor input, see PACSafe 262: Press Control Mute Sensor on p. 53).

The Sequential Stop input can be a single-channel or dual-channel input depending on the requirements of the system. The input devices must be positioned to ensure that the press ram stops in a position that does not have a gap large enough that a finger can enter (must be a finger-safe gap of less than 6 mm/0.25 in).

Note: If a single-channel configuration is selected for the Sequential Stop input, it must work in unison with the Press Control Mute Sensor input to mute the Press Control Mutable Safety Stop input. If a dual-channel configuration is selected for the Sequential Stop input, it can directly mute the Press Control Mutable Safety Stop input by itself.

US and International standards require the user to arrange, install, and operate the safety system so that personnel are protected and the possibility of defeating the safeguard is minimized.

WARNING:

- Avoid Hazardous Installations
- A single-channel SQS device is not permitted unless it is used in conjunction with a Press Control Mute Sensor (PCMS) input device. When a two-channel SQS input is used without a PCMS, each SQS channel must be an independent position switch and must be properly adjusted or positioned so that they close only after the hazard no longer exists, and open again when the cycle is complete or the hazard is again present. If the switches are improperly adjusted or positioned, injury or death may result.
- The user is responsible to satisfy all local, state, and national laws, rules, codes, and regulations relating to the use of safety equipment in any particular application. Make sure that all appropriate agency requirements have been met and that all installation and maintenance instructions contained in the appropriate manuals are followed.

SQS Devices must, at a minimum, comply with the following requirements. If the SQS device is being used as a mute input with the Press Control Mute Sensor then the pair must comply with the following requirements.

1. There must be a minimum of two independent hard-wired devices.
2. The devices must have one of the following: normally open contacts, PNP outputs (both of which must fulfill the input requirements listed in Specifications and Requirements on p. 19), or a complementary switching action. At least one of these contacts must close when the switch is actuated, and must open (or not conduct) when the switch is not actuated or is in a power-off state.
3. The activation of the inputs of this mute function must come from separate sources. These sources must be mounted separately to prevent an unsafe condition resulting from

misadjustment, misalignment, or a single common mode failure, such as physical damage to the mounting surface. Only one of these sources may pass through, or be affected by, a PLC or similar device.

4. The devices must be installed so that they cannot be easily defeated or bypassed.
5. The devices must be mounted so that their physical position and alignment cannot be easily changed.
6. It must not be possible for environmental conditions, such as extreme airborne contamination, to initiate the mute condition.
7. The devices must not use any delay or other timing functions unless such functions are accomplished so that no single component failure prevents the removal of the hazard, subsequent machine cycles are prevented until the failure is corrected, and no hazard is created by extending the muted period.

7.5.15 PACSafe 262: Press Control Mute Sensor

Safety device muting is an automatically controlled suspension of the Mutable Safety Stop input of the Press Control function block during a portion of the press cycle when no immediate hazard is present or when access to the hazard is safeguarded by other means. Map the Press Control Mute Sensors to the M Sensor input of the Press Control Input Function Block to work with the Sequential Stop (SQS) input to mute one or more of the following safety input devices:

- Safety Gate (interlocking) switches
- Optical sensors
- Safety Mats
- Protective stops

US and International standards require the user to arrange, install, and operate the safety system so that personnel are protected and the possibility of defeating the safeguards is minimized.

> **WARNING:**
> - Avoid Hazardous Installations
> - Two (1 SQS and 1 Press Control Mute Sensor) or four (2 SQS and 2 Press Control Mute Sensors) independent position switches must be properly adjusted or positioned so that they close only after the hazard no longer exists, and open again when the cycle is complete or the hazard is again present. If the switches are improperly adjusted or positioned, injury or death may result.
> - The user is responsible to satisfy all local, state, and national laws, rules, codes, and regulations relating to the use of safety equipment in any particular application. Make sure that all appropriate agency requirements have been met and that all installation and maintenance instructions contained in the appropriate manuals are followed.

The Press Control Mute Sensor (with the SQS Device) must, at a minimum, comply with the following requirements:

1. There must be a minimum of two independent hard-wired devices.
2. The devices must have one of the following: normally open contacts, PNP outputs (both of which must fulfill the input requirements listed in Specifications and Requirements on p. 19), or a complementary switching action. At least one of these contacts must close when the switch is actuated, and must open (or not conduct) when the switch is not actuated or is in a power-off state.
3. The activation of the inputs of this mute function must come from separate sources. These sources must be mounted separately to prevent an unsafe condition resulting from misadjustment, misalignment, or a single common mode failure, such as physical damage to the mounting surface. Only one of these sources may pass through, or be affected by, a PLC or similar device.
4. The devices must be installed so that they cannot be easily defeated or bypassed.
5. The devices must be mounted so that their physical position and alignment cannot be easily changed.

6. It must not be possible for environmental conditions, such as extreme airborne contamination, to initiate the mute condition.
7. The devices must not use any delay or other timing functions unless such functions are accomplished so that no single component failure prevents the removal of the hazard, subsequent machine cycles are prevented until the failure is corrected, and no hazard is created by extending the muted period.

7.5.16 PACSafe 262: Foot Pedal

The Foot Pedal input can be used with the Press Control function blocks in a number of ways:

- It can be connected to the GO node of the Press Control function block as a cycle initiation device when the block is set for Single Actuator Control.
- It can be connected to the GO node of the Press Control function block when configured for the Manual Upstroke Setting and the SQS input is enabled. (Engaging the FP1 input drives the RAM to the SQS point. At this time, the FP1 is released. Because the Mutable Safety Stop input is now muted, the operator can adjust the workpiece. Engaging the FP1 again drives the ram to the BOS point then back up to the TOS point.)
- It can be used as described in the following paragraph.

The Foot Pedal input can be added to the Press Control Input function block and configured when the SQS input is configured. The press stops at the SQS input, allowing the operator to remove their hands from the Two-Hand Control input. The operator can ensure that the work piece is positioned properly and sometimes needs to hold the work piece in position. The operator can then engage the input device connected to the Food Pedal input to re-engage the press to finish the process.

The Foot Pedal input can also be configured to the Press GO node. In that case, the Foot Pedal can be used with and without SQS being configured. This allows for more flexibility in use cases.

A physical on/off input or a Foot Pedal input can be connected to the Ft Pedal input of the Press Control Input function block. The device can be a foot pedal but can also be other initiation devices.

Access to the hazard must be prevented using other means than the Mutable Safety Stop input device (for example, the internal opening must be finger-safe, less than 6 mm/0.25 in). Protection can also be provided by safety devices connected to the non-mutable Safety Stop input.

> ⚠ CAUTION: Other means must be provided to ensure that operators are protected from the hazards because their hands do not have to engage the button during this final movement of the press. The input can be single- or dual-channel (2 NO or 1 NO/1 NC).

7.6 Non-Safety Input Devices

The non-safety input devices include manual reset devices, ON/OFF switches, mute enable devices, and cancel delay inputs.

Manual Reset Devices

Used to create a reset signal for an output or function block configured for a manual reset, requiring an operator action for the output of that block to turn on. Resets can also be created using virtual reset input; see Virtual Non-Safety Input Devices on p. 58.

WARNING:
- Non-monitored resets
- Failure to follow these instructions could result in serious injury or death.
- If a non-monitored reset (either latch or system reset) is configured and if all other conditions for a reset are in place, a short from the reset terminal to +24 V will turn on the safety output(s) immediately.

ON/OFF Switch

Provides an ON or OFF command to the machine. When all controlling safety inputs are in the Run state, this function permits the safety output to turn ON and OFF. This is a single-channel signal; the Run state is 24 V DC and the Stop state is 0 V DC. An ON/OFF input can be added without mapping to a safety output, which allows this input to control only a status output. An ON/OFF switch can also be created using a virtual input; see Virtual Non-Safety Input Devices on p. 58.

PACSafe 262: The ON/OFF inputs are used to select the mode of the Press Control Mode function block. Three separate inputs are required to satisfy this block. The block does accept Virtual ON/OFF inputs.

Mute Enable Switch

Signals the Safety Controller when the mute sensors are permitted to perform a mute function. When the mute enable function is configured, the mute sensors are not enabled to perform a mute function until the mute enable signal is in the Run state. This is a single-channel signal; the enable (Run) state is 24 V DC and the disable (Stop) state is 0 V DC. A mute enable switch can also be created using a virtual input; see Virtual Non-Safety Input Devices on p. 58.

Cancel OFF-Delay Devices

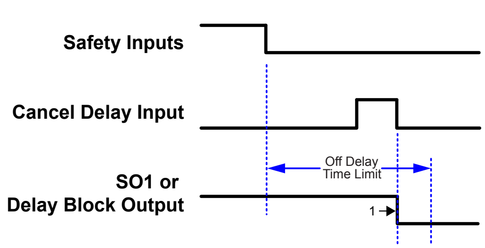
Provide the option to cancel a configured OFF-delay time of a safety output or a delay block output, or to cancel a configured One Shot time of a one shot block output. It functions in one of the following ways:

- Keeps the safety output or delay block output ON
- Turns the safety output, delay block output, or one shot block output OFF immediately after the Safety Controller receives a Cancel OFF-Delay signal
- When **Cancel Type** is set to **Control Input**, the safety output or delay block output stays on if the input turns ON again before the end of the delay (does not apply to a One Shot block output)

A status output function (Output Delay in Progress) indicates when a Cancel Delay Input can be activated to keep the OFF-delayed safety output ON. A cancel OFF-delay device can also be created using a virtual input; see Virtual Non-Safety Input Devices on p. 58.

Cancel OFF-Delay Timing

Figure 20. Safety Input remains in Stop mode



Note 1 - If "turn output off" function is selected

Figure 21. Turn Output OFF function

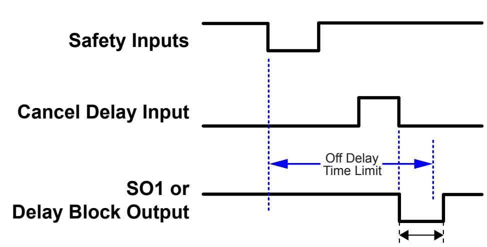


Figure 22. Keep Output ON function for Safety Inputs with the Latch Reset

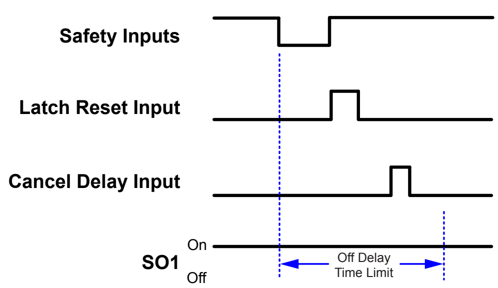
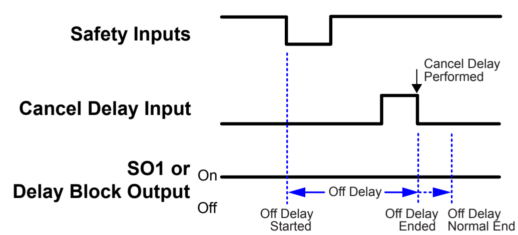


Figure 23. Keep Output ON function for Safety Inputs without the Latch Reset



7.6.1 Manual Reset Input

The Manual Reset input may be configured to perform any combination of the following (see Adding Inputs and Status Outputs on p. 81):

Reset of Safety Inputs

Sets the output of the Latch Reset Block(s) to a Run state from a Latched state when the IN node is in a Run state

Reset of Safety Outputs

Sets the Output to ON if the Output Block configured for Latch Reset is ON.

Exceptions:

A Safety Output cannot be configured to use a Manual Reset when associated with a Two-Hand Control input or an Enabling Device function block.

System Reset

Sets the System to a Run state from a Lockout state due to a system fault if the cause of the fault has been removed. Possible scenarios when System Reset is needed include:

- Signals are detected on unused terminal pins
- Configuration Mode timeout
- Exiting Configuration Mode
- Internal faults
- Press Control faults

Note: A manual reset selected as a system reset can be used to finish the confirmation of a new configuration so that the power does not have to be cycled to the device.

Output Fault Reset

Clears the fault and allows the output to turn back ON if the cause of the fault has been removed. Possible scenarios when an Output Fault Reset is needed include:

- Output faults
- EDM or AVM faults

Manual Reset on Power-Up

Allows various Latch Reset Blocks and/or Output Blocks to be controlled by a single reset input after the power up.

Enable Mode Exit

A reset is required to exit the Enable Mode.

Track Input Group Reset

Resets the Status Output function **Track Input Group** and the Virtual Status Output function **Track Input Group**.

The reset switch must be mounted at a location that complies with the following warning. A key-actuated reset switch provides some operator or supervisory control, as the key can be removed from the switch and taken into the guarded area. However, this does not prevent from any unauthorized or inadvertent resets due to spare keys being in the possession of others, or additional personnel entering the guarded area unnoticed (a pass-through hazard).

WARNING:

- Install reset switches properly
- Failure to properly 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 cannot 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 that are not visible from the reset switches, provide additional safeguarding.

Important: Resetting a safeguard must not initiate hazardous motion. Safe work procedures require a start-up procedure to be followed and the individual performing the reset to verify that the entire hazardous area is clear of all personnel **before each reset of the safeguard is performed.** If any area cannot be observed from the reset switch location, additional supplemental safeguarding must be used: at a minimum, visual and audible warnings of the machine start-up.

Note: Automatic Reset sets an output to return to an ON state without action by an individual once the input device(s) changes to the Run state and all other logic blocks are in their Run state. Also known as "Trip mode," automatic reset is typically used in applications in which the individual is continually being sensed by the safety input device.

WARNING:

- Automatic Power Up
- On power-up, the Safety Outputs and Latch Reset Blocks configured for automatic power-up will turn their outputs ON if all associated inputs are in the Run state.
- If manual reset is required, configure the outputs for a manual power mode.

Automatic and Manual Reset Inputs Mapped to the Same Safety Output

By default, Safety Outputs are configured for automatic reset (trip mode). They can be configured as a Latch Reset using the Solid-State Output Properties attribute of the Safety Output (see Function Blocks on p. 109).

Safety Input Devices operate as automatic reset unless a Latch Reset Block is added. If a Latch Reset Block is added in line with an output configured for Latch Reset mode, the same or different Manual Reset Input Device(s) may be used to reset the Latch Reset Block and the Safety Output latch. If the same Manual Reset Input Device is used for both, and all inputs are in their Run state, a single reset action will unlatch the function block and the output block. If different Manual Reset Input Devices are used, the reset associated with the Safety Output must be the last one activated. This can be used to force a sequenced reset routine, which can be used to reduce or eliminate pass-through hazards in perimeter guarding applications (see Safety Input Device Properties on p. 33).

If the controlling inputs to a Latch Reset Block or a Safety Output Block are not in the Run state, the reset for that block will be ignored.

Reset Signal Requirements

Reset Input devices can be configured for monitored or non-monitored operation, as follows:

Monitored Reset

Requires the reset signal to transition from low (0 V DC) to high (24 V DC) and then back to low. The high state duration must be 0.5 seconds to 2 seconds. This is called a trailing edge event.

Non-Monitored Reset

Requires only that the reset signal transitions from low (0 V DC) to high (24 V DC) and stays high for at least 0.5 seconds. After the reset, the reset signal can be either high or low. This is called a leading-edge event.

7.7 Virtual Non-Safety Input Devices

The virtual non-safety input devices include manual reset, ON/OFF, mute enable, and cancel OFF-Delay.

WARNING: Virtual Non-Safety Inputs must never be used to control any safety-critical applications. If a Virtual Non-Safety Input is used to control a safety-critical application, a failure to danger is possible and may lead to serious injury or death.

Important: Resetting a safeguard must not initiate hazardous motion. Safe work procedures require a start-up procedure to be followed and the individual performing the reset to verify that the entire hazardous area is clear of all personnel before each reset of the safeguard is performed. If any area cannot be observed from the reset switch location, additional supplemental safeguarding must be used: at a minimum, visual and audible warnings of the machine start-up.

7.7.1 Virtual Manual Reset and Cancel Delay (RCD) Sequence

According to section 5.2.2 of EN ISO 13849-1:2015, a deliberate action by the operator is required to reset a safety function. Traditionally, this requirement is met by using a mechanical switch and associated wires connected to specified terminals on the Safety Controller. For a monitored reset, the contacts must be open initially, then closed, and then open again within the proper timing. If the timing is not too short or too long, it is determined to be deliberate and the reset is performed.

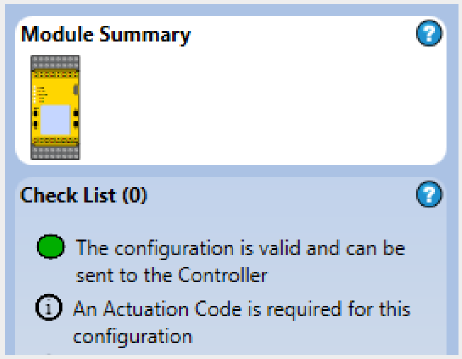
Emerson has created a virtual reset solution that requires deliberate action. For example, in place of the mechanical switch, an HMI may be used. In place of the wires, a unique Actuation Code is used for each Safety Controller on a network. Also, each virtual reset within a Safety Controller is associated with a specific bit in a register. This bit, along with the Actuation Code, must be written and cleared in a coordinated way. If the steps are completed with the proper sequence and timing, it is determined to be deliberate and the reset is performed.

While the standards do not require a deliberate action to perform a virtual cancel delay, to avoid additional complexity, Emerson has implemented this function in the same way as the virtual manual reset.

The user must set matching Actuation Codes in both the Safety Controller and the controlling network device (PLC, HMI, etc.). The Actuation Code is part of the Network Settings and is not included in the configuration Cyclic Redundancy Check (CRC). There is no default Actuation Code. The user must set one up on the **Network Settings** screen. The Actuation Code can be active for up to 2 seconds for it to be effective. Different Safety Controllers on the same network should have different Actuation Codes.

Note: When a virtual manual reset or cancel delay is added in on the **Functional View** tab, the checklist adds a note that an actuation code must be entered under **Network Settings**.

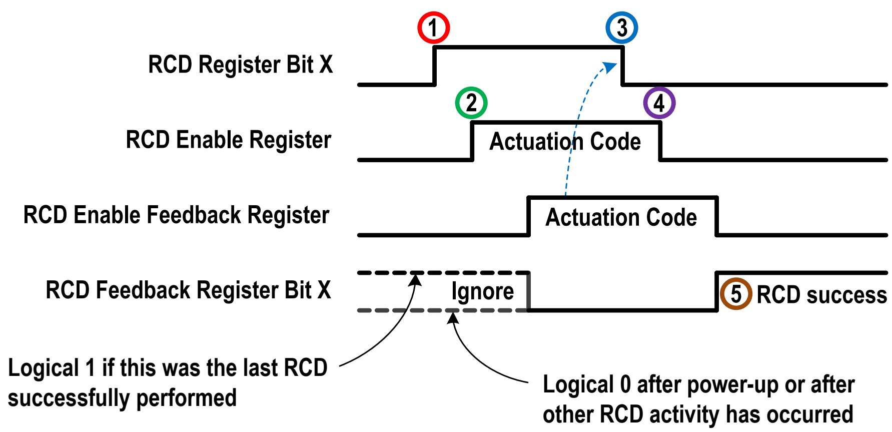
Figure 24. Example Checklist Warning



The HMI/PLC programmer can choose from two different methods, depending on their preferences; a feedback-based sequence or a timed sequence. These methods are described in the following figures. The actual register location depends upon which protocol is being used.

Virtual Reset or Cancel Delay (RCD) Sequence—Feedback Method

Figure 25. Virtual Reset or Cancel Delay (RCD) Sequence—Feedback Method

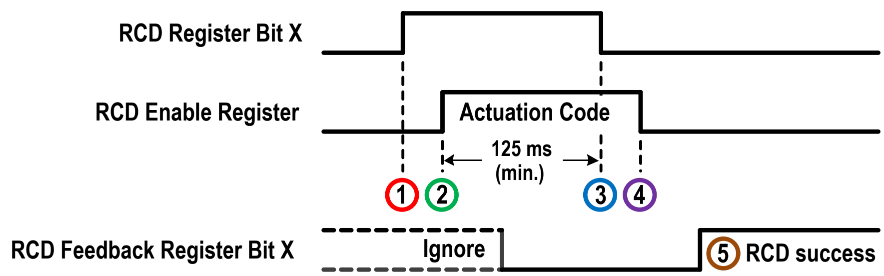


1. Write a logical 1 to the RCD Register Bit(s) corresponding to the desired Virtual Reset or Cancel Delay.
2. At the same time, or any time later, write the Actuation Code to the RCD Enable Register.
3. Monitor the RCD Enable Feedback Register for the Actuation Code to appear (125 ms typical). Then write a logical 0 to the RCD Register Bit.
4. At the same time, or any time later, clear the Actuation Code (write a logical 0 to the RCD Enable Register). This step must be completed within 2 seconds of when the code was first written (step 2).
5. If desired, monitor the RCD Feedback Register to know if the desired Reset or Cancel Delay was accepted (175 ms typical).

Note: The various needed register Bits can be found on the **Industrial Ethernet** tab of the Software by changing the Virtual Status Output selection to Virtual Non-Safety Inputs. The Actuation Code is created by the user under the Network Settings icon on the Tool bar.

Virtual Reset or Cancel Delay (RCD) Sequence—Timed Method

Figure 26. Virtual Reset or Cancel Delay (RCD) Sequence—Timed Method



1. Write a logical 1 to the RCD Register Bit(s) corresponding to the desired Virtual Reset or Cancel Delay.
2. At the same time, or any time later, write the Actuation Code to the RCD Enable Register.
3. At least 125 ms after step 2, write a logical 0 to the RCD Register Bit.
4. At the same time, or any time later, clear the Actuation Code (write a logical 0 to the RCD Enable Register). This step must be completed within 2 seconds from when the code was first written (step 2).
5. If desired, monitor the RCD Feedback Register to know if the desired Reset or Cancel Delay was accepted (175 ms typical).

Virtual Manual Reset Devices are used to create a reset signal for an output or function block configured for a manual reset, requiring an operator action for the output of that block to turn on. Resets can also be created using physical reset input; see Non-Safety Input Devices on p. 54.

WARNING: Virtual Manual Reset—Any Virtual Manual Reset configured to perform a Manual Power Up function in conjunction with equipment in several locations on the same network should be avoided unless all hazardous areas can be verified safe.

Virtual Cancel OFF-Delay Devices: provide the option to cancel a configured OFF-delay or One Shot time. It functions in one of the following ways:

- Keeps the safety output or delay block output ON
- Turns the safety output, delay block output, or one shot block output OFF immediately after the Safety Controller receives a Cancel OFF-Delay signal
- When **Cancel Type** is set to "Control Input", the safety output or delay block output stays on if the input turns ON again before the end of the delay

A status output function (Output Delay in Progress) indicates when a Cancel Delay Input can be activated to keep the OFF-delayed safety output ON. A cancel OFF-delay device can also be created using a physical input; see Non-Safety Input Devices on p. 54.

Virtual Cancel OFF-Delay Timing

Figure 27. Safety Input remains in Stop mode

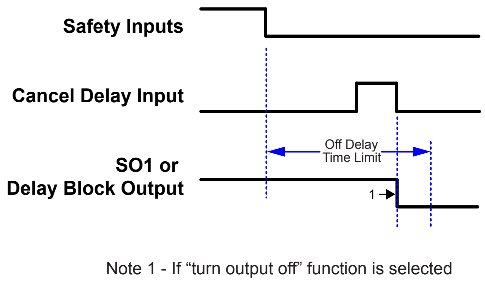


Figure 28. Turn Output OFF function

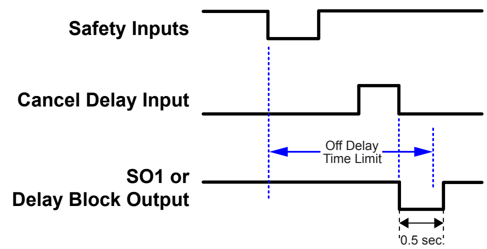


Figure 29. Keep Output ON function for Safety Inputs with the Latch Reset

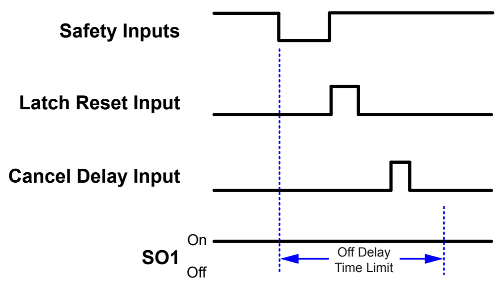
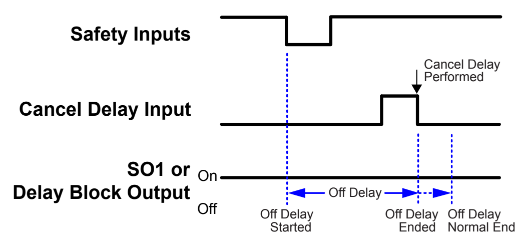


Figure 30. Keep Output ON function for Safety Inputs without the Latch Reset



7.7.2 Virtual ON/OFF and Mute Enable

Virtual ON/OFF

Provides an ON or OFF command to the machine. When all of the controlling safety inputs are in the Run state, this function permits the safety output to turn ON and OFF. The Run state is a logical 1 and the Stop state is a logical 0. A virtual ON/OFF input can be added without mapping to a safety output, allowing it to control a non-safety status output. An ON/OFF switch can also be created using a physical input; see Non-Safety Input Devices on p. 54.

PACSafe 262 : The virtual ON/OFF inputs are used to select the mode of the Press Control Mode Function Block. Three separate inputs are required to satisfy this block. The block does accept ON/OFF inputs.

Virtual Mute Enable

Signals the Safety Controller when the mute sensors are permitted to perform a mute function. When the mute enable function is configured, the mute sensors are not enabled to perform a mute function until the mute enable signal is in the Run state. The enable (Run) state is a logical 1 and the disable (Stop) state is a logical 0. A mute enable switch can also be created using a physical input; see Non-Safety Input Devices on p. 54.

7.8 Safety Outputs

PACSafe 262

The Base Controller has two pairs of solid-state safety outputs (terminals SO1a and b, and SO2a and b). These outputs provide up to 500 mA each at 24 V DC. Each redundant Solid-State Safety Output can be configured to function individually or in pairs, for example, split SO1a independent of SO1b, or SO1 as a dual-channel output.

Additional safety outputs can be added to expandable models of the Base Controller by incorporating I/O modules. These additional safety outputs can be isolated relay outputs that can be used to control/switch a wide range of power characteristics (see PACSafe 262 Specifications on p. 19).

PACSafe 102

The PACSafe 102 has two isolated redundant relay outputs. Each relay output has three independent sets of contacts. See PACSafe 102 Specifications on p. 22 for rating and derating considerations.

PACSafe 262 and PACSafe 102

WARNING:

- **Connect the safety outputs properly**
- Failure to follow these instructions could result in serious injury or death.
- Safety outputs must be connected to the machine control so that the machine's safety-related control system interrupts the circuit to the machine primary control element(s), resulting in a non-hazardous condition.
- Do not wire an intermediate device(s), such as a PLC, PES, or PC, that can fail in such a manner that there is the loss of the safety stop command, or that the safety function can be suspended, overridden, or defeated, unless accomplished with the same or greater degree of safety.

The following list describes additional nodes and attributes that can be configured from the Safety Output function block **Properties** window (see Adding Inputs and Status Outputs on p. 81):

EDM (External Device Monitoring)

Enables the Safety Controller to monitor devices under control (FSDs and MPCEs) for proper response to the stopping command of the safety outputs. **It is strongly recommended to incorporate EDM (or AVM)** in the machine design and the Safety Controller configuration to ensure the proper level of safety circuit integrity (see EDM and FSD Wiring on p. 69).

AVM (Adjustable Valve Monitoring)

Enables the Safety Controller to monitor valves or other devices that may become slow, stick, or fail in an energized state or position and whose operation needs to be verified after a Stop signal occurs. Up to three AVM inputs can be selected if EDM is not used. **It is strongly recommended to incorporate AVM (or EDM)** in the machine design and the Safety Controller configuration to ensure the proper level of safety circuit integrity (see Adjustable Valve Monitoring (AVM) Function on p. 49).

LR (Latch Reset)

Keeps the SO or RO output OFF until the input changes to the Run state and a manual reset operation is performed. See Manual Reset Input on p. 56 for more information.

RE (Reset Enable)

This option appears only if **LR (Latch Reset)** is enabled. The **Latch Reset** can be controlled by selecting **Reset Enable** to restrict when the safety output can be reset to a Run condition.

FR (Fault Reset)

Provides a manual reset function when input faults occur. The FR node needs to be connected to a Manual Reset button or signal. This function is used to keep the SO or RO output OFF until the Input device fault is cleared, the faulted device is in the Run state , and a manual reset operation is performed. This replaces power down/up cycle reset operation. See Manual Reset Input on p. 56 for more information.

Power-up mode

The safety output can be configured for three power-up scenarios (operational characteristics when power is applied):

- Normal Power-Up Mode (default)
- Manual Power-up Mode
- Automatic Power-Up Mode

See Manual Reset Input on p. 56 for more information.

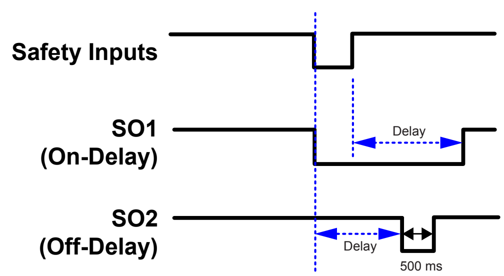
Split (Safety Outputs)—PACSafe 262 only

This option is only available for solid-state safety outputs. Each redundant solid-state safety output can be configured to function individually or in pairs (default). Splitting a solid-state safety output creates two independent single-channel outputs (control of SO1a is independent of SO1b). To combine a split safety output, open the Mx:SOxA **Properties** window and click **Join.**

ON-Delays and OFF-Delays

Each safety output can be configured to function with either an ON-delay or an OFF-delay (see Figure 31 on p. 63), where the output turns ON or OFF only after the time limit has elapsed. An output cannot have both ON- and OFF-delays. The ON- and OFF-delay time limit options range from 100 milliseconds to 5 minutes, in 1 millisecond increments.

Figure 31. Timing Diagram—General Safety Output ON-Delay and OFF-Delay



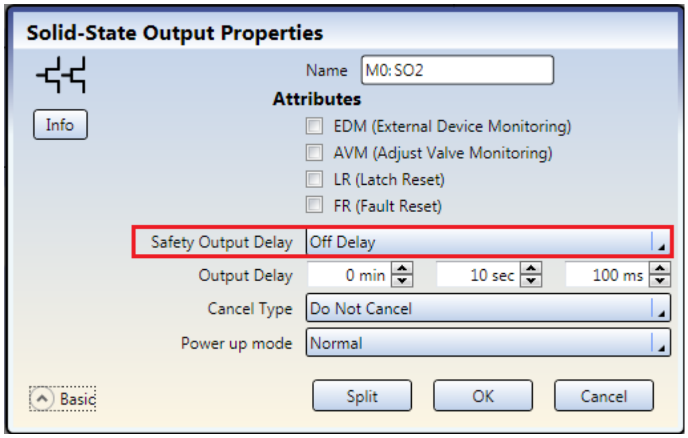
WARNING:

- **With a power interruption or loss, an OFF-delay time can end immediately.**
- Failure to follow these instructions could result in serious injury or death.
- The safety output OFF-delay time is honored even if the safety input that caused the OFF-delay timer to start switches back to the Run state before the delay time expires. If such an immediate machine stop condition could cause a potential danger, taken additional safeguarding measures to prevent injuries.

Two safety outputs can be linked together when one of the safety outputs is configured for an OFF-delay, and the other does not have a delay. After it is linked, the non-delayed output does not immediately turn back on if the controlling input turns on during the OFF-delay as shown in Figure 34 on p. 65. To link two safety outputs:

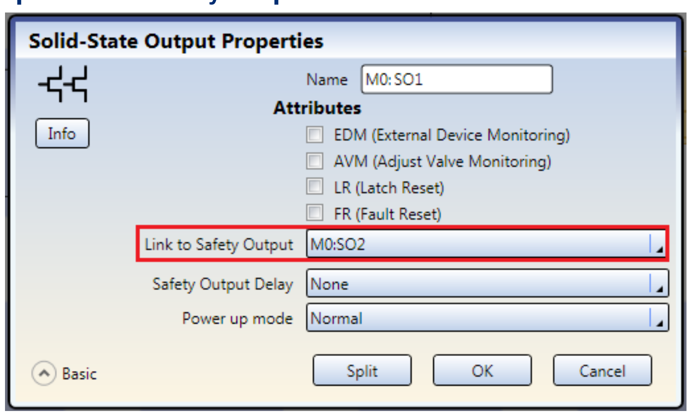
1. Open the **Properties** window of the safety output that needs to have an OFF-delay.
2. Select **OFF-Delay** from the *Safety Output Delay* drop-down list.

Figure 32. Example Safety Output Delay Selection: OFF-Delay



3. Set the desired Output Delay time.
4. Click **OK**.
5. Open the **Properties** window of the safety output that will link to the safety output with an OFF-Delay.
6. From *Link to Safety Output* drop-down list, select the safety output with an OFF-Delay to which you wish to link this safety output.

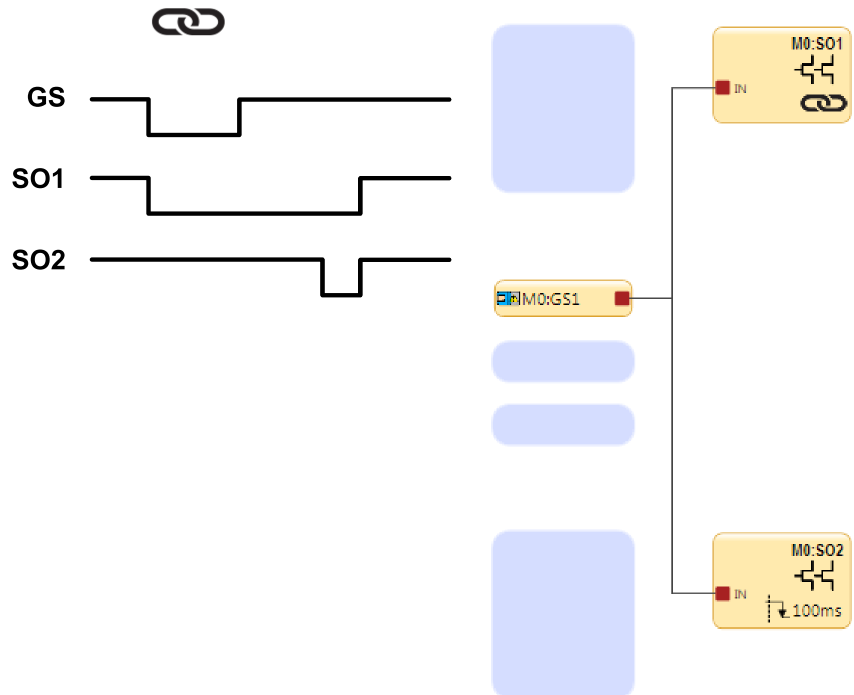
Figure 33. Example Link to Safety Output Selection



Note: The same input(s) need to be connected to both safety outputs for outputs to show up as available for linking.

7. Click **OK**. The linked safety output will have a link icon indicator.

Figure 34. Timing Diagram—Linked Safety Outputs



7.8.1 PACSafe 262 Solid-State Safety Outputs

The solid-state Safety Outputs, for example, SO1a and b, and SO2a and b, are actively monitored to detect short circuits to the supply voltage, to each other, and to other voltage sources and are designed for Category 4 safety applications. If a failure is detected on one channel of a safety output pair, both outputs attempt to turn Off and will enter a lockout state. The output without the fault is able to turn off the hazardous motion.

Similarly, a Safety Output that is used individually (split), is also actively monitored to detect short circuits to other power sources, but is unable to perform any actions. Take extreme care in the wiring of the terminals and in the routing of the wires to avoid the possibility of shorts to other voltage sources, including other Safety Outputs. Each split Safety Output is sufficient for Category 3 applications due to an internal series connection of two switching devices, but an external short must be prevented.

Important: When Solid-State Safety Output modules (IC225SDL720 or IC225SDL740) are used, the power to those modules must be applied either prior to or within 5 seconds after applying the power to the Base Controller, if using separate power supplies.

WARNING:

- Single-Channel (Split) Outputs use in Safety Critical Applications
- Failure to incorporate proper fault exclusion methods when using single-channel outputs in safety critical applications may cause a loss of safety control and result in a serious injury or death.
- If a single-channel output is used in a safety critical application then fault exclusion principles must be incorporated to ensure Category 3 safety operation. Routing and managing single-channel output wires so shorts to other outputs or other voltage sources are not possible is an example of a proper fault exclusion method.

Whenever possible, incorporating External Device Monitoring (EDM) and/or Adjustable Valve Monitoring (AVM) is highly recommended to monitor devices under control (FSDs and MPCEs) for unsafe failures. See External Device Monitoring (EDM) on p. 69 for more information.

Output Connections

The Safety Outputs must be connected to the machine control such that the machine's safety-related control system interrupts the circuit or power to the machine primary control element(s) (MPCE), resulting in a non-hazardous condition.

When used, Final Switching Devices (FSDs) typically accomplish this when the safety outputs go to the Off state. Refer to the PACSafe 262 Specifications on p. 19 before making connections and interfacing the Safety Controller to the machine.

The level of the safety circuit integrity must be determined by risk assessment; this level is dependent on the configuration, proper installation of external circuitry, and the type and installation of the devices under control (FSDs and MPCEs). The solid-state safety outputs are suitable for Category 4 PL e / SIL 3 applications when controlled in pairs (not split) and for applications up to Category 3 PL d / SIL 2 when acting independently (split) when appropriate fault exclusion has been employed. See Figure 35 on p. 66 for hookup examples.

WARNING:

- Safety Output Lead Resistance
- A resistance higher than 10 ohms could mask a short between the dual-channel safety outputs and could create an unsafe condition that could result in serious injury or death.
- Do not exceed 10 ohms resistance in the safety output wires.

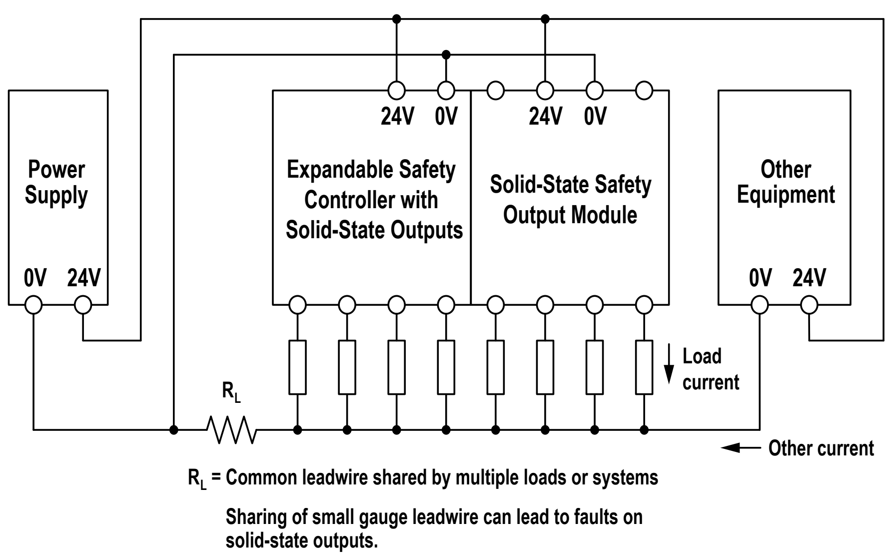
Common Wire Installation

Consider the wire resistance of the 0 V common wire and the currents flowing in that wire to avoid nuisance lockouts. Notice the location of the resistance symbol in the diagram below, representing 0 V common wire resistance (RL).

Methods to prevent this situation include:

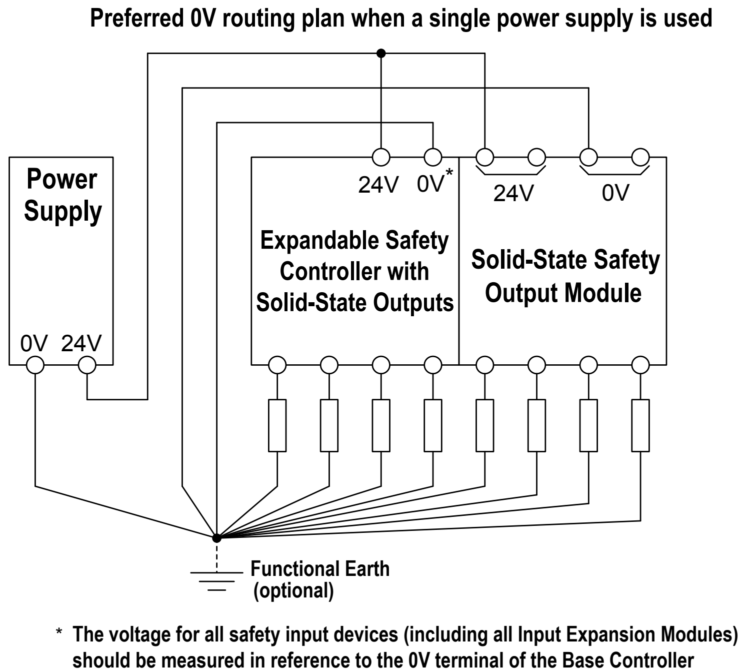
- Using larger gauge or shorter wires to reduce the resistance (R_L) of the 0 V common wire
- Separate the 0 V common wire from the loads connected to the Safety Controller and the 0 V common wire from other equipment powered by the common 24 V supply

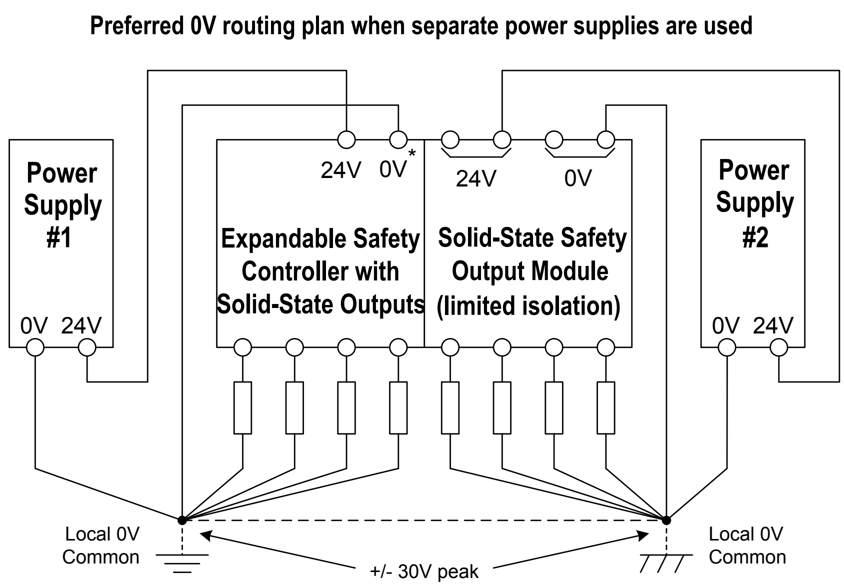
Figure 35. Common Wire Installation



Note: When the Safety Output turns Off, the voltage at that output terminal must drop below 1.7 V with respect to the 0 V terminal on that module. If the voltage is higher than 1.7 V, the Safety Controller will decide that the output is still on, resulting in a lockout. Consider using larger gauge wires, shorter wires, or using a single point grounding scheme similar to what is shown in the following diagrams.

Figure 36. Wiring Diagram—Recommended Grounding





7.8.2 Safety Relay Outputs

PACSafe 262 Expansion Safety Relay modules and the PACSafe 102 have isolated redundant relay outputs that can be used to control/switch a wide range of power characteristics (see PACSafe 262

Specifications on p. 19 and PACSafe 102 Specifications on p. 22). Unlike a solid-state Safety Output, within an output module an individual safety relay output (Mx:ROx) functions as a group and cannot be split.

The Safety Relay Outputs are controlled and monitored by the PACSafe 262 Base Controller or the PACSafe 102 without requiring additional wiring.

For circuits requiring the highest levels of safety and reliability, when used in pairs (two normally open), either Safety Output must be capable of stopping the motion of the guarded machine in an emergency. When used individually (a single normally open output), fault exclusion must ensure that failures cannot occur that would result in the loss of the safety function, for example, a short-circuit to another safety output or a secondary source of energy or voltage. For more information, see *Single-channel Control* in Safety (Protective) Stop Circuits on p. 72 and Fault Exclusion on p. 33.

Whenever possible, incorporating External Device Monitoring (EDM) and/or Adjustable Valve Monitoring (AVM) is highly recommended to monitor devices under control (FSDs and MPCEs) for unsafe failures. See External Device Monitoring (EDM) on p. 69 for more information.

Output Connections—The Safety Relay Outputs must be connected to the machine control such that the machine's safety-related control system interrupts the circuit or power to the machine primary control element(s) (MPCE), resulting in a non-hazardous condition. When used, Final Switching Devices (FSDs) typically accomplish this when the safety outputs go to the OFF state.

The Safety Relay Outputs can be used as the Final Switching Device (FSD) and can be interfaced in either a dual-channel or single-channel safety (protective) stop circuit (see FSD Interfacing Connections on p. 71). Refer to PACSafe 262 Specifications on p. 19 and PACSafe 102 Specifications on p. 22 before making connections and interfacing the Safety Controller to the machine.

The level of the safety circuit integrity must be determined by risk assessment; this level is dependent on the configuration, proper installation of external circuitry, and the type and installation of the devices under control (FSDs and MPCEs). The safety relay outputs are suitable for Category 4 PL e / SIL 3. See Figure 35 on p. 66 for wiring examples.

Important: The user is responsible for supplying overcurrent protection for all relay outputs.

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

The PACSafe 262 and PACSafe 102 are rated for Overvoltage Category III when voltages of 1 V to 150 V AC/DC are applied to the output relay contacts. They are 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 PACSafe 262 or PACSafe 102 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 PACSafe 262 or PACSafe 102 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 PACSafe 262 or PACSafe 102 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 PACSafe 262 or PACSafe 102 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 PACSafe 262 or PACSafe 102 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 PACSafe 262 or PACSafe 102 output contacts (see the warning on arc suppressors in Generic PACSafe 262 Hookup: Safety Output with EDM on p. 74 and Generic PACSafe 102 Hookup: Safety Output with EDM on p. 76).

7.8.3 EDM and FSD Wiring

External Device Monitoring (EDM)

The Safety Controller's safety outputs can control external relays, contactors, or other devices that have a set of normally closed (NC), force-guided (mechanically linked) contacts that can be used for monitoring the state of the machine power contacts. The monitoring contacts are normally closed (NC) when the device is turned OFF. This capability allows the Safety Controller to detect if the devices under load are responding to the safety output, or if the normally open (NO) contacts are possibly welded closed or stuck ON.

Note: The relays internal to the IC225SDL910, IC225SDL920 and the PACSafe 102 are always monitored by the modules. EDM is only needed for devices that are external to the controllers.

The EDM function provides a method to monitor these types of faults and to ensure the functional integrity of a dual-channel system, including the MPCEs and the FSDs.

A single EDM input can be mapped to one or multiple Safety Outputs. This is accomplished by opening the Safety Output **Properties** window and checking **EDM**, then adding **External Device Monitoring** from the **Safety Input** tab in the **Add Equipment** window (accessed from the **Equipment** tab or **Functional View** tab), and connecting the **External Device Monitoring** input to the **EDM** node of the Safety Output.

The EDM inputs can be configured as one-channel or two-channel monitoring. One-channel EDM inputs are used when the OSSD outputs directly control the de-energizing of the MPCEs or external devices.

One-Channel Monitoring

A series connection of closed monitor contacts that are forced-guided (mechanically linked) from each device controlled by the Safety Controller. The monitor contacts must be closed before the Safety Controller outputs can be reset (either manual or automatic). After a reset is executed and the safety outputs turn ON, the status of the monitor contacts are no longer monitored and may change state. However, the monitor contacts must be closed within 250 milliseconds of the safety outputs changing from ON to OFF. See Figure 39 on p. 71.

Two-Channel Monitoring

An independent connection of closed monitor contacts that are forced-guided (mechanically linked) from each device controlled by the Safety Controller. Both EDM inputs must be closed before the Safety Controller can be reset and the OSSDs can turn ON. While the OSSDs are ON, the inputs may change state (either both open, or both closed). A lockout occurs if the inputs remain in opposite states for more than 250 milliseconds. See Figure 41 on p. 71.

No Monitoring (default)

If no monitoring is desired, do not enable the Safety Output EDM node. If the Safety Controller does not use the EDM function in Category 3 or Category 4 applications, the user must make sure that any single failure or accumulation of failures of the external devices does not result in a hazardous condition and that a successive machine cycle is prevented.

WARNING:

- External Device Monitoring (EDM)
- Creating a hazardous situation could result in serious injury or death.
- If the system is configured for “no monitoring,” it is the user’s responsibility to ensure this does not create a hazardous situation.

CAUTION:

- Use Machine Primary Control Element (MPCE) monitoring contacts to maintain control reliability.
- Failure to follow these instructions could result in serious injury or death.
- Wire at least one normally closed, forced-guided monitoring contact of each MPCE or external device to monitor the state of the MPCEs (as shown). If this is done, proper operation of the MPCEs will be verified.

Figure 37. One-channel EDM Wiring

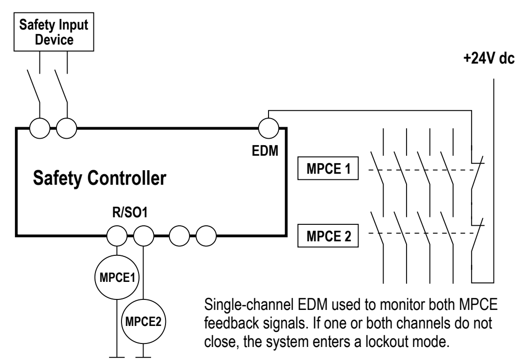


Figure 38. Two-channel EDM Wiring

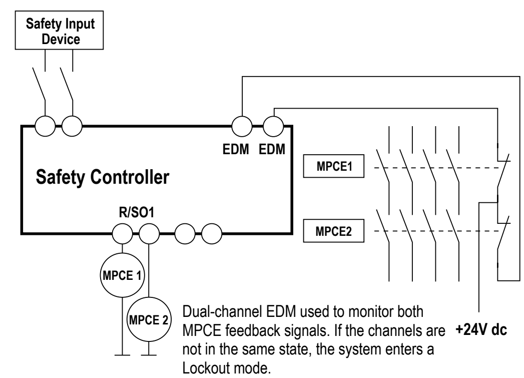
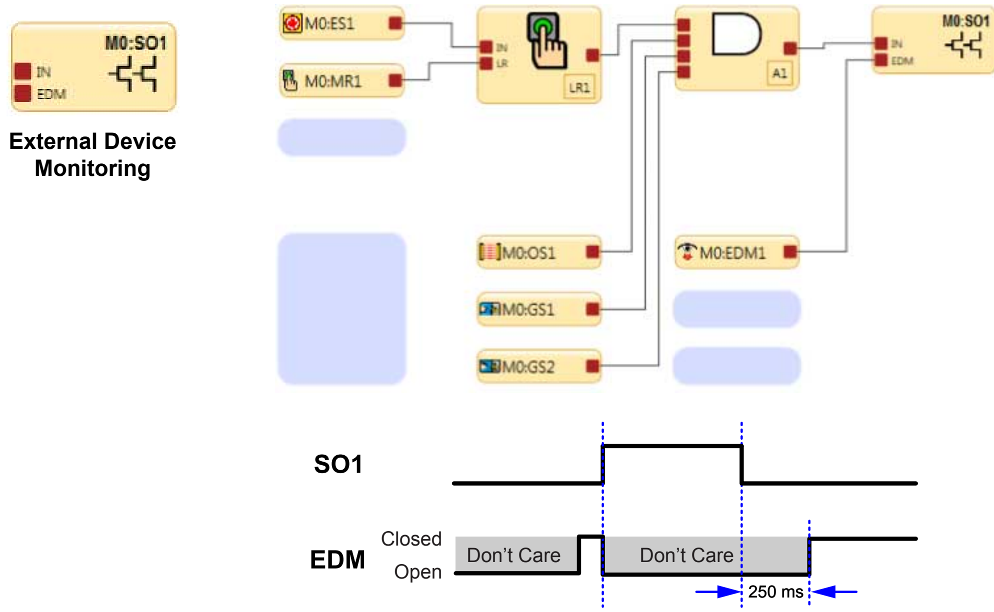


Figure 39. Timing logic: One-channel EDM status, with respect to Safety Output



External Device Monitoring EDM is a way to check the operation of dual-channel final switching devices or machine primary control elements. The force guided NC monitoring contacts of the FSD or MPCE are used as an input to detect a "stuck on" fault condition and will prevent the safety controller outputs from turning ON.

For two-channel EDM, as shown below, both channels must be closed before the Safety Output(s) turn ON.

Figure 40. Timing logic: Two-channel EDM, timing between channels

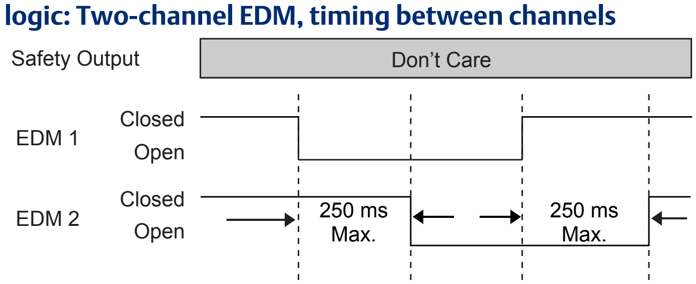
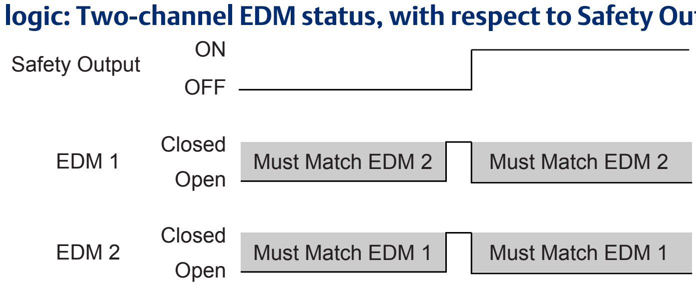


Figure 41. Timing logic: Two-channel EDM status, with respect to Safety Output



FSD Interfacing Connections

Final switching devices (FSDs) interrupt the power in the circuit to the Machine Primary Control Element (MPCE) when the Safety Outputs go to the Off-state. FSDs can take many forms, though the most common are forced-guided (mechanically linked) relays or Interfacing Modules. The mechanical linkage between the contacts allows the device to be monitored by the external device monitoring circuit for certain failures.

Depending on the application, the use of FSDs can facilitate controlling voltage and current that differs from the Safety Outputs of the Safety Controller. FSDs may also be used to control an additional number of hazards by creating multiple safety stop circuits.

Safety (Protective) Stop Circuits

A safety stop allows for an orderly cessation of motion or hazardous situation for safeguarding purposes, which results in a stop of motion and removal of power from the MPCEs (assuming this does not create additional hazards). A safety stop circuit typically comprises a minimum of two normally open (NO) contacts from forced-guided (mechanically linked) relays, which are monitored (via a mechanically linked normally closed (NC) contact) to detect certain failures so that the loss of the safety function does not occur. Such a circuit can be described as a "safe switching point."

Typically, safety stop circuits are a series connection of at least two NO contacts coming from two separate, positive-guided relays, each controlled by one separate safety output of the Safety Controller. The safety function relies on the use of redundant contacts to control a single hazard, so that if one contact fails ON, the second contact stops the hazard and prevents the next cycle from occurring.

Interfacing safety stop circuits must be wired so that the safety function cannot be suspended, overridden, or defeated, unless accomplished in a manner at the same or greater degree of safety as the machine's safety-related control system that includes the Safety Controller.

The NO outputs from an interfacing module are a series connection of redundant contacts that form safety stop circuits and can be used in either single-channel or dual-channel control methods.

Dual-Channel Control—Dual-channel (or two-channel) control has the ability to electrically extend the safe switching point beyond the FSD contacts. With proper monitoring, such as EDM, this method of interfacing is capable of detecting certain failures in the control wiring between the safety stop circuit and the MPCEs. These failures include a short-circuit of one channel to a secondary source of energy or voltage, or the loss of the switching action of one of the FSD outputs, which may lead to the loss of redundancy or a complete loss of safety if not detected and corrected.

The possibility of a wiring failure increases as:

- As the physical distance between the FSD safety stop circuits and the MPCEs increase
- As the length or the routing of the interconnecting wires increases
- If the FSD safety stop circuits and the MPCEs are located in different enclosures

Thus, dual-channel control with EDM monitoring should be used in any installation where the FSDs are located remotely from the MPCEs.

Single-Channel Control—Single-channel (or one-channel) control uses a series connection of FSD contacts to form a safe switching point. After this point in the machine's safety-related control system, failures that would result in the loss of the safety function can occur, for example, a short-circuit to a secondary source of energy or voltage.

Thus, this method of interfacing should be used only in installations where FSD safety stop circuits and the MPCEs are physically located within the same control panel, adjacent to each other, and are directly connected to each other; or where the possibility of such a failure can be excluded. If this cannot be achieved, then two-channel control should be used.

Methods to exclude 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
- Routing interconnecting control wires with low voltage or neutral that cannot result in energizing the hazard
- Locating all elements (modules, switches, devices under control, etc.) within the same control panel, adjacent to each other, and directly connected with short wires
- Properly installing multi-conductor cabling and multiple wires that pass through strain-relief fittings. Over-tightening of a strain-relief can cause short circuits at that point

- Using positive-opening or direct-drive components installed and mounted in a positive mode

WARNING:

- **Properly install arc or transient suppressors**
- Failure to follow these instructions could result in serious injury or death.
- Install any suppressors as shown across the coils of the FSDs or MPCEs. Do not install suppressors directly across the contacts of the FSDs or MPCEs. In such a configuration, it is possible for suppressors to fail as a short circuit.

WARNING:

- **Safety Output Interfacing** — To ensure proper operation, the Emerson product output parameters and machine input parameters must be considered when interfacing the solid-state safety outputs to the machine inputs.
- **Failure to properly interface the safety outputs to the guarded machine may result in serious bodily injury or death.**
- Machine control circuitry must be designed so that:

  The maximum cable resistance value between the Safety Controller solid-state safety outputs and the machine inputs is not exceeded.

  The Safety Controller's solid-state safety output maximum OFF state voltage does not result in an ON condition.

  The Safety Controller's solid-state safety output maximum leakage current, due to the loss of 0 V, does not result in an ON condition.

WARNING:

- **Risk of electric shock**
- Use extreme caution to avoid electrical shock. Serious injury or death could result.
- Always disconnect power from the safety system (for example, device, module, interfacing, etc.), guarded machine, and/or the machine being controlled before making any connections or replacing any component. Lockout/tagout procedures might be required. Refer to OSHA 29CFR1910.147, ANSI Z244-1, 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 [6] 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.

WARNING:

- **Properly Wire the Device**
- Failure to properly wire the Safety Controller to any particular machine could result in a dangerous condition that could result in serious injury or death.
- The user is responsible for properly wiring the Safety Controller. The generalized wiring configurations are provided only to illustrate the importance of proper installation.

[6] 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.

Generic PACSafe 262 Hookup: Safety Output with EDM

Figure 42. Generic PACSafe 262 Hookup: Solid-State Safety Output with EDM

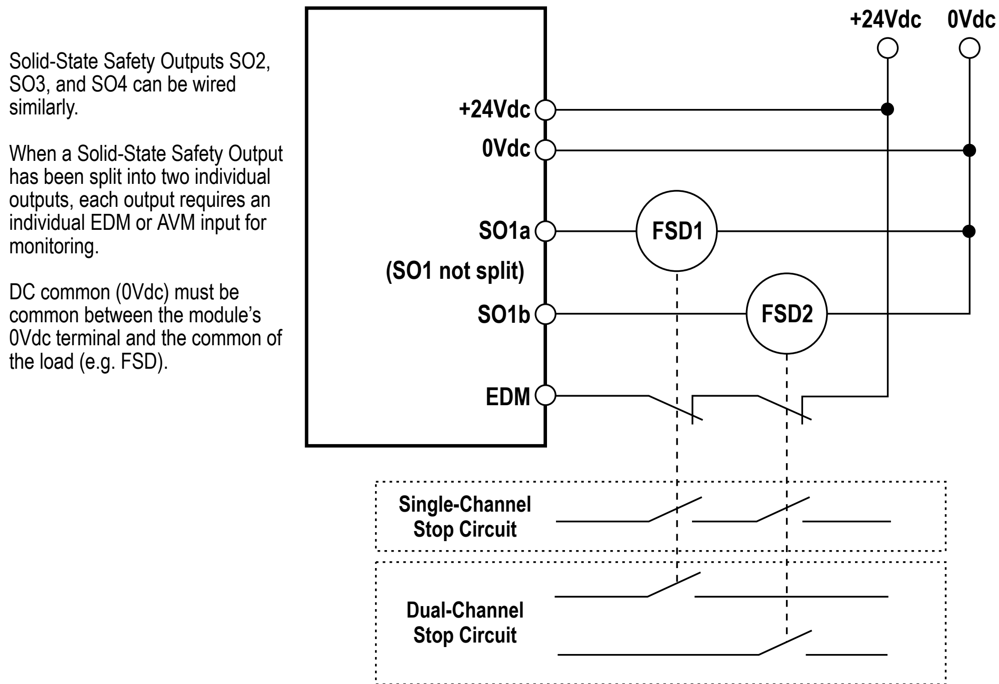
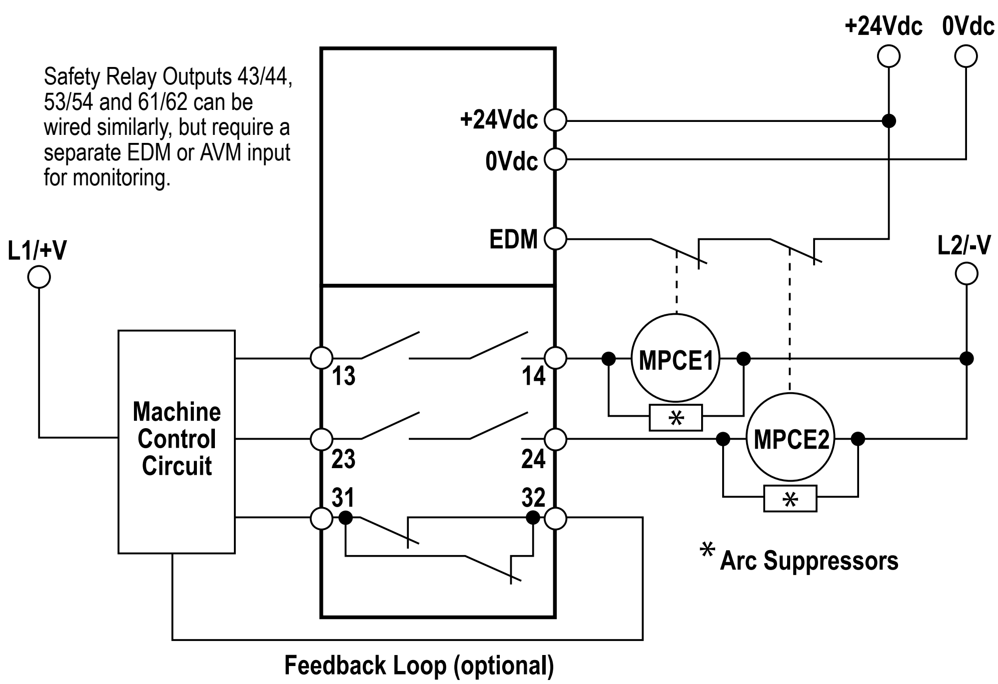


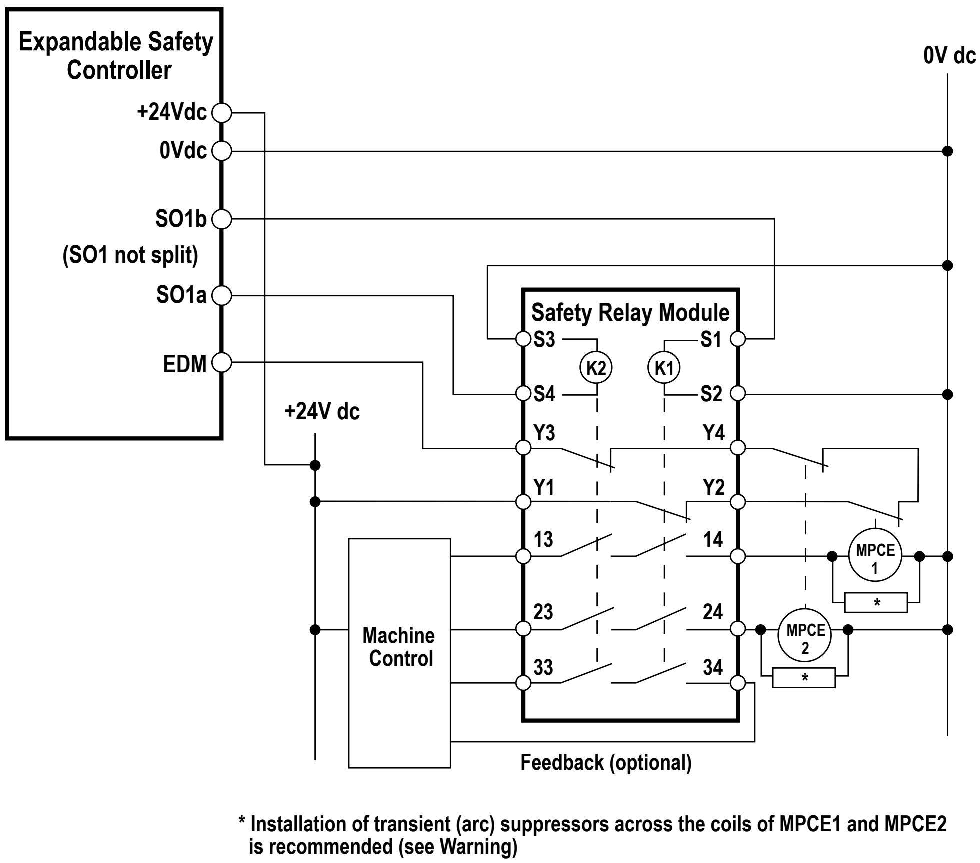
Figure 43. Generic PACSafe 262 Hookup: Safety Relay Output (Dual-Channel) with EDM



* Installation of transient (arc) suppressors across the coils of MPCE1 and MPCE2 is recommended (see Warning)

WARNING:
- Properly install arc or transient suppressors
- Failure to follow these instructions could result in serious injury or death.
- Install any suppressors as shown across the coils of the machine 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.

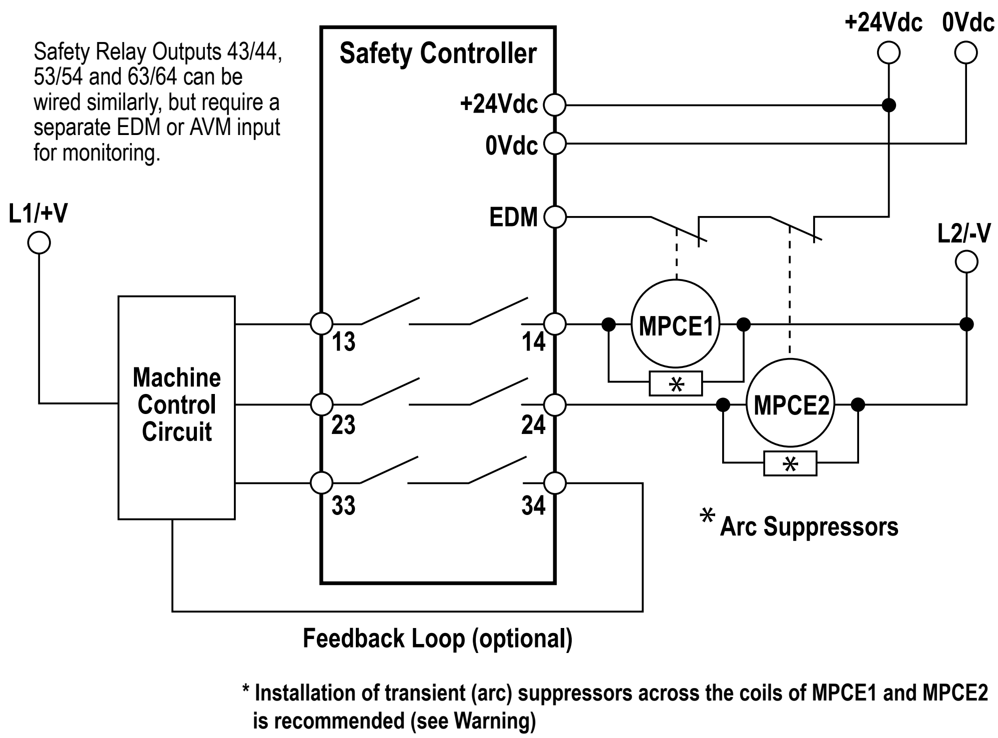
Figure 44. Generic PACSafe 262 Hookup: Solid-State Safety Output to Safety Relay Module



WARNING:
- Properly install arc or transient suppressors
- Failure to follow these instructions could result in serious injury or death.
- Install any suppressors as shown across the coils of the machine 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.

Generic PACSafe 102 Hookup: Safety Output with EDM

Figure 45. Generic PACSafe 102 Hookup: Safety Relay Output (Dual-Channel) with EDM



WARNING:

- Properly install arc or transient suppressors
- Failure to follow these instructions could result in serious injury or death.
- Install any suppressors as shown across the coils of the machine 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.

7.9 Status Outputs

For instructions on how to add a status output, see Adding Status Outputs on p. 84.

A status output can be used to send a non-safety signal to devices such as lights or programmable logic controllers (PLCs) to signify the state of an input, safety output, or logic block or function block. For example, a Track Input status output is used to signify the state (ON or OFF) of the selected input (to the light or the PLC).

7.9.1 Status Output Signal Conventions

Note: You cannot use the safety outputs as status outputs in the PACSafe 102.

There are two signal conventions selectable for each status output: "PNP ON" (sourcing 24 V DC), or "PNP OFF" (non-conducting). The default convention is Active = PNP ON.

A flashing rate can also be configured for a status output in the ON state. The three options are:

- None (for ON solid)

- Normal (cycling 500 ms ON and 500 ms OFF)
- Fast (cycling 150 ms ON and 150 ms OFF)

The default flashing rate is none. Configuring a flash rate is not possible for a Mute status output (see Mute in Status Output Functionality on p. 77).

Table 4: Status Output Signal Conventions

Function	Signal Conventions			
	Active = PNP ON		Active = PNP OFF	
	Status Output State		Status Output State	
	+24 V DC	OFF	OFF	24 V DC
Bypass	Bypassed	Not Bypassed	Bypassed	Not Bypassed
Mute	Muted	Not Muted	Muted	Not Muted
Output Delay In Progress	Delay	No Delay	Delay	No Delay
Track Input	Run	Stop	Run	Stop
Track Input Fault	Fault	Ok	Fault	Ok
Track Any Input Fault	Fault	Ok	Fault	Ok
Track Input Group	Initiated Stop	Other Input Caused Stop	Initiated Stop	Other Input Caused Stop
Track Output	SO ON	SO OFF	SO ON	SO OFF
Track Output Fault	Fault	Ok	Fault	Ok
Track Output Fault All	Fault	Ok	Fault	Ok
Track Output Logical State	Logically ON	Logically OFF	Logically ON	Logically OFF
Track Function Block State (PACSafe 102)	Run	Stop	Run	Stop
Track Press Function Block (PACSafe 262)	See PACSafe 262: Press Control Status Output Functionality on p. 78 for details.			
Waiting for Manual Reset	Reset Needed	Not Satisfied	Reset Needed	Not Satisfied
System Lockout	Lockout	Run Mode	Lockout	Run Mode

7.9.2 Status Output Functionality

PACSafe 102: Up to four convertible inputs may be used as Status Outputs.

PACSafe 262: Up to 32 convertible inputs or safety outputs may be used as status outputs. Solid-state safety outputs may be split and used as status outputs. Relay safety outputs cannot be used as status outputs and cannot be split.

Status outputs can be configured to perform the following functions:

Bypass

Indicates when the input to the Bypass function block is bypassed.

Mute

Indicates a muting active status for the input to the particular Muting function block:

- ON when a mutable input is muted
- OFF when a mutable input is not muted
- Flashing when the conditions to start a mute-dependent override exist (an inactive muting cycle, the Mutable Safety input is in the stop state, and at least one muting sensor is in the stop (blocked) state); not available for Virtual Status Output

- ON during an active mute-dependent override function (not a bypass function) of a Mutable Safety input

Output Delay In Progress

Indicates when either an ON- or OFF-Delay is active.

Track Input

Indicates the state of a particular safety input.

Track Input Fault

Indicates when a particular safety input has a fault.

Track Any Input Fault

Indicates when any safety input has a fault.

Track Input Group

Indicates the state of a group of safety inputs, for example, which safety input turned off first. Once this function has been indicated, the function may be re-enabled by a configured Reset input. Up to three Input Groups can be tracked.

Track Output

Indicates the physical state of a particular safety output (ON or OFF).

Track Output Fault

Indicates when a particular safety output has a fault.

Track Output Fault All

Indicates a fault from any safety output.

Track Output Logical State

Indicates the logical state of a particular safety output. For example, the logical state is OFF but the safety output is in an OFF-Delay and not physically off yet.

Track Function Block State

Indicates the state of a particular function block.

Track Press Function Block (PACSafe 262)

Indicates the state of a number of Press Function events; see PACSafe 262: Press Control Status Output Functionality on p. 78 for details.

Waiting for Manual Reset

Indicates a particular configured reset is needed.

> **Note:** If the manual reset input is connected to a Reset OR block, this status output cannot be used.

System Lockout

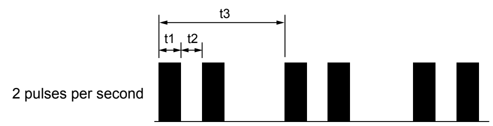
Indicates a non-operating lockout condition, for example unmapped input connected to 24 V.

7.9.3 PACSafe 262: Press Control Status Output Functionality

The Press Control function block has multiple inputs and outputs. This results in a status output function that is not a simple on/off for an individual item. The status output of the Press Control block has seven different events that can be signaled via the status output. The status output of the Press Control block can be configured to provide one, two, or three signals. Each signal from the status output of the Press Control block can be as follows:

- Solid On
- 2 pulses per second

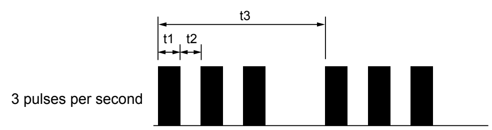
Figure 46. 2 Pulses Per Second



t1 = 100 ms, t2 = 100 ms, and t3 = 1 second

- 3 pulses per second

Figure 47. 3 Pulses Per Second

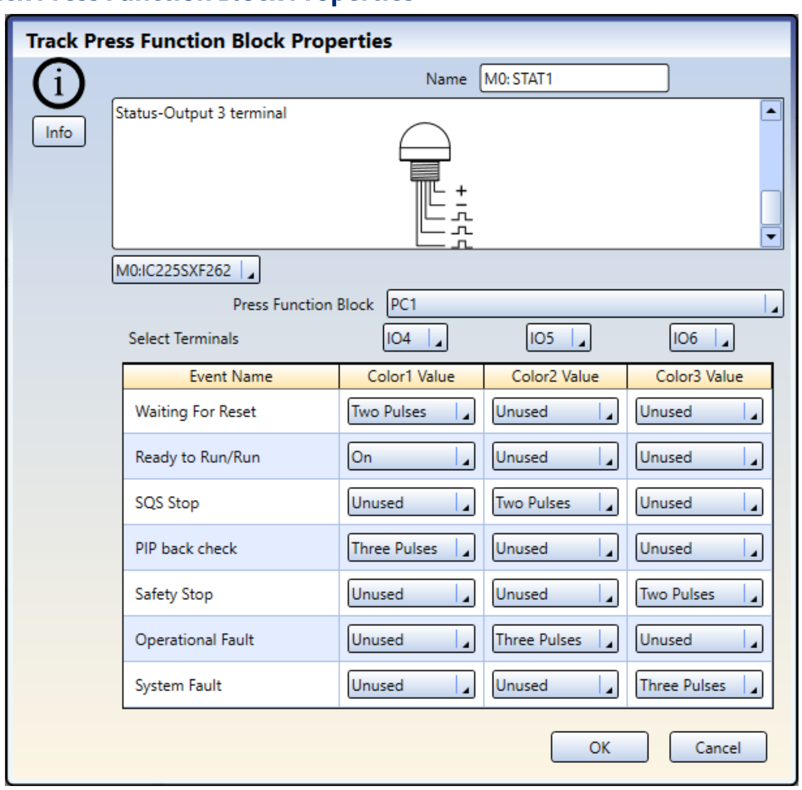


t1 = 100 ms, t2 = 100 ms, and t3 = 1 second

The Press Control block status output is only available as physical status outputs. Each physical status output can be used to signify three different events.

The following figure shows the default settings of the status output of the Press Control function block:

Figure 48. Track Press Function Block Properties



The default setting of the function block configures three of the IO pins as status outputs. If all seven events are not required to be displayed for a given application, use the slide bar on the right of the figure to select fewer pins. Moving the bar up one position reduces the number of terminals to two, moving the bar up two positions reduces the number of terminals to one.

The functionality of each event is as follows:

- **Waiting for Reset**—Turns on when a reset input is needed, after the non-mutable and mutable (if configured) safety stop inputs return to the ON state
- **Ready to Run/Run**—Is on any time the press is ready to run (mutable and non-mutable safety stop inputs are on and reset) or the press is running in the up or down stroke
- **SQS Stop**—Turns on when the press ram reaches the Sequence Stop point
- **PIP back check alert**—Turns on when the press is ready to run and an attempt is made to start a press cycle and the PIP (Part in Place) input, if configured, is off or has not turned off then back on (part not removed and replaced)
- **Safety Stop**—Turns on when either the mutable or non-mutable safety stop input turns off, the GO input node goes low (when configured for Manual Upstroke Setting) before SQS, BOS, or TOS is reached (depending on settings and portion of the process)
- **Operational Fault**—Turns on when mutually exclusive operational inputs are on (for example, TOS and BOS, TOS and SQS, TOS and PCMS, SQS and BOS, etc; if more than 3 seconds elapse between the SQS and PCMS signals both turn on, if configured)
- **System Fault**—Turns on when a system fault exists

7.10 Virtual Status Outputs

Up to 256 Virtual Status Outputs can be added to the Safety Controller. These outputs can communicate the same information as the Status Outputs over the network. See Status Output Functionality on p. 77 for more information. The **Auto Configure** function, located on the **Industrial Ethernet** tab of the Software, automatically configures the Virtual Status Outputs to a set of commonly used functions, based on the current configuration. This function is best used after the configuration has been determined. Virtual Status Output configuration can be manually revised after the **Auto Configure** function has been used. The information available over the network is consistent with the logical state of the inputs and outputs within 100 ms for the Virtual Status Output tables (viewable via the Software) and within 1 second for the other tables. The logical state of inputs and outputs is determined after all internal debounce and testing is complete. See Industrial Ethernet Tab on p. 112 for details on configuring Virtual Status Outputs.

8 Getting Started

Power up the Safety Controller, and verify that the power LED is ON green.

8.1 Creating a Configuration

The following steps are required to complete and confirm (write to controller) the configuration:

1. Define the safeguarding application (risk assessment).
   - Determine the required devices
   - Determine the required level of safety
2. Install the PACSafe Studio software. See Installing the Software on p. 27.
3. Become familiar with the Software options. See Software Overview on p. 101.
4. Start the Software and select the desired device.
5. Start a new project by clicking **New Project/Recent Files**.
6. Define the **Project Settings**. See Project Settings on p. 103.
7. PACSafe 262: Customize the Base Controller and add Expansion Modules (if used). See Equipment Tab on p. 104.
8. Add Safety Input devices, Non-Safety Input devices, and Status Outputs. See Adding Inputs and Status Outputs on p. 81.
9. Design the control logic. See Designing the Control Logic on p. 85.
10. Set optional Safety Output On- or Off-time delays.
11. If used, configure the network settings. See Network Settings: Modbus/TCP on p. 113 or Network Settings: PROFINET on p. 114.
12. Save and confirm the configuration. See Saving and Confirming a Configuration on p. 86.

The following steps are optional and may be used to aid with the system installation:

- Modify the configuration access rights. See PACSafe 262 Password Manager on p. 117 or PACSafe 102 Password Manager on p. 118.
- View the **Configuration Summary** tab for the detailed device information and response times. See Configuration Summary Tab on p. 115.
- Print the configuration views, including the **Configuration Summary** and **Network Settings**. See Print Options on p. 116.
- Test the configuration using Simulation Mode. See Simulation Mode on p. 122.

8.2 Adding Inputs and Status Outputs

Safety and Non-Safety Inputs can be added from either the **Equipment** tab or the **Functional View** tab. Status Outputs can be added from the **Equipment** tab only. Virtual Non-Safety inputs can be added from the **Functional View** tab only. When inputs are added on the **Equipment** tab, they are automatically placed in the **Functional View** tab. All inputs and **Logic** and **Function Blocks** can be moved around on the **Functional View** tab. The **Safety Outputs** are statically positioned on the right side.

8.2.1 Adding Safety and Non-Safety Inputs

1. On the **Equipment** tab, click ✚ below the module which will have the input device connected (the module and terminals can be changed from the input device **Properties** window) or any of the placeholders on the **Functional View** tab.

> **Note:** Virtual Non-Safety Inputs are available only from the **Functional View** tab.

2. Click **Safety Input** or **Non-Safety Input** to add input devices:

Figure 49. PACSafe 262: Adding inputs from the Functional View (Virtual Non-Safety Inputs can only be added from this view)

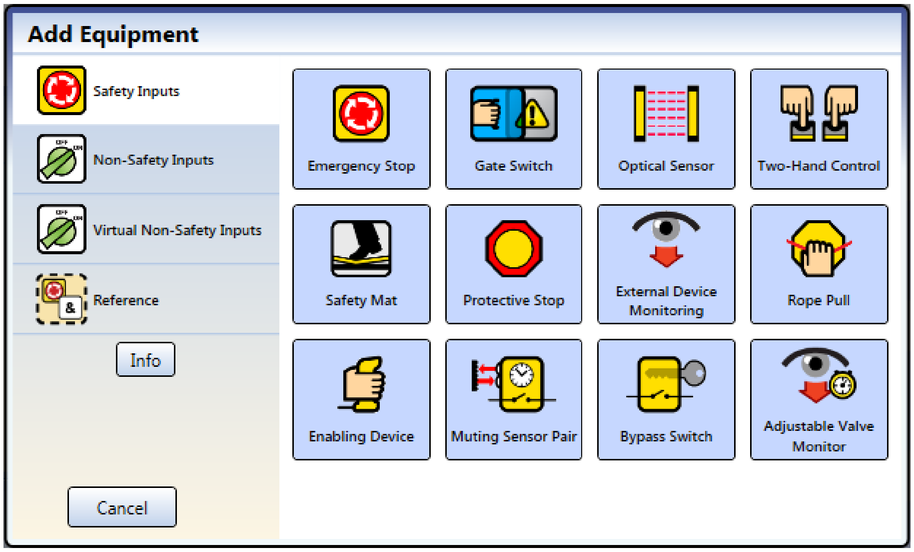


Figure 50. PACSafe 102: Adding inputs from Equipment View (physical status output can only be added from this view)

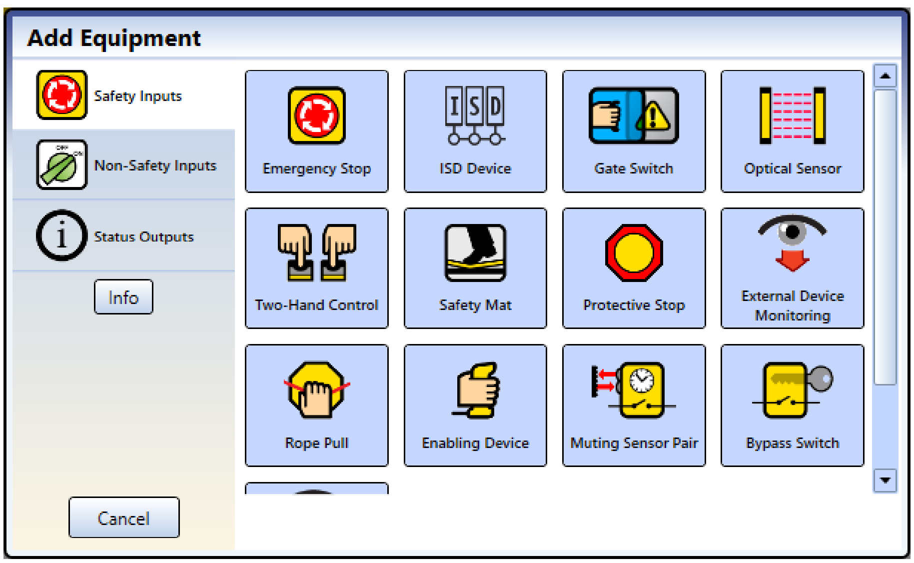
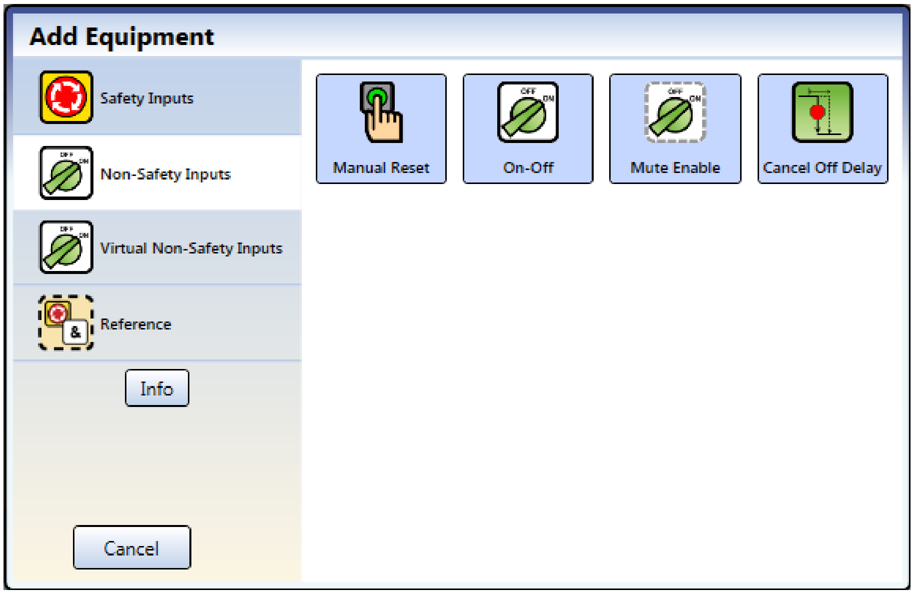


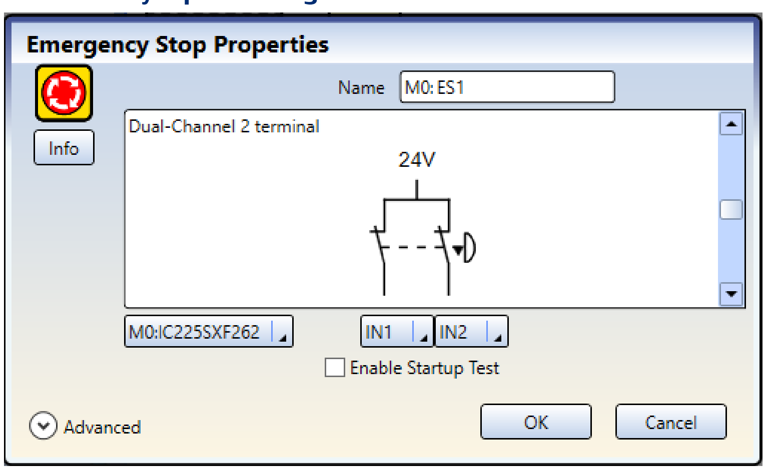
Figure 51. Non-Safety Inputs (Virtual Non-Safety Inputs available only from the Functional View Tab)



3. Select appropriate device settings:

Basic settings:

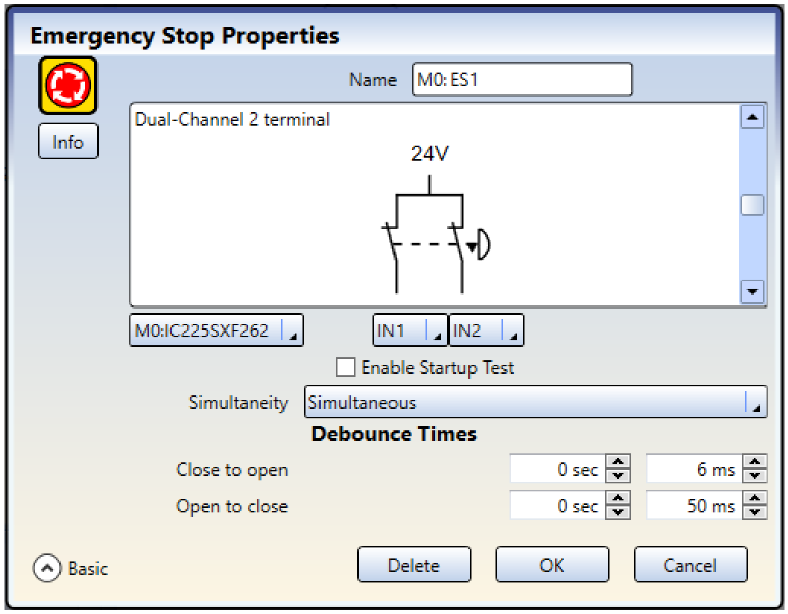
Figure 52. Basic Safety Input Settings



- *Name*—input device name; generated automatically and can be changed by the user
- *Circuit Type*—the circuit and signal convention options appropriate for the selected input device; scroll to see and select the desired option
- *Module*— the module to which the input device is connected (for example, M0:IC225SXF262)
- *I/O Terminals*—the assignment of input terminals for the selected device on the selected module
- *Enable Startup Test* (where applicable)—an optional precautionary safety input device test required after each power-up
- *Reset Options* (where applicable)—various reset options such as Manual Power Up, System Reset, and Reset Track Input Group

Advanced settings (where applicable):

Figure 53. Advanced Safety Input Settings

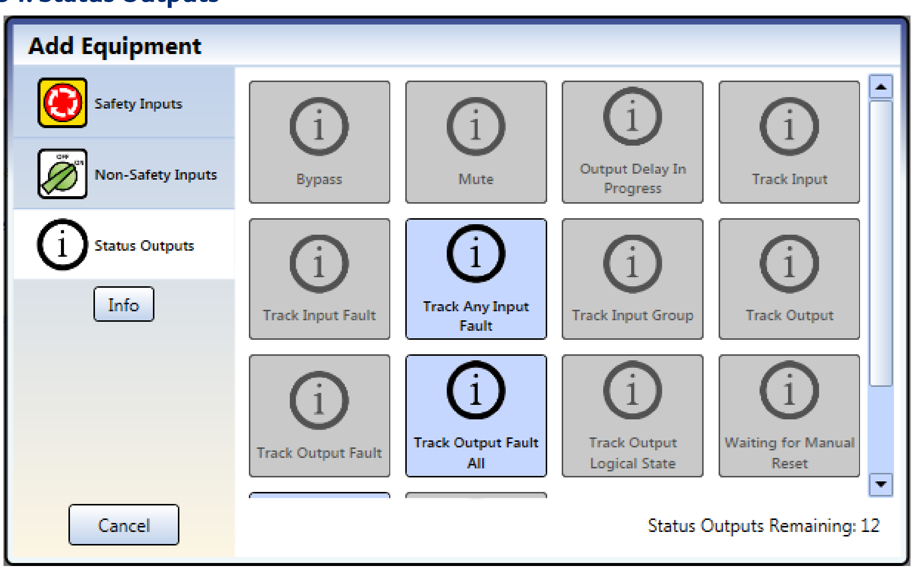


- *Simultaneity* (where applicable)—Simultaneous or Concurrent (see Glossary on p. 235 for definitions)
- *Debounce Times*—the signal state transition time
- *Monitored/Non-Monitored* (where applicable)—see Reset Signal Requirements on p. 58

8.2.2 Adding Status Outputs

1. On the **Equipment** tab, click ✚ below the module which will have the status monitoring.
2. Click **Status Outputs** to add status monitoring [7].

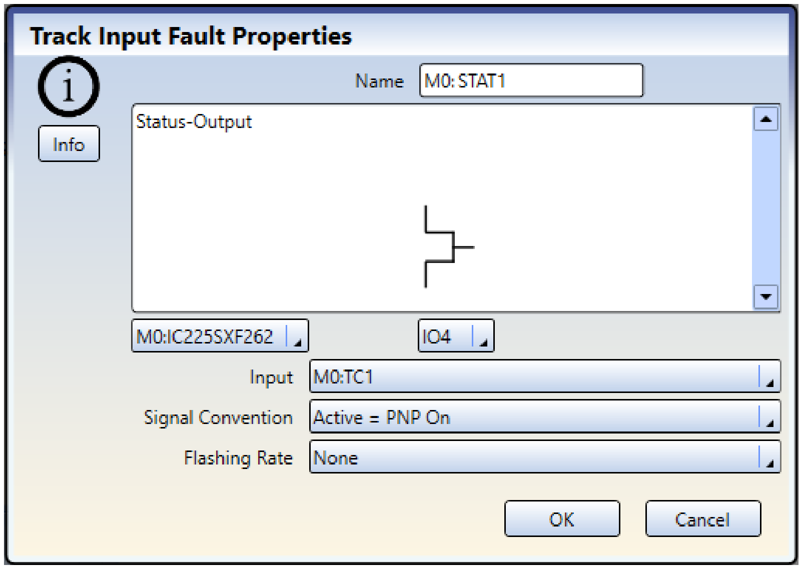
Figure 54. Status Outputs



[7] Status outputs can be configured when the state of an input device or an output needs to be communicated. The IOx terminals are used for these status signals.

3. Select appropriate Status Output settings:

Figure 55. Status Output Properties



- *Name*
- *Module*
- *I/O (where applicable)*
- *Terminal*
- *Input or Output (where applicable)*
- *Signal Convention*
- *Flashing Rate*

8.3 Designing the Control Logic

To **design the control logic**:

1. Add the desired **Safety** and **Non-Safety Inputs**:
   - On the **Equipment** tab: click under the module to which the input will be connected (the module can be changed in the input **Properties** window)
   - On the **Functional View** tab: click any of the empty placeholders in the left column

   See Adding Inputs and Status Outputs on p. 81 for more information and device properties.
2. Add **Logic** and/or **Function Blocks** (see Logic Blocks on p. 106 and Function Blocks on p. 109) by clicking any of the empty placeholders in the middle area.

   Note: The response time of the Safety Outputs can increase if a large number of blocks are added to the configuration. Use the function and logic blocks efficiently to achieve the optimum response time.
3. Create the appropriate connections between added inputs, **Function** and **Logic Blocks**, and Safety Outputs.

   Note: The checkList on the left displays connections that are required for a valid configuration and all items must be completed. The Safety Controller will not accept an invalid configuration.

   Note: The output node of any item can be connected to multiple input nodes. An input node can only have one item connected to it.

Tip: To aid with creating a valid configuration, the program displays helpful tooltips if you attempt to make an invalid connection.

8.4 Saving and Confirming a Configuration

Confirmation is a verification process where the Safety Controller analyzes the configuration generated by the Software for logical integrity and completeness. The user must review and approve the results before the configuration can be saved and used by the Safety Controller. Once confirmed, the configuration can be sent to a Safety Controller or saved on a PC or an IC225ACC001 drive.

WARNING:

- Complete the Commissioning Checkout Procedure
- Failure to follow the commissioning process may lead to serious injury or death.
- After confirming the configuration, the Safety Controller operation must be fully tested (commissioned) before it can be used to control any hazards.

8.4.1 Saving a Configuration

1. Click **Save Project**.
2. Select **Save As**.
3. Navigate to the folder where you wish to save the configuration.
4. Name the file (may be the same or different from the configuration name).
5. Click **Save**.

8.4.2 Confirming a Configuration

The Safety Controller must be powered up and connected to the PC via the IC225CBL001 cable.

1. Click .
2. Click **Write Configuration to Controller**.
3. If prompted, enter the password (default password is 1901).
   The **Entering config-mode** screen opens.
4. Click **Continue** to enter the configuration mode.
   After the **Reading Configuration from the Controller** process is completed, the **Confirm Configuration** screen opens.
5. Verify that the configuration is correct.
6. **Scroll to the end of the configuration and click Confirm.**
7. After the **Writing Configuration To Controller** process is completed, click **Close**.

Note:

- Network settings are sent separately from the configuration settings. Click **Send** from the **Network Settings** window to write the network settings to the Safety Controller.
- Network settings are automatically sent only if the Safety Controller is a factory default Safety Controller. Otherwise, use the **Network Settings** window.
- Passwords are automatically written only if the Safety Controller is a factory default Safety Controller or the configuration is confirmed. In any other case, use the **Password Manager** window to write passwords to the Safety Controller.

The **Do you want to change the passwords of the controller?** screen may display.

8. If prompted and if desired, change the passwords.
9. Cycle power or perform a System Reset for the changes to take effect in the Safety Controller.
10. Save the confirmed configuration on the PC.

> **Note:** Saving the now confirmed configuration is recommended. Confirmed configurations are a different file format (.xcc) than an unconfirmed file (.xsc). Confirmed configurations are required for loading into an IC225ACC001 drive. Click **Save As** to save.

8.4.3 Write a Confirmed Configuration to an IC225ACC001 using the Programming Tool

1. Insert the IC225ACC001 into the IC225ACC002 programming tool.
2. With the PACSafe Studio software running, insert the programming tool into a USB port of the PC.
   The IC225ACC001 icon should go live (become a bit darker than grayed out).
3. Click and select **Write ACC001**.

> **Note:** If **Write ACC001** is grayed out, the configuration is not a .xcc (confirmed version).

4. Verify the desired passwords.
5. Click **Send to ACC001**.
   The **Writing Configuration to ACC001 drive** window opens.

> **Note:** This process copies all data (configuration, network settings, and passwords) to the IC225ACC001 drive.

6. After it is finished, click **Save Confirmed Configuration** and then **Close**, or click **Close** if the file has already been saved to the PC.

8.4.4 Notes on Confirming or Writing a Configuration to a Configured Safety Controller

User settings and passwords affect how the system responds when confirming a configuration or writing a confirmed configuration to a configured Safety Controller.

User1

1. Click **Write configuration to Controller** to confirm a configuration (or write a confirmed configuration) to a configured Safety Controller.
2. Enter the User1 password.
3. The confirmation (or writing) process begins.

At the end of the confirmation (or writing) process, the Safety Controller will have received:

- New passwords
- New configuration

Network settings are not changed.

User2 or User3—Successful Configuration Confirmation or Writing

This scenario assumes the following settings for User2 or User3:

- **Allowed to change the configuration** = enabled
- **Allowed to change the network settings** = enabled OR disabled

1. Click **Write configuration to Controller** to confirm a configuration (or write a confirmed configuration) to a configured Safety Controller.
2. Enter the User2 or User3 password.
3. The confirmation (or writing) process begins.

At the end of the confirmation (or writing) process, the Safety Controller will have received:

- New configuration

Passwords and Network settings are not changed.

User2 or User3—Unsuccessful Configuration Confirmation or Writing

This scenario assumes the following settings for User2 or User3:

- **Allowed to change the configuration** = disabled
- **Allowed to change the network settings** = enabled OR disabled

1. Click **Write configuration to Controller** to confirm a configuration (or write a confirmed configuration) to a configured Safety Controller.
2. Enter the User2 or User3 password.
3. The confirmation (or writing) process is aborted.

8.5 Sample Configurations

The Software provides several sample configurations that demonstrate various features or applications of the Safety Controller. To access these configurations, go to **Open Project > Sample Projects** and select the desired project.

The PACSafe 262 has three groupings of sample configurations:

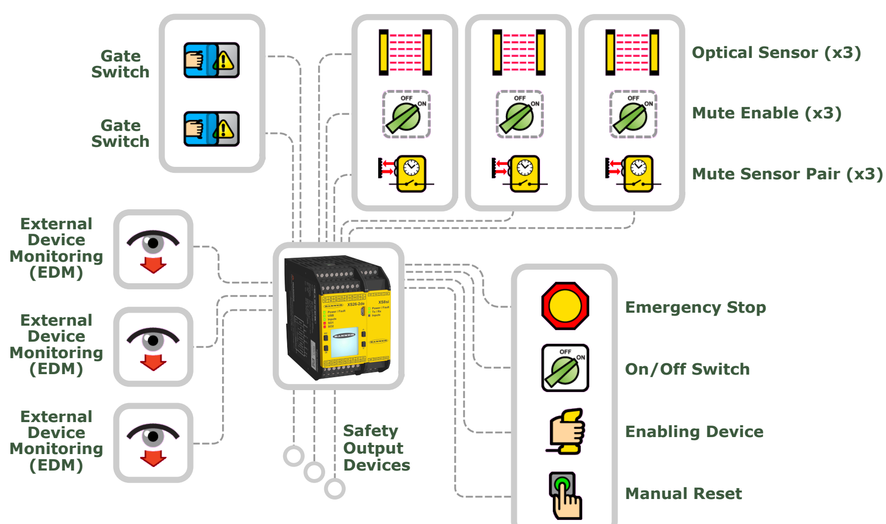
- **Applications**—Includes samples of simple potential applications of the controller.
- **Documentation**—Includes samples. Most of the samples included here are described in the following sections, and one is described in the Quick Start Guide (available online).
- **Examples**—Includes three divisions: **Function Blocks**, **Logic Blocks**, and **Safety Outputs**. These examples show the functionality of the various blocks. For example, to see how a bypass block operates, select **Function Blocks > Bypass Block (All Features Enabled)** and run it in Simulation Mode.

The PACSafe 102 has several sample configurations. These samples include typical applications of the PACSafe 102 model. Use the samples as a starting point and modify them for your specific needs.

8.5.1 PACSafe 262 Sample Configuration

This section describes designing the sample configuration "3 Zone Muting Instruction Manual", which is located under the **Documentation** section of the PACSafe 262 sample programs. This sample configuration is for a robotic palletizer application that utilizes an PACSafe Expandable 262 Safety Controller, IC225SDD841 Safety Input Module, three optical sensors (muting is added via the software), two interlock switches, a manual reset, and an Emergency Stop button.

Figure 56. Sample Configuration Schematic



To design the configuration for this application:

1. Click **New Project**.
2. Define project settings. See Project Settings on p. 103.
3. Select Base Controller model. See Equipment Tab on p. 104 (for this configuration, only the **Is Expandable** box is required to be checked).
4. Add the expansion module **IC225SDD841** by clicking on to the right of the Base Controller.
    a. Click **Input Modules**.
    b. Select **IC225SDD841**.
5. Add the following inputs, changing only the circuit type:

Input	Qty.	Type	Module	Terminals	Circuit
Emergency Stop	1	Safety Input	IC225SDD841	IO1, IN1, IN2	Dual-Channel 3 terminal
Enabling Device	1	Safety Input	IC225SDD841	IO1, IN3, IN4	Dual-Channel 3 terminal
External Device Monitoring	3	Safety Input	Base	1. IO3 2. IO4 3. IO5	Single-Channel 1 terminal
Gate Switch	2	Safety Input	Base	1. IO1, IN15, IN16 2. IO2, IN17, IN18	Dual-Channel 3 terminal
Manual Reset	1	Non-Safety Input	IC225SDD841	IN6	Single-Channel 1 terminal
Muting Sensor Pair	3	Safety Input	Base	1. IN9, IN10 2. IN11, IN12 3. IN13, IN14	Dual-Channel 2 terminal
Mute Enable	3	Non-Safety Input	Base	1. IN1 2. IN2 3. IO8	Single-Channel 1 terminal
On-Off	1	Non-Safety Input	IC225SDD841	IN5	Single-Channel 1 terminal
Optical Sensor	3	Safety Input	Base	1. IN3, IN4 2. IN5, IN6 3. IN7, IN8	Dual-Channel PNP

6. Go to the **Functional View** tab.

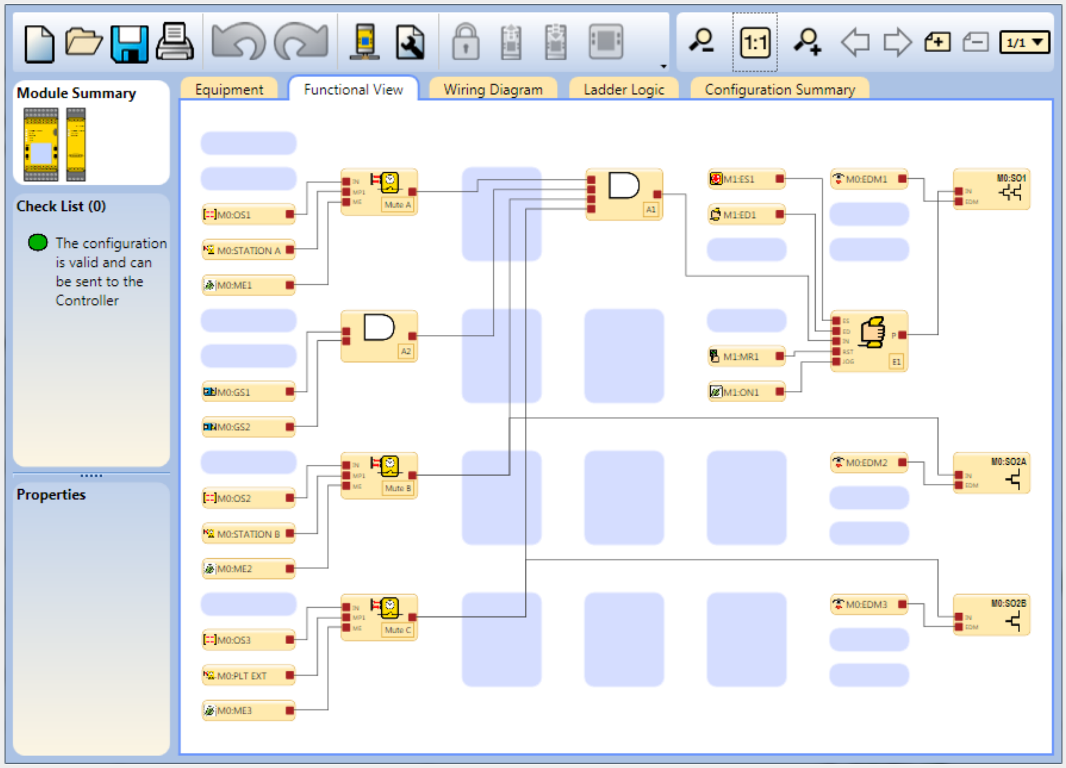
> **Tip:** You may notice that not all inputs are placed on Page 1. There are two solutions to keep the configuration on one page. Perform one of the following steps:
>
> 1. Add a **Reference** to the block located on a different page—click any of the empty placeholders in the middle area, select **Reference** and select the block that is on the next page. Only blocks from other pages can be added as a **Reference.**
> 2. Re-assign page—by default all inputs added on the **Equipment** tab are placed on the **Functional View** tab to the first available placeholder in the left column. However, inputs can be moved to any location in the middle area. Move one of the blocks to any of the placeholders in the middle area. Go to the page which contains the block that needs to be moved. Select the block and change the page assignment below the **Properties** table.

7. Split **M0:SO2**:
    a. Double-click **M0:SO2** or select it and click **Edit** under the **Properties** table.
    b. Click **Split.**
8. Add the following **Function Blocks** by clicking on any of the empty placeholders in the middle area of the **Functional View** tab (see Function Blocks on p. 109 for more information):
    - **Muting Block** x **3** (**Muting Mode**: One Pair, **ME (Mute Enable)**: Checked)
    - **Enabling Device Block** (**ES**: Checked, **JOG (Jog)**: Checked)
9. Add the following **Logic Blocks** by clicking on any of the empty placeholders in the middle area of the **Functional View** tab (see Logic Blocks on p. 106 for more information):
    - **AND** with 2 input nodes
    - **AND** with 4 input nodes
10. Connect the following to each **Muting Block**:
    - 1 x **Optical Sensor** (**IN** node)
    - 1 x **Mute Sensor Pair** (**MP1** node)
    - 1 x **Mute Enable** (**ME** node)
11. Connect **Gate Switch** x 2 to the **AND** block with 2 nodes.
12. Connect **Muting Block** x 3, and **AND** block with 2 nodes to the **AND** block with 4 nodes.
13. Connect one of the **Muting Blocks** to one of the split safety outputs (**M0:SO2A** or **M0:SO2B**) and one to the other split safety output.
14. Connect the following to the **Enabling Device Block**:
    - **Emergency Stop** (**ES** node)
    - **Enabling Device** (**ED** node)
    - **AND** block with four input nodes (**IN** node)
    - **Manual Reset** (**RST** node)
    - **On-Off** (**JOG** node)
15. Connect **Enabling Device Block** to the remaining Safety Output (**M0:SO1**).
16. Enable *EDM (External Device Monitoring)* in each of the Safety Output **Properties** windows.
17. Connect 1x **External Device Monitoring** input to each of the Safety Outputs.

The Sample Configuration is complete.

Note: At this point you may want to reposition the blocks in the **Functional View** tab for a better configuration flow, as shown in the following figure:

Figure 57. Sample Configuration—Functional View Tab

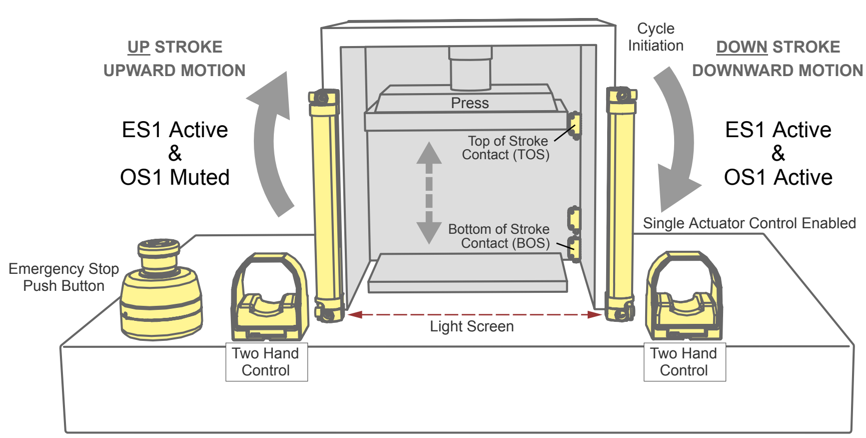


8.5.2 PACSafe 262: Simple Press Control with Mutable Safety Input Sample Configuration

This section describes designing a simple press control system, which is located under the Documentation section of the PACSafe 262 sample programs.

This sample configuration is for a simple hydraulic/pneumatic press application that utilizes a PACSafe Expandable 262 Safety Controller, Press Status inputs, a Cycle Initiation, a manual reset, an optical safety sensor, and an emergency stop.

Figure 58. Simple Sample Press Control Configuration



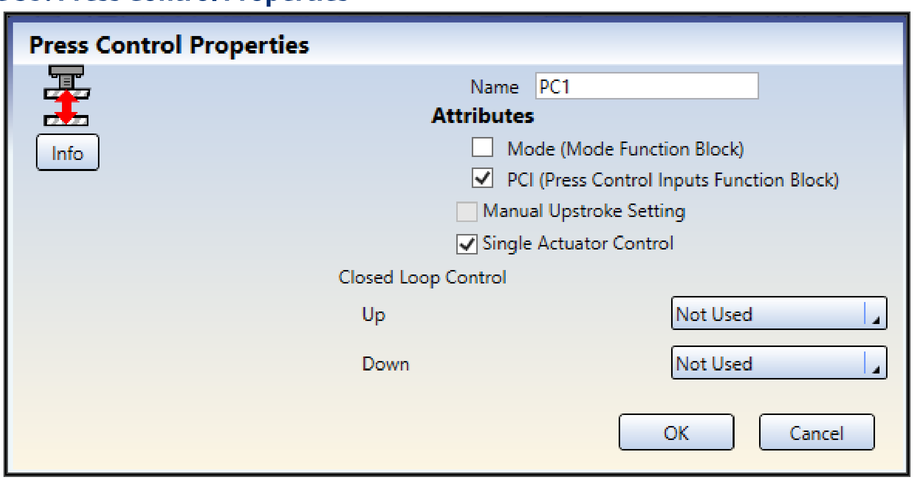
To design the configuration for this application:

1. Click **New Project**.
2. Define the project settings.
   See Project Settings on p. 103.
3. Select the desired Base Controller model.
   See Equipment Tab on p. 104.
4. Add the following inputs, changing name and circuit type as needed.

Input	Quantity	Type	Terminals	Circuit
Cycle Initiation	1	Safety Input	IN1, IN2	Dual-Channel 2 Terminal
TOS (on/off)	1	Non-Safety	IN5	Single-Channel 1 Terminal
BOS (on/off)	1	Non-Safety	IN6	Single-Channel 1 Terminal
Manual Reset	1	Non-Safety	IN7	Single-Channel 1 Terminal
Emergency Stop	1	Safety Input	IN10, IN11	Dual-Channel 2 Terminal
Optical Sensor	1	Safety Input	IN8, IN9	Dual-Channel PNP

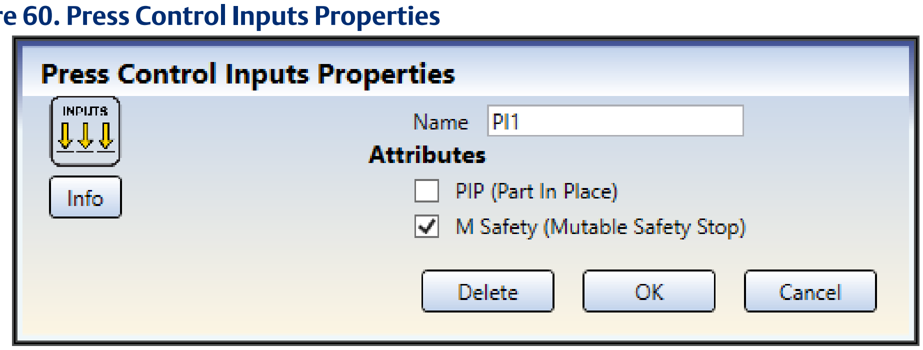
5. Go to the **Functional View** tab.
6. Add and configure the Press Control function block.
   a) Click on any of the empty placeholders in the middle area of the **Functional View** tab. For more information, see Function Blocks on p. 109.
   b) Select **Function Blocks** and select **Press Control**.
   c) In the **Press Control Properties** window, select **PCI (Press Control Input Function Block)** and **Single Actuator Control**.

Figure 59. Press Control Properties



   The check in the **Manual Upstroke Setting** box disappears.
   d) Click **OK**.
   The **Press Control Inputs Properties** window opens.

Figure 60. Press Control Inputs Properties



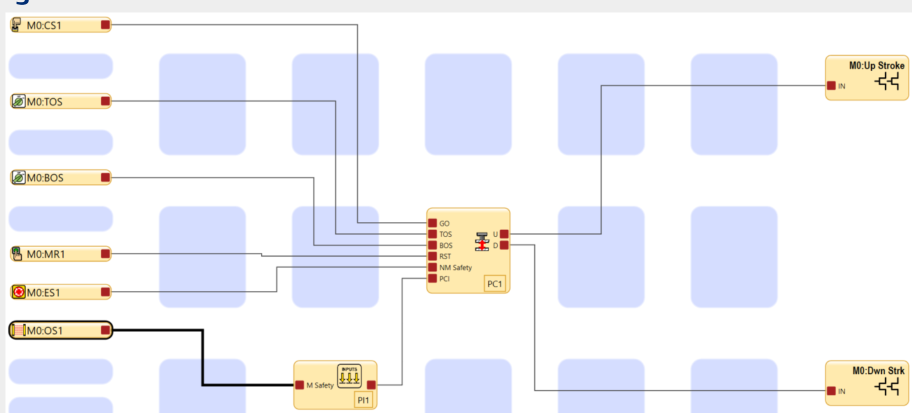
e) Select **M Safety (Mutable Safety Stop)**.
f) Click **OK**.

7. Connect the following:
   - Cycle Initiation input to the GO node of the Press Control function block
   - TOS to the TOS node of the Press Control function block
   - BOS to the BOS node of the Press Control function block
   - Manual Reset to the RST node of the Press Control function block
   - Emergency Stop to the NM Safety node of the Press Control function block
   - Optical Sensor to the M Safety node of the Press Control Input Function Block
8. Connect the U output node of the Press Control function block to SO1 (change the name of SO1 to "Up Stroke").
9. Connect the D output node of the Press Control function block to SO2 (change the name of SO2 to "Dwn Strk").

The sample configuration is complete.

Note: At this point, it can be helpful to reposition the blocks in the Functional View for better configuration flow, as shown in the following figure:

Figure 61. Function Block Position



PACSafe 262: Simulate the Functionality of the Simple Press Control Configuration

The following is how to simulate the functionality of the simple press control configuration:

1. Click  to enter Simulation Mode.
2. Click **Play** to turn on the simulation timer (similar to powering on the machine).
3. Click the emergency stop, optical sensor, and TOS inputs to the ON state (green).
4. Click the MR1 reset input.
   The Press Control Function block should turn ON (green).
5. Click the CS1 input to the ON state (green).
   The Dwn Strk output turns ON (green).
6. Click the TOS input to the OFF state (red).
7. Click the BOS input to the ON state (green).
   The Dwn Strk output turns OFF (red) and the Up Stroke Output turn ON (green).
8. Click the BOS input OFF (red).
9. Click the TOS input to the ON state (green).
   The Up Stroke Output turns OFF (red).
10. Click the CS1 input to the OFF state (red). This can be done any time after the Dwn Strk output turns ON (green).
11. Click the Optical Sensor input to the OFF state (red), then back to the ON state (green).

The system is ready to start the next cycle by turning the CS1 input on again.

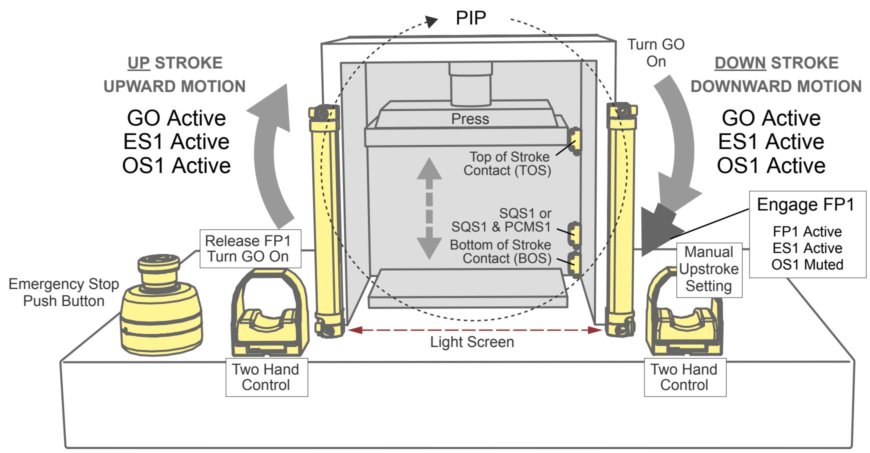
If the Optical sensor or E-stop are turned OFF during the up or down stroke, the MR1 input must be cycled, then the CS1 engaging will turn the Up Stroke output ON.

8.5.3 PACSafe 262: Full Feature Press Control Sample Configuration

This section describes designing a press control system that uses all of the possible features (except AVM). The sample configuration is located under the Documentation section of the PACSafe 262 sample programs.

This sample configuration is for a more complex hydraulic/pneumatic press application that uses a PACSafe Expandable 262 Safety Controller, IC225SDL720 Safety Output Module, Press Status inputs, cycle start, a manual reset, an optical safety sensor, sequential stop, mute sensor, foot pedal input, and an Emergency Stop button.

Figure 62. Full Feature Sample Press Control Configuration



To design the configuration for this application:

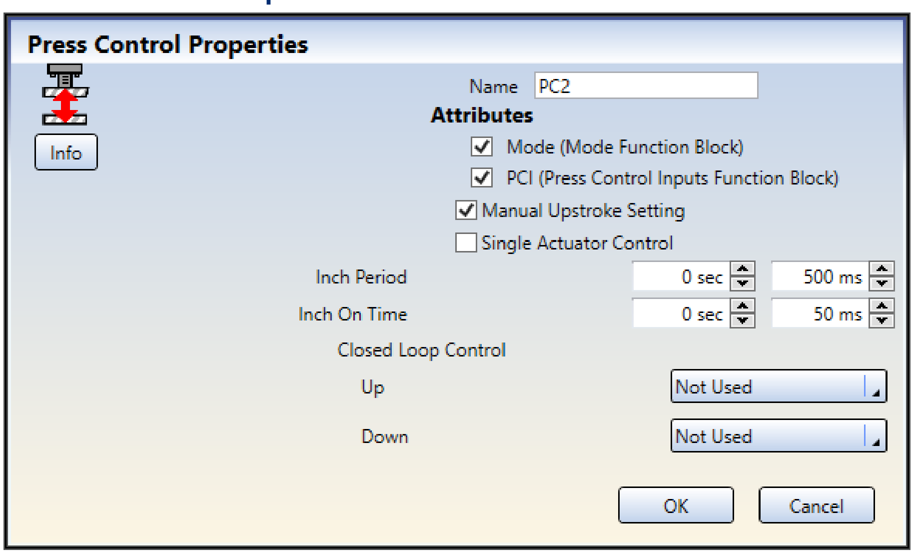
1. Click **New Project**.
2. Define the project settings.
   See Project Settings on p. 103.
3. Select the desired Base Controller model.
   See Equipment Tab on p. 104 (for this configuration, only **Is Expandable** is required to be selected).
4. Add expansion module IC225SDL720.
   a) Click ✚ to the right of the Base Controller.
   b) Click **Output Modules**.
   c) Select IC225SDL720.
5. Add the following inputs, changing name and circuit type as needed.

Input	Qty.	Type	Terminals	Circuit
Two-Hand Control	1	Safety Input	IN9, IN10	Dual-Channel PNP
TOS (ON/OFF)	1	Non-Safety	IN1	Single-Channel 1 Terminal
BOS (ON/OFF)	1	Non-Safety	IN2	Single-Channel 1 Terminal
Manual Reset	1	Non-Safety	IN11	Single-Channel 1 Terminal
Emergency Stop	1	Safety Input	IO1, IN3, IN4	Dual-Channel 3 Terminal
Run (ON/OFF)	1	Non-Safety	IN12	Single-Channel 1 Terminal

Input	Qty.	Type	Terminals	Circuit
Up (ON/OFF)	1	Non-Safety	IN13	Single-Channel 1 Terminal
Down (ON/OFF)	1	Non-Safety	IN14	Single-Channel 1 Terminal
PIP (ON/OFF)	1	Non-Safety	IN5	Single-Channel 1 Terminal
Press Control SQS	1	Safety Input	IN6	Single-Channel 1 Terminal
Foot Pedal	1	Safety Input	IO2	Single-Channel 1 Terminal
Press Control Mute Sensor	1	Safety Input	IO3	Single-Channel 1 Terminal
Optical Sensor	1	Safety Input	IN7, IN8	Dual-Channel PNP

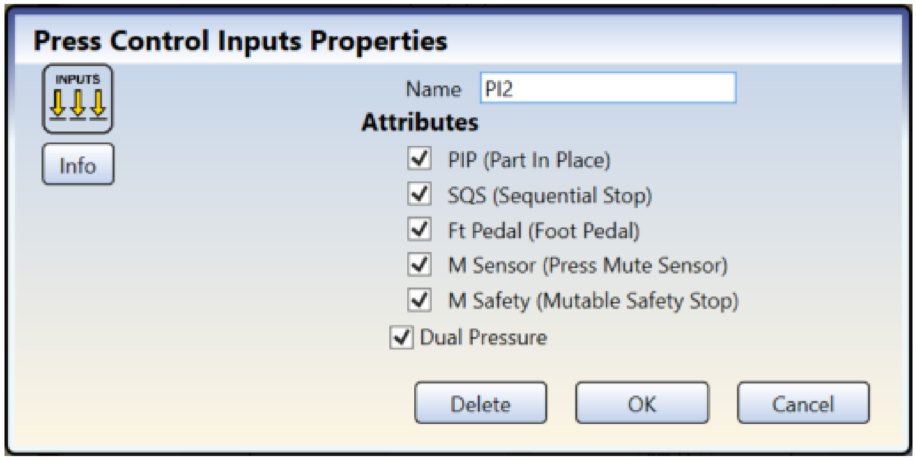
6. Go to the **Functional View** tab.
7. Add and configure the Press Control function block.
   a) Click on any of the empty placeholders in the middle area of the **Functional View** tab. For more information, see Function Blocks on p. 109.
   b) Select **Function Blocks** and select **Press Control**.
   c) In the **Press Control Properties** window, select **Mode (Mode Function Block)** and **PCI (Press Control Input Function Block)**. Leave the **Manual Upstroke Setting** box checked.

Figure 63. Press Control Properties



   d) Click **OK**.
   The **Press Control Inputs Properties** window opens.

Figure 64. Press Control Inputs Properties



e) Select all of the check boxes. Note that when **SQS** is selected, three more options display; select them also (all six boxes should be checked).

f) Click **OK**.
The **Mode Properties** window displays.

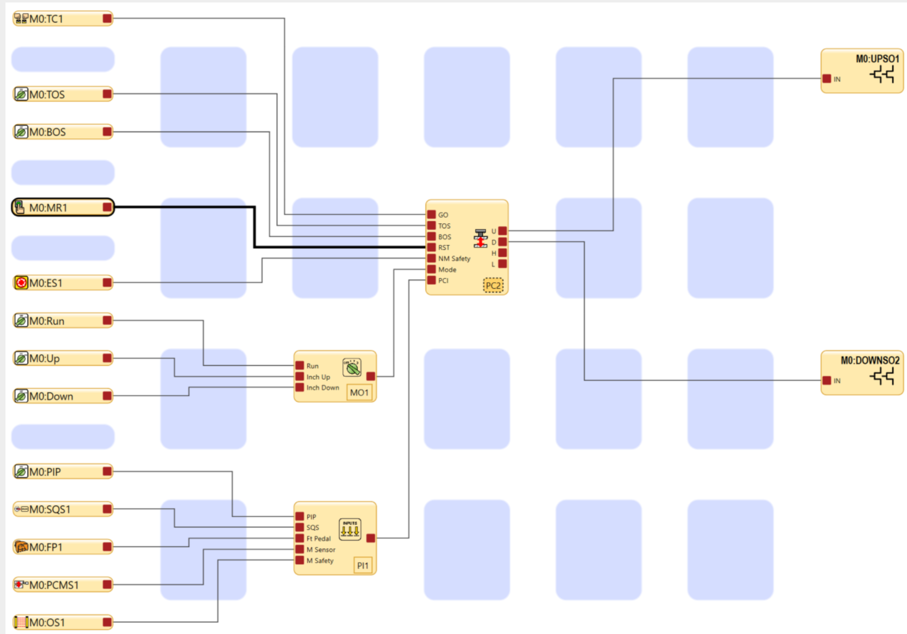
g) Click **OK**.

8. Connect the following to the Mode Selection Block:
   - Run input to the Run Input node
   - Up input to the Inch Up input node
   - Down input to the Inch Down input node
9. Connect the following to the Press Control Inputs Block:
   - Part-In-Place (PIP) input to the PIP input node
   - Sequential Stop (SQS) input to the SQS input node
   - Foot Pedal input to the Ft Pedal input node
   - Press Control Mute Sensor (PCMS) to the M Sensor input node
   - Optical Sensor to the M Safety input node
10. Connect the following to the Press Control Block:
    - Two-Hand Control input to the GO input node
    - TOS to the TOS input node
    - BOS to the BOS input node
    - Manual Reset to the RST input node
    - Emergency Stop to the NM Safety input node
11. Connect the U output node of the Press Control function block to SO1 (change the name of SO1 to "UPSO1").
12. Connect the D output node of the Press Control function block to SO2 (change the name of SO2 to "DOWNSO2").
13. Go to page 2 of the Functional View tab (use the arrow in the upper right-hand corner).
14. Create a reference node for PCx-H and another for PCx-L.
15. Connect the PCx-H to SO1 (change the name of SO1 to "HIGHSO1").
16. Connect the PCx-L to SO2 (change the name of SO2 to "LOWSO2").

The sample configuration is complete.

Note: At this point, it can be helpful to reposition the blocks in the **Functional View** for better configuration flow, as shown in the following figure.

Figure 65. Function Block Position



PACSafe 262: Simulate the Functionality of the Full Feature Press Control Configuration

The following is how to simulate the functionality of this press control configuration:

1. Click  to enter Simulation Mode.
2. Click **Play** to turn on the simulation timer (similar to powering on the machine).
3. Click the E-stop, optical sensor, TOS, and Run inputs to the On state (green).
4. Click the MR1 reset input.
   The Press Control Function block and LOWSO2 output should turn to the On state (green). This is on page 2; click the arrow in the upper right to change pages.
5. Click the PIP input to the On state (green).
6. Click the TC1 input to the On state (green).
   The DOWNSO2 output turns On (green).
7. Click the TOS input to the Off state (red).
8. Click the SQS1 and PCMS1 inputs to the On state (green).
   The DOWNSO2 output turns Off (red), LOWSO2 output turns Off (red), and the HIGHSO1 (page 2) output turns On (green).
9. Click the TC1 input to the Off state (red).
10. Click the FP1 input to the On state (green).
    The DOWNSO2 output turns On (green).
11. Click the BOS input to the On state (green).
    The DOWNSO2 and the HIGHSO1 (page 2) output turn Off (red) and the LOWSO2 (page 2) output turns On (green).
12. Click the FP1 input to the Off state (red).
13. Click the TC1 input to the On state (green).
    The UPSO1 output turns On (green).
14. Click the BOS, PCMS1, and SQS1 inputs to the Off state (red).
15. Click the TOS input to the On state (green).
    The UPSO1 output turns Off (red).

16. Click the TC1 input to the Off state (red).
17. Click the Optical Sensor input to the Off state (red), click the PIP input to the Off state (red) then back to the On state (green), then click the Optical Sensor input back to the On state (green).

The system is ready to start the next cycle by turning the TC1 input to the On state (green) again.

If the TC1 input is turned Off (red) during the down stroke, turning it back On does not change the down stroke; the press continues with the down stroke. To make the press go up (instead of down) after the TC1 input is turned Off, click the MR1 input, then turn the TC1 input back On. If the Optical sensor or E-stop are turned Off during the up or down stroke, the TC1 input should be turned Off, then the MR1 input should be cycled, and then engaging TC1 will turn the UPSO1 output On.

9 Software

The PACSafe Studio Software is an application with real-time display and diagnostic tools that are used to:

- Design and edit configurations
- Test a configuration in Simulation Mode
- Write a configuration to the Safety Controller
- Read the current configuration from the Safety Controller
- Display real-time information, such as device statuses
- Display fault information

The Software uses icons and circuit symbols to assist in making appropriate input device and property selections. As the various device properties and I/O control relationships are established on the **Functional View** tab, the program automatically builds the corresponding wiring and ladder logic diagrams.

See Creating a Configuration on p. 81 for the configuration design process. See PACSafe 262 Sample Configuration on p. 88 for a sample configuration design process.

See Wiring Diagram Tab on p. 110 to connect the devices, and Ladder Logic Tab on p. 111 for the ladder logic rendering of the configuration.

See Live Mode on p. 120 for the Safety Controller Run-time information.

9.1 Abbreviations

Abbreviation [8]	Description
AVM	Adjustable Valve Monitoring input node of the Safety Outputs
AVMx	Adjustable Valve Monitoring input
BP	Bypass input node of the Bypass Blocks and Muting Blocks
BPx	Bypass Switch input
BOS	Bottom of Stroke input node of the Press Control blocks (PACSafe 262 only)
CD	Cancel Delay input node of the Safety Outputs, Delay Blocks, and One Shot Blocks
CDx	Cancel Delay input
CSx	Cycle Initiation input
ED	Enabling Device input node of the Enabling Device Blocks
EDx	Enabling Device input
EDM	External Device Monitoring input node of the Safety Outputs
EDMx	External Device Monitoring input
ES	Emergency Stop input node of the Enabling Device Blocks
ESx	Emergency Stop input
ETB	External Terminal Block (PACSafe 102 only)
FPx	Foot Pedal input
FR	Fault Reset input node of the Safety Outputs
Ft Pedal	Foot Pedal input node of the Press Control Blocks (PACSafe 262 only)
GO	Cycle Start input node of the Press Control Blocks (PACSafe 262 only)
GSx	Gate Switch input

[8] The "x" suffix denotes the automatically assigned number.

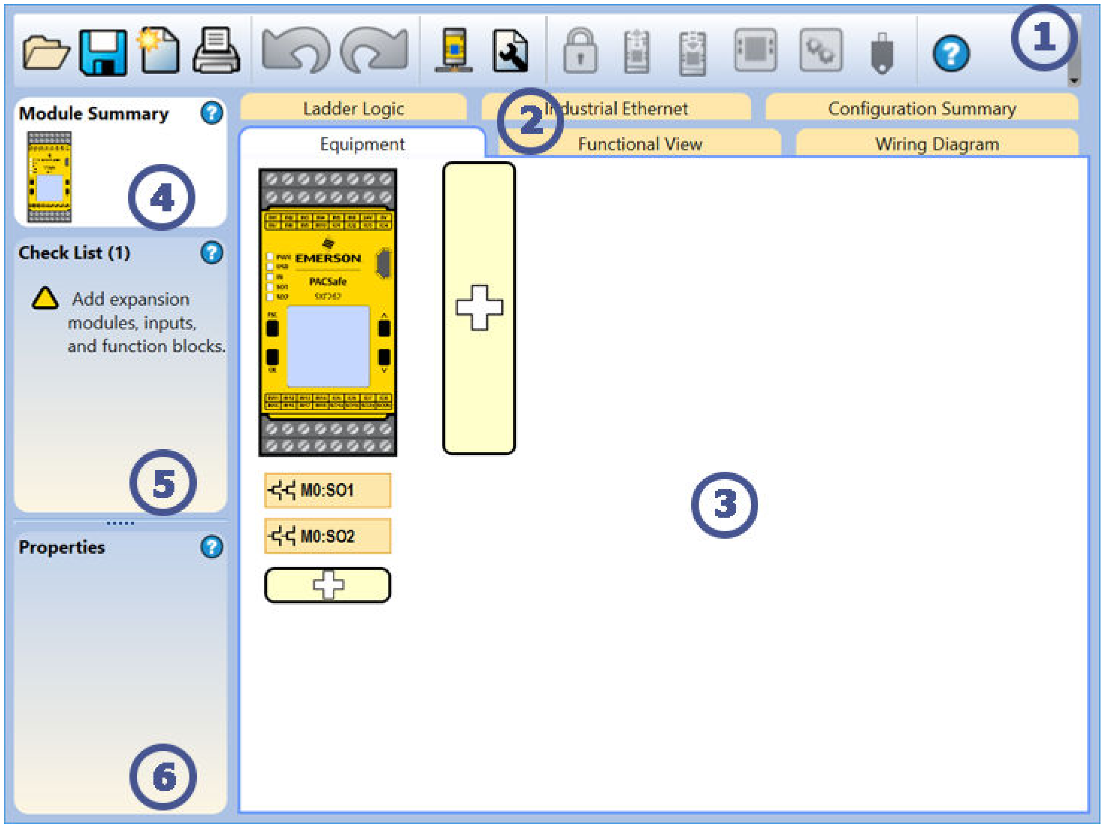
Abbreviation [8]	Description
JOG	Jog Input node of the Enabling Device Blocks
IN	Normal Input node of function blocks and Safety Output blocks
LR	Latch Reset input node of the Latch Reset Block and the Safety Outputs
ME	Mute Enable input node of the Muting Blocks and Two-Hand Control Blocks
MEx	Mute Enable input
MP1	First Muting Sensor Pair input node in Muting Blocks and Two-Hand Control Blocks
MP2	Second Muting Sensor Pair input node (Muting Blocks only)
M Safety	Mutable Safety Input node of the Press Control blocks (PACSafe 262 only)
M Sensor	Press Control Mute Sensor input node of the Press Control blocks (PACSafe 262 only)
Mx	Base Controller and Expansion modules (in the order displayed on the **Equipment** tab)
MRx	Manual Reset input
MSPx	Muting Sensor Pair input
NM Safety	Non-Mutable Safety input node of the Press Control blocks (PACSafe 262 only)
ONx	On-Off input
OSx	Optical Sensor input
PCMSx	Press Control Mute Sensor input
PIP	Part in Place input node of the Press Control blocks (PACSafe 262 only)
PSx	Protective Stop input
RE	Reset Enable input node of the Latch Reset Blocks and the Safety Outputs
ROx	Relay Output
RPI	Requested Packet Interval
RPx	Rope Pull input
RST	Reset node of the SR-Flip-Flop, RS-Flip-Flop, Latch Reset Blocks, Press Control blocks, and Enabling Device Blocks
RUN	Standard operation (RUN) mode input node of the Press Control Mode Blocks (PACSafe 262 only)
SET	Set node of the SR- and RS-Flip-Flop Blocks
SMx	Safety Mat input
SOx	Safety Output
SQS	Sequential Stop input node of the Press Control blocks (PACSafe 262 only)
SQSx	Press Control SQS (Sequential Stop) input
STATx	Status Output
TC	Two-Hand Control input node of the Two-Hand Control Blocks
TCx	Two-Hand Control input
TOS	Top of Stroke input node of the Press Control blocks (PACSafe 262 only)

[8] The "x" suffix denotes the automatically assigned number.

9.2 Software Overview

Note: The following sections use the PACSafe 262 as an example. The PACSafe 102 interface is similar.

Figure 66. PACSafe Studio Software



(1) Navigation Toolbar

 Opens an existing project, opens a **Recent** project, or opens **Sample Projects**

 Saves (or Save As) the project to the user-defined location

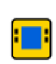
 Starts a **New project**

 Prints a customizable Configuration Summary

 Reverts up to ten previous actions

 Reads the data, such as Fault Log, Configuration, Network Settings, and Device Information from the Safety Controller

 Writes the data, such as Configuration Settings to the Safety Controller

 Makes the Live Mode view available

 Makes the Simulation Mode view available

 Indicates IC225ACC001 drive connection

Re-applies up to ten previously reverted actions	Opens the **Help** options • **Help**—Opens Help topics • **About**—Displays Software version number and user responsibilities warning • **Icons**—Switches between US- and European-style icons • **Support Information**—Describes how to request help from the Emerson Advanced Technical Support Group • **Language**—Selects the Software language options
Displays Network Settings and writes the Network Settings to the Safety Controller	
Displays Project Settings	
Opens Password Manager	

(2) Tabs for Worksheets and Diagrams

Equipment—Displays an editable view of all connected equipment

Functional View—Provides editable iconic representation of the control logic

Wiring Diagram—Displays the I/O device wiring detail for the use by the installer

Ladder Logic—Displays a symbolic representation of the Safety Controller's safeguarding logic for the use by the machine designer or controls engineer

Industrial Ethernet—Displays editable network configuration options

Configuration Summary—Displays a detailed configuration summary

Live Mode (when enabled)—Displays the live mode data, including current faults

Simulation Mode (when enabled)—Displays the simulation mode data

(3) Selected View

Displays the view corresponding to the selected tab (**Equipment** view shown)

(4) Module Summary

Displays the Base Controller and any connected modules or displays the PACSafe 102

(5) Check List

Provides action items to configure the system and correct any errors to successfully complete the configuration

(6) Properties

Displays the properties of the selected device, function block, or connection (properties cannot be edited in this view; click **Edit** below to make changes)

Delete—Deletes the selected item

Edit—Displays the configuration options for the selected device or function block

See Software: Troubleshooting on p. 211 for issues related to the Software functionality.

9.3 New Project

Click **New Project** to select the desired controller and open the **Start a New Project** screen. This screen includes project information that is only available upon initial creation of a project and is not available from the **Project Settings** screen.

PACSafe 262

All checkboxes are selected by default. The following options are available:

Has Display

Select this checkbox if your controller has a display.

Is Expandable

Select this checkbox if your controller is a PACSafe Expandable 262. Clear this checkbox if your controller is a PACSafe Standalone 262.

PACSafe 102

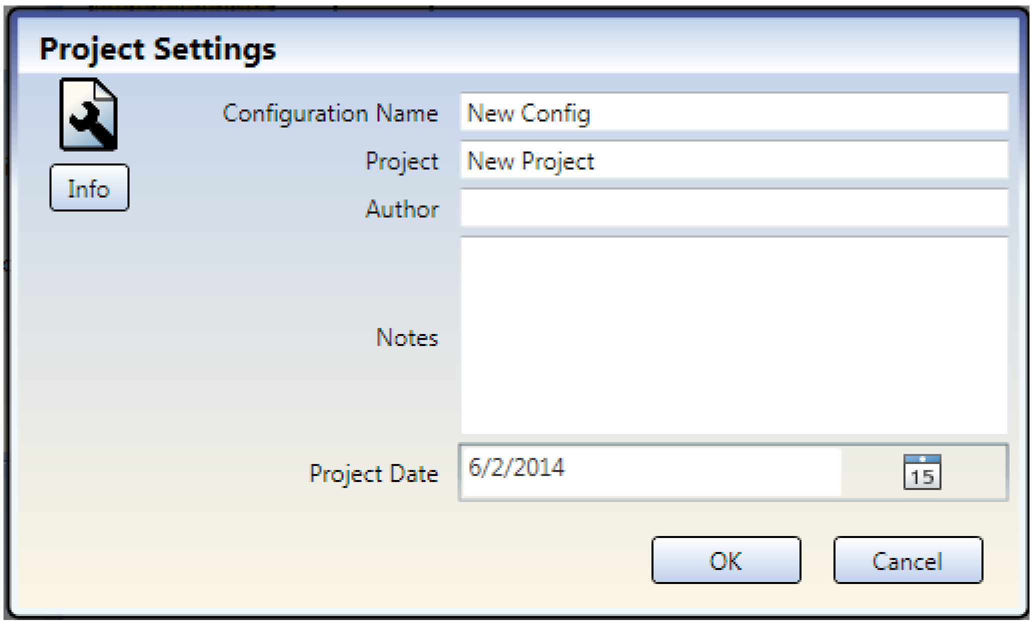
Disable Automatic Terminal Optimization Feature (PACSafe 102 only)

Enable or disable Automatic Terminal Optimization, which allows for the expansion of the number of inputs using an external terminal block (ETB).

> **Note:** The project information listed above is not available from **Project Settings**, however it is editable from the **Edit** function of the **Module Properties**.

9.4 Project Settings

Figure 67. Project Settings



Each configuration has an option to include additional project information for easier differentiation between multiple configurations. To enter this information click **Project Settings**.

Configuration Name

Name of the configuration; displayed on the Safety Controller (models with display); different from file name.

Project

Project name; useful for distinguishing between various application areas.

Author

Person designing the configuration.

Notes

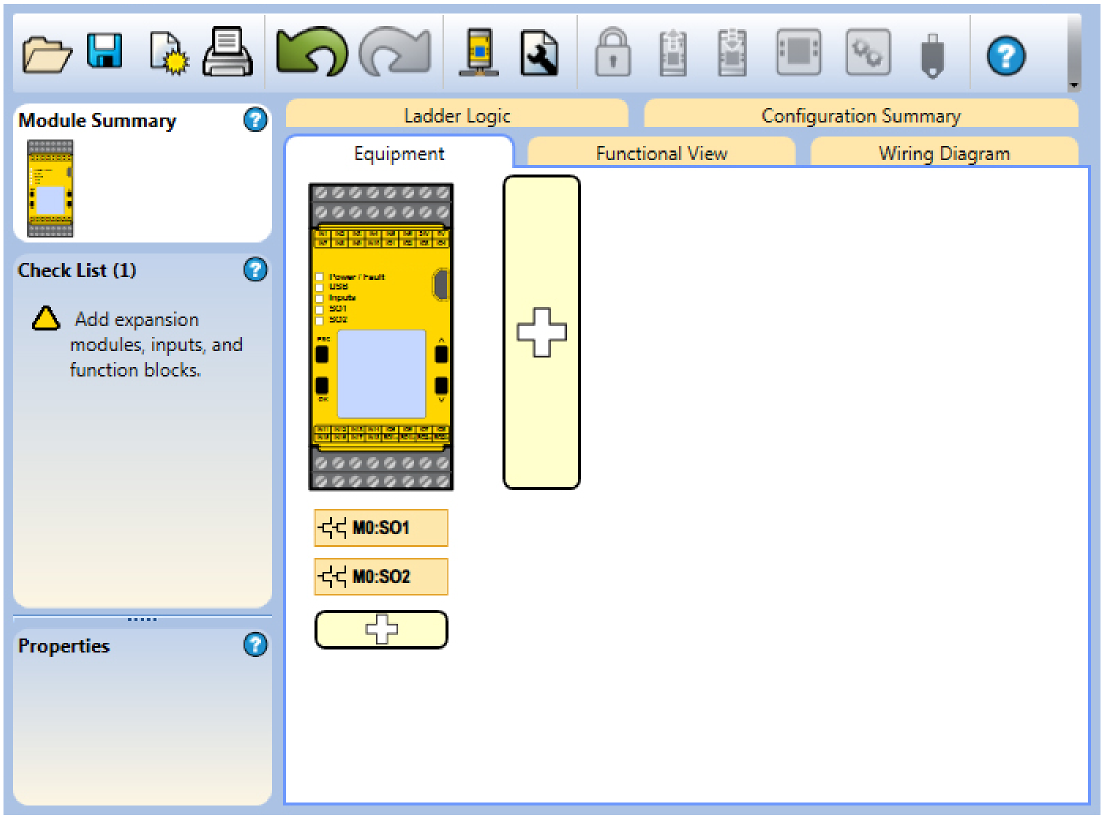
Supplemental information for this configuration or project.

Project Date

Date pertaining to the project.

9.5 Equipment Tab

Figure 68. Example PACSafe 262 Equipment Tab



PACSafe 262: The **Equipment** tab is used to select the base model, add the expansion modules (input and output), and add input devices and status outputs. Add the expansion modules by clicking ✚ to the right of the Base Controller module.

PACSafe 102: The **Equipment** tab is used to add input devices and status outputs.

Customize the Base Controller module or PACSafe 102 by either double-clicking the module or selecting it and clicking **Edit** under the **Properties** table on the left and selecting the appropriate Safety Controller features . The properties of Safety and Non-Safety inputs, Status Outputs, Logic Blocks, and Function Blocks are also configured by either double-clicking the block or selecting it and clicking **Edit** under the **Properties** table. Clicking the block the second time de-selects it.

Figure 69. PACSafe 262 Module Properties

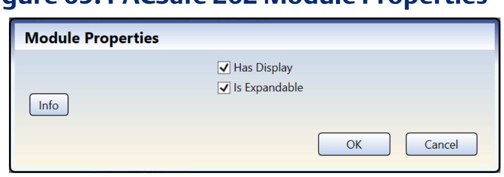
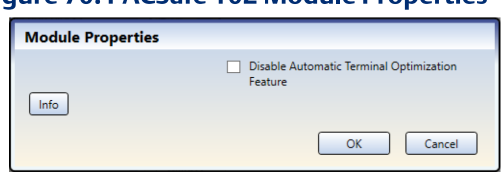
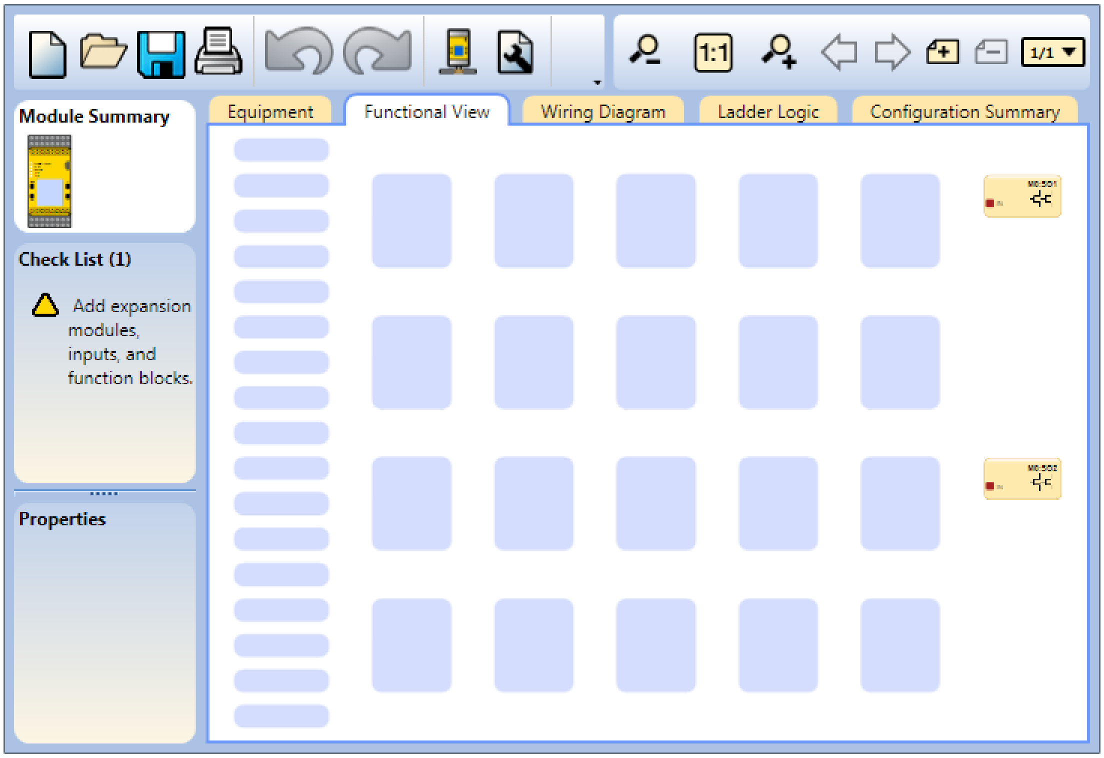


Figure 70. PACSafe 102 Module Properties



9.6 Functional View Tab

Figure 71. Functional View Tab



The **Functional View** tab is used to create the control logic. The left column of the **Functional View** tab is used for Safety and Non-Safety Inputs; the middle area is used for Logic and Function Blocks and the right column is reserved for Safety Outputs. Safety and Non-Safety Inputs can be moved between the left and middle areas. Function and Logic Blocks can only be moved within the middle area. Outputs are placed statically by the program and cannot be moved. Reference blocks of any type can be placed anywhere within the left and middle areas.

Important: The PACSafe Studio Software is designed to assist in creating a valid configuration, however, the user is responsible for verifying the integrity, safety, and functionality of the configuration by following the Commissioning Checkout Procedure on p. 184.

On the **Functional View** tab you can:

- Customize the look of the diagram by repositioning inputs, Function blocks, and Logic blocks
- **Undo** and **Redo** up to 10 most recent actions
- Add additional pages for larger configurations using the page navigation toolbar (see Figure 72 on p. 105)
- Zoom in and out of the diagram view, or automatically adjust it to the best ratio for the current window size (see Figure 72 on p. 105)

Figure 72. Page Navigation and Diagram Size toolbar

- Navigate between pages by clicking the left and right arrows within the page navigation area in the top right corner of the Software

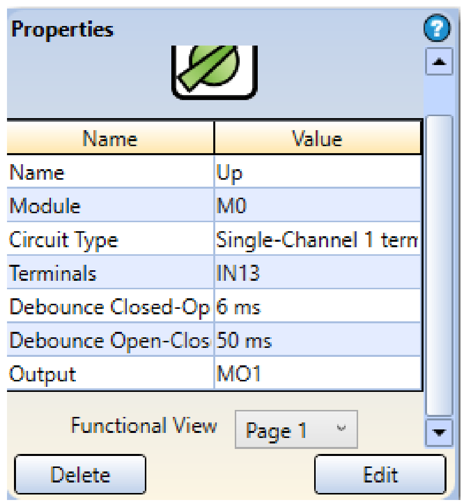
- Modify properties of all blocks by either double-clicking a block or by selecting a block and clicking **Edit** under the **Properties** table
- Delete any block or connection by selecting the item and then either pressing the **Delete** key on your keyboard or clicking **Delete** under the **Properties** table

> **Note:** There is no confirmation of the object deletion. You may undo the deletion by clicking **Undo**.

By default all inputs added on the **Equipment** tab are placed on the **Functional View** tab to the first available placeholder in the left column. There are two ways to move signals from one page to another. To do so, perform one of the following steps:

1. Add a **Reference** to the block located on a different page—click any of the empty placeholders in the middle area, select **Reference** and select the block that is on the next page. Only blocks from other pages can be added as a **Reference**.
2. Re-assign the page—on the page where you want to keep the configuration, move one of the blocks to any of the placeholders in the middle area. Go to the page which contains the block that needs to be moved. Select the block and change the page assignment below the **Properties** table.

Figure 73. Properties Table



9.6.1 Logic Blocks

Logic Blocks are used to create Boolean (True or False) functional relationships between inputs, outputs, and other logic and function blocks. Logic Blocks accept appropriate safety inputs, non-safety inputs, or safety outputs as an input. The state of the output reflects the Boolean logic result of the combination of the states of its inputs (**1** = On, **0** = Off, **x** = do not care).

> **CAUTION: Inverted Logic**
>
> It is not recommended to use Inverted Logic configurations in safety applications where a hazardous situation can occur.

Signal states can be inverted by the use of NOT, NAND, and NOR logic blocks, or by selecting "Invert Output" or "Invert Input Source" check boxes (where available). On a Logic Block input, inverted logic treats a Stop state (0 or Off) as a "1" (True or On) and causes an output to turn On, assuming all inputs are satisfied. Similarly, the inverted logic causes the inverse function of an output when the block becomes "True" (output turns from On to Off). Because of certain failure modes that would result in loss of signal, such as broken wiring, short to GND/0 V, loss of safeguarding device supply power, etc., inverted logic is not typically used in safety applications. A hazardous situation can occur by the loss of a stop signal on a safety input, resulting in a safety output turning On.

AND

 (US) & (EU)

The output value is based on the logical AND of **2** to **5** inputs.

Output is On when <u>all inputs</u> are On.

Input 1	Input 2	Output
0	x	0
x	0	0
1	1	1

OR

 (US) ≥1 (EU)

The output value is based on the logical OR of **2** to **5** inputs.

Output is On when <u>at least one input</u> is On.

Input 1	Input 2	Output
0	0	0
1	x	1
x	1	1

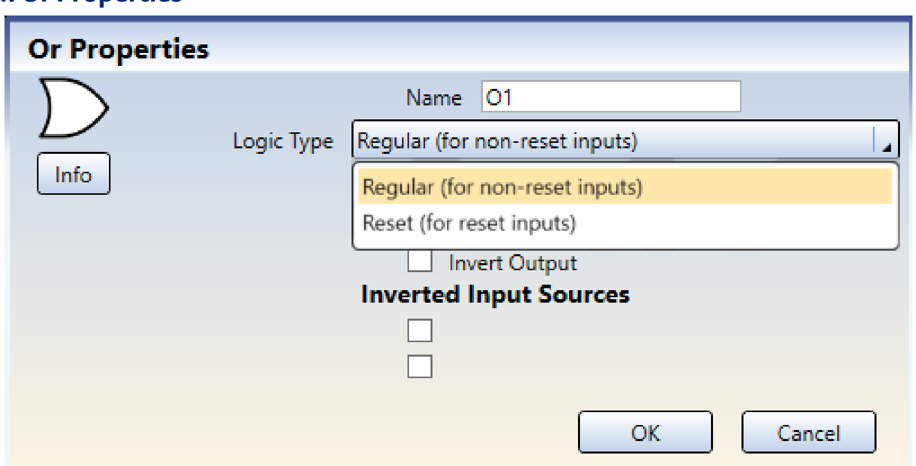
There are two types of OR logic blocks: Regular and Reset.

Reset Type OR Block Use so that more than one reset can perform the same reset function (like a hard-wired manual reset and a virtual manual reset) a Reset OR block function has been created. This special type of OR block only accepts reset inputs and can only be connected like a manual reset input in the logic.

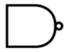
Regular Type OR Block Use to perform OR logic on any function that can be connected to an OR block (besides resets) the Regular Logic Type should be selected. Regular is the default setting for the OR logic block.

To select the desired Logic Type (regular or reset), use the **Logic Type** menu in the **Or Properties**.

Figure 74. Or Properties



NAND

 (US) 

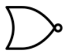
(EU)

The output value is based on inverting the logical AND of 2 to 5 inputs.

Output is Off when all inputs are On.

Input 1	Input 2	Output
0	x	1
x	0	1
1	1	0

NOR

 (US) 

(EU)

The output value is based on inverting the logical OR of 2 to 5 inputs.

Output is On when all inputs are Off.

Input 1	Input 2	Output
0	0	1
1	x	0
x	1	0

XOR

 (US) 

(EU)

The output value is an exclusive OR of 2 to 5 inputs.

Output is On when only one (exclusive) input is On.

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	0

NOT

 (US) 

(EU)

Output is the opposite of the input.

Input	Output
0	1
1	0

RS Flip-Flop

This block is Reset Dominant (Reset has priority if both inputs are On).

Input 1 (Set)	Input 2 (Reset)	Output
0	0	Value remains the same
0	1	0 (Reset)
1	0	1 (Set)
1	1	0 (Reset has priority)

SR Flip-Flop

SR

This block is Set Dominant (Set has priority if both inputs are On).

Input 1 (Set)	Input 2 (Reset)	Output
0	0	Value remains the same
0	1	0 (Reset)
1	0	1 (Set)
1	1	1 (Set has priority)

9.6.2 Function Blocks

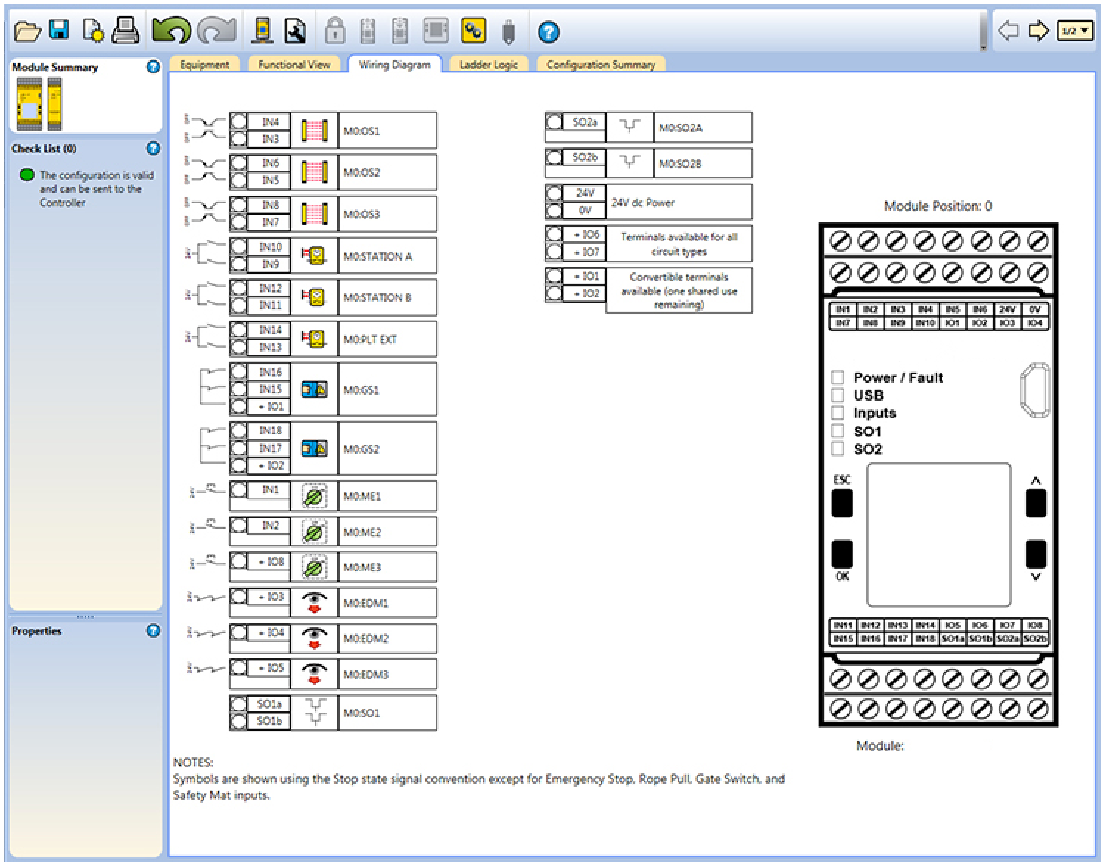
Function blocks provide built-in functionality for most common applications in one block. Although it is possible to design a configuration without any function blocks, using the function blocks offers substantial efficiency, ease of use, and improved functionality.

Most function blocks expect the corresponding safety input device to be connected to it. The checklist on the left creates a notification if any required connections are missing. Depending on the application, some function blocks may be connected to other function blocks and/or logic blocks.

Dual-channel safety input devices have two separate signal lines. Dual-channel signals for some devices are both positive (+24 V DC) when the device is in the Run state. Other devices may have a complementary circuit structure where one channel is at 24 V DC and the other is at 0 V DC when the device is in the Run state. This manual uses the Run state/Stop state convention instead of referring to a safety input device as being ON (24 V DC) or OFF (0 V DC).

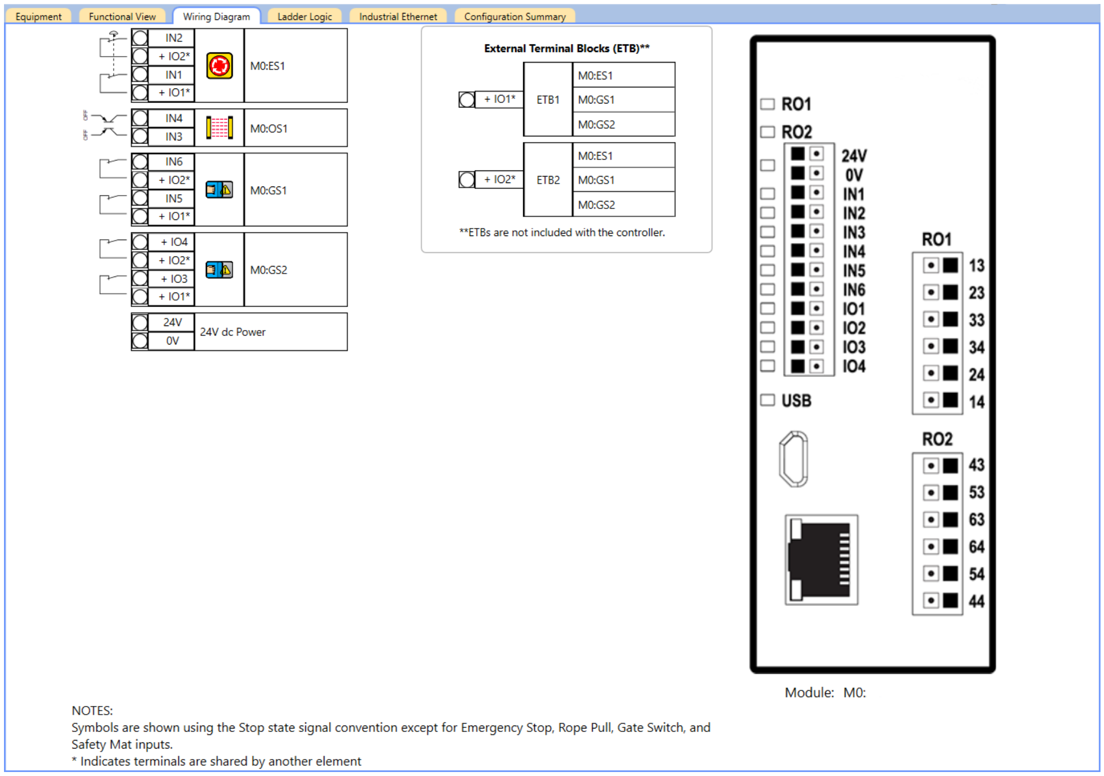
9.7 Wiring Diagram Tab

Figure 75. Wiring Diagram Tab—PACSafe Expandable 262



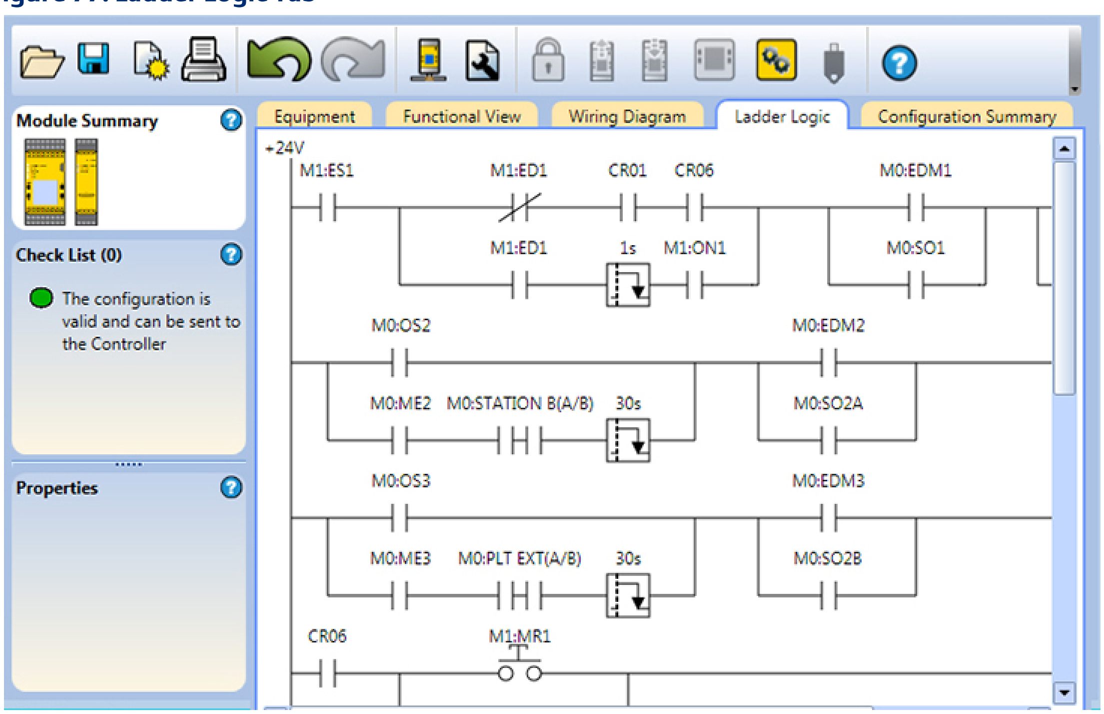
The **Wiring Diagram** tab shows the terminal assignments and the electrical circuits for the safety and non-safety inputs, Safety Outputs, and status outputs, and any terminals that are still available for the selected module. Use the wiring diagram as a guide to physically connect the devices. Navigate between modules using the Page Navigation toolbar at the top right corner of the Software.

Figure 76. Wiring Diagram Tab—PACSafe 102 with External Terminal Blocks



9.8 Ladder Logic Tab

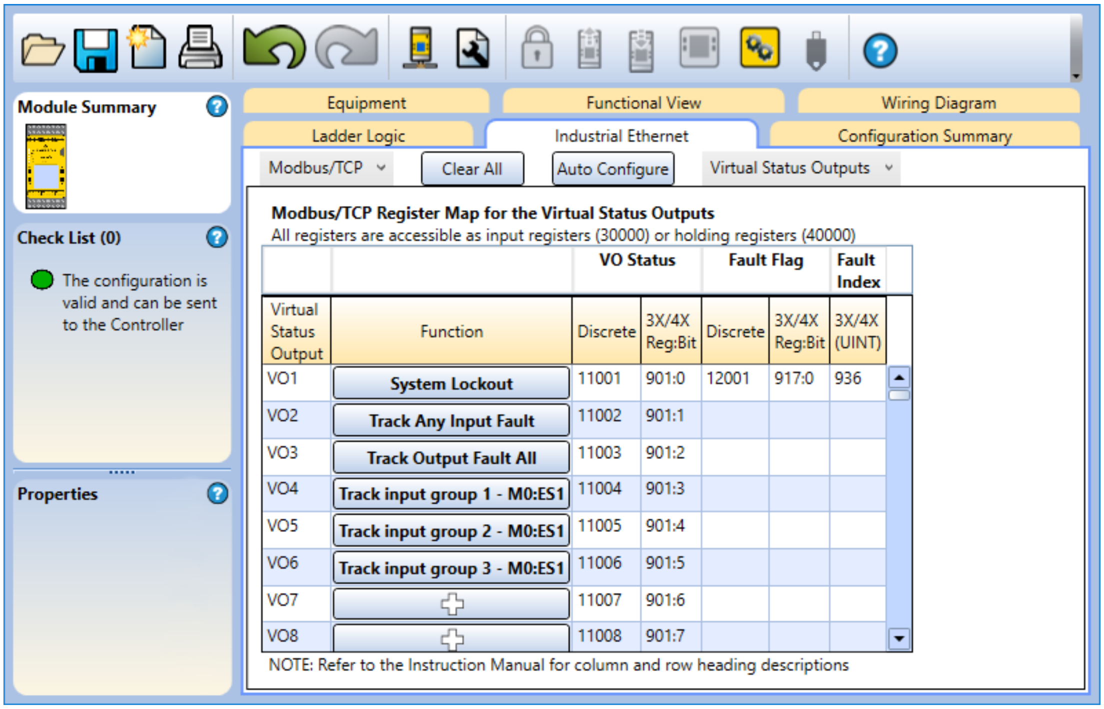
Figure 77. Ladder Logic Tab



The **Ladder Logic** tab displays a simplified relay logic rendering of the configuration.

9.9 Industrial Ethernet Tab

Figure 78. Industrial Ethernet Tab



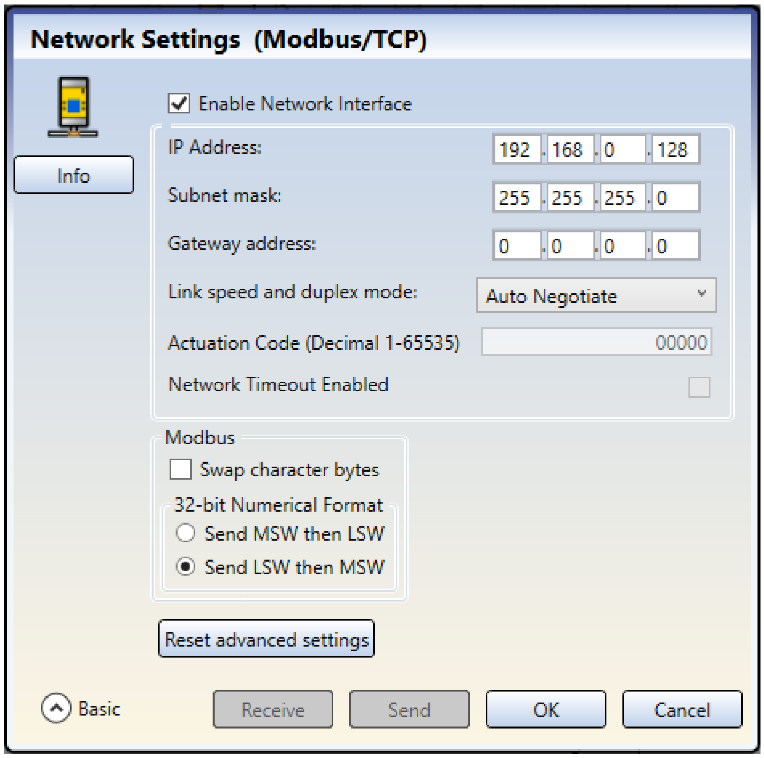
The **Industrial Ethernet** tab allows configuration of the Virtual Status Outputs, which offer the same functionality as **Status Outputs** (added on the **Equipment** tab) over the network (see Status Output Signal Conventions on p. 76 and Status Output Functionality on p. 77 for detailed information). Up to 256 Virtual Status Outputs can be added to the Safety Controller.

Use the **Auto Configure** function, located on the **Industrial Ethernet** tab, to automatically configure the Virtual Status Outputs to a set of commonly used functions, based on the current configuration. Click in the **Function** column next to any of the **VOx** cells to add a Virtual Status Output manually. Functions of all Virtual Status Outputs can be modified by clicking on the button that contains the name of the function of the Virtual Status Output or by clicking **Edit** under the **Properties** table when VOx is selected.

9.9.1 Network Settings

Network Settings: Modbus/TCP

Figure 79. Network Settings



Click **Network Settings** to open the **Network Settings** window. In the case of a Modbus/TCP connection, the default TCP port used is 502, by specification. This value is not shown in the **Network Settings** window.

Table 5: Default Network Settings

Setting Name	Factory Default Value
IP Address	192.168.0.128
Subnet Mask	255.255.255.0
Gateway Address	0.0.0.0
Link Speed and Duplex Mode	Auto Negotiate

An **Actuation Code** is required for configurations containing a virtual manual reset or cancel delay input.

The **Advanced** option allows further configuration of Modbus/TCP settings, such as Swap character bytes and MSW and LSW sending precedence.

Click **Send** to write the network settings to the Safety Controller. Network settings are sent separately from the configuration settings.

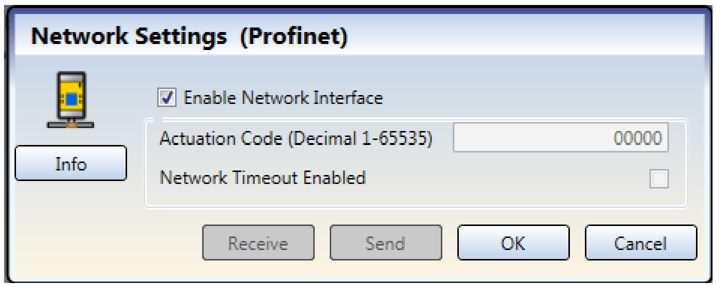
Click **Network Timeout Enabled** to have any configured Virtual On/Off or Virtual Mute Enable become inactive in the event of a network timeout condition. The network timeout time is fixed at 5 seconds.

Note: Use **Password Manager** to enable or disable the ability for User2 and User3 to change the network settings.

Network Settings: PROFINET

After selecting the PROFINET protocol on the **Industrial Ethernet** tab, click **Network Settings** to open the **Network Settings** window.

Figure 80. Network Settings—PROFINET



Click **Send** to write the network settings to the Safety Controller. Network settings are sent separately from the configuration settings.

Click **Network Timeout Enabled** to have all configured Virtual On/Off or Virtual Mute Enable become inactive in the event of a network timeout condition. The network timeout time is fixed at 5 seconds.

Note: Use **Password Manager** to enable or disable the ability for User2 and User3 to change the network settings.

9.9.2 PLC Tags/Labels File Creation

Use the PACSafe Studio Software to generate an .xml file that contains the names of all the virtual status outputs and inputs.

To use the names created in the PACSafe Studio software as the PLC Tags/Labels, import the .xml file into the PLC software for PLCs using PROFINET.

First, create all of the status outputs and inputs that are desired in the PACSafe Studio Software. Assign an actuation code under **Network Settings**, if needed. Then, make sure that the desired protocol is selected (PROFINET).

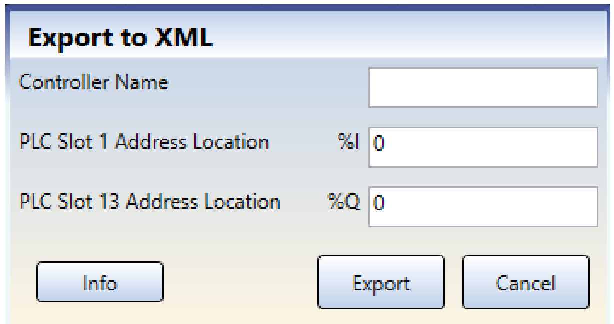
Create a XML File For PROFINET

Several items must be known:

- The name assigned to the Safety Controller in the PLC. This is needed to generate the file to import into the PROFINET PLC software
- PLC Slot 1 address location
- PLC Slot 13 address location

1. On the **Industrial Ethernet** tab, make sure **Profinet** is selected from the list at the left.
2. Click **Export**.
   The **Export to XML** window opens.

Figure 81. Export to XML

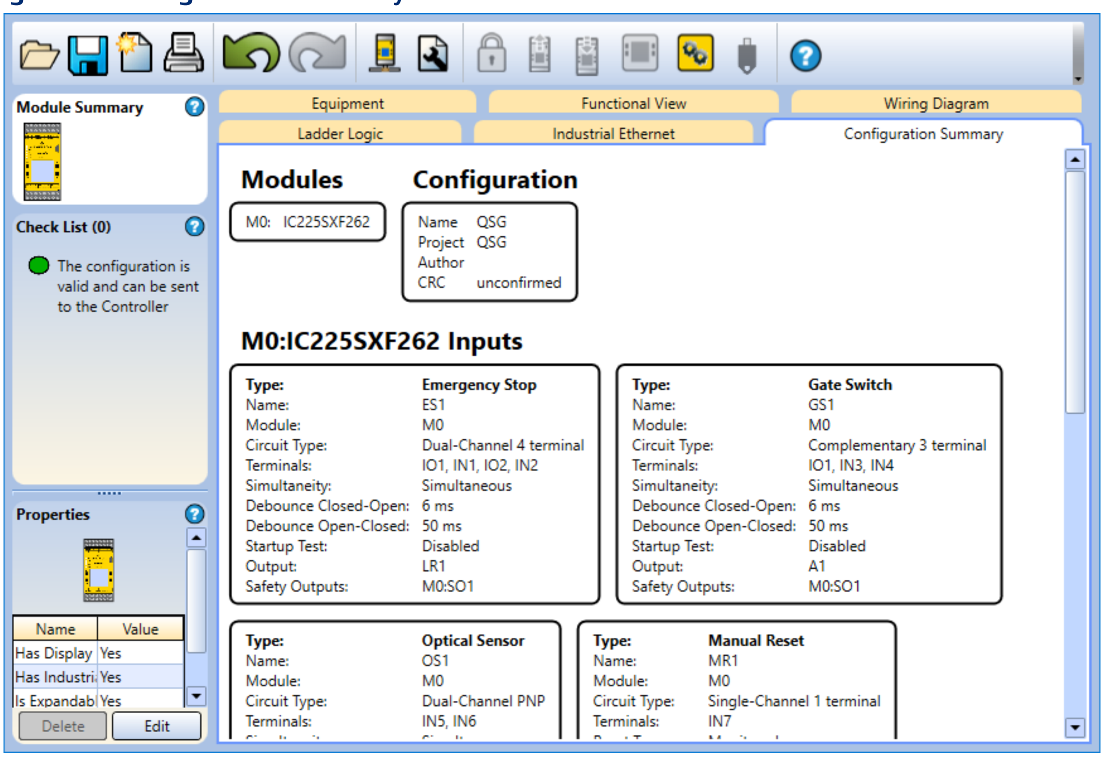


3. In the **Controller Name** field, enter the name assigned to the Safety Controller in the PLC software.
4. In the **PLC Slot 1 Address Location** field, enter the beginning address location of slot 1 (status outputs).
5. In the **PLC Slot 13 Address Location** field, enter the beginning address location of slot 13 (virtual inputs).
6. Click **Export**.
7. Save the .xml file to the desired location.

The .xml file is ready to be directly imported into the PROFINET PLC software or the file can be opened with any software that can read an .xml file.

9.10 Configuration Summary Tab

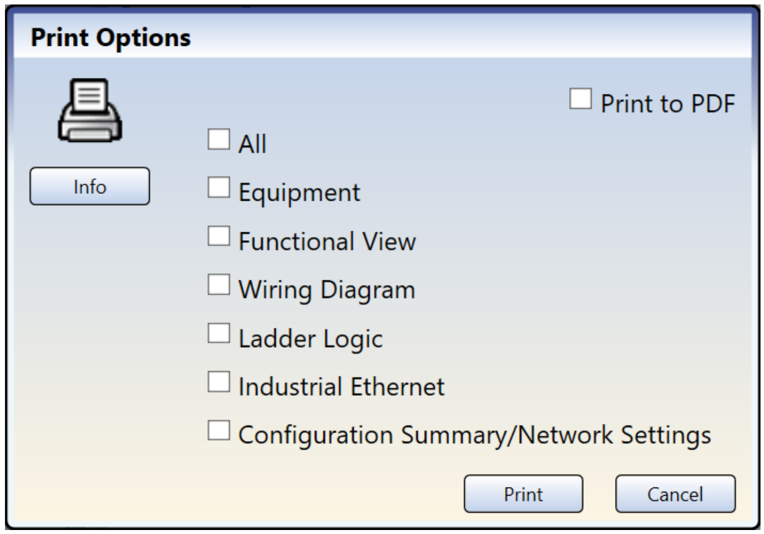
Figure 82. Configuration Summary Tab



The **Configuration Summary** tab displays the detailed information about all configured inputs, Function and Logic Blocks, Safety Outputs, Status Outputs, and the related Response Times in a text format.

9.11 Print Options

Figure 83. Print Options



The Software provides several options to print the configuration. Click **Print** on the toolbar to access the **Print Options** window.

The following print choices are available:

- **All**—Prints all views, including **Network Settings**
- **Equipment**—Prints the **Equipment** tab
- **Functional View**—Prints the **Functional View** tab
- **Wiring Diagram**—Prints the **Wiring Diagram** tab
- **Ladder Logic**—Prints the **Ladder Logic** tab
- **Industrial Ethernet**—Prints the **Industrial Ethernet** tab
- **Configuration Summary/Network Settings**—Prints the **Configuration Summary** and **Network Settings** (when available)

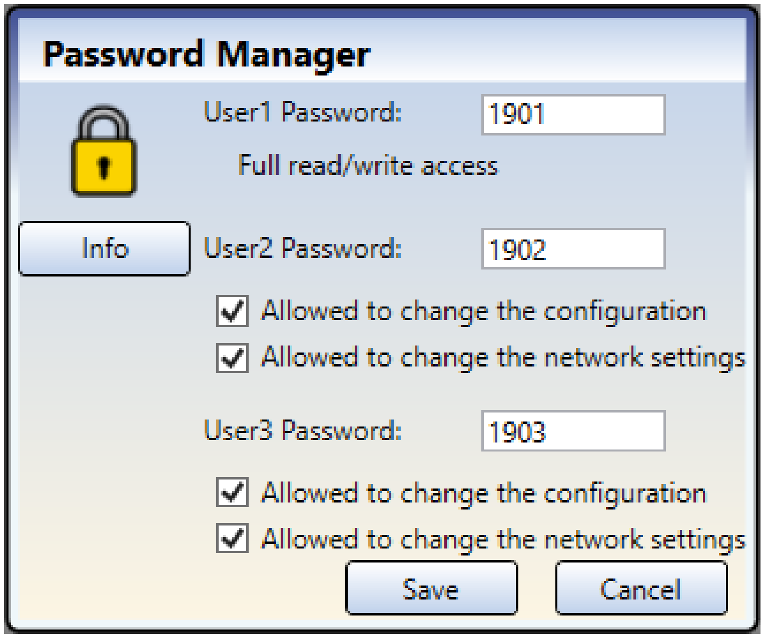
Printing Options:

- **Print to PDF**—Prints the selection to a PDF file stored in a user-defined location
- **Print**—Opens the default Windows Print dialog and sends the selection to the user-defined printer

9.12 PACSafe 262 Password Manager

Password Manager is available when a Safety Controller is connected to the PC via USB. The information shown in **Password Manager** comes from the Safety Controller.

Figure 84. PACSafe 262 Password Manager



Click **Password Manager** on the Software toolbar to edit the configuration access rights. The Safety Controller stores up to three user passwords to manage different levels of access to the configuration settings. The password for User1 provides full read/write access and the ability to set access levels for User2 and User3 (user names cannot be changed). Basic information, such as network settings, wiring diagrams, and diagnostic information, is accessible without a password. A configuration stored on a PC or an IC225ACC001 drive is not password-protected.

User2 or User3 can write the configuration to the Safety Controller when **Allowed to change the configuration** is enabled. They can change the network settings when **Allowed to change the network settings** is enabled.

Click **Save** to write the password information to the Safety Controller.

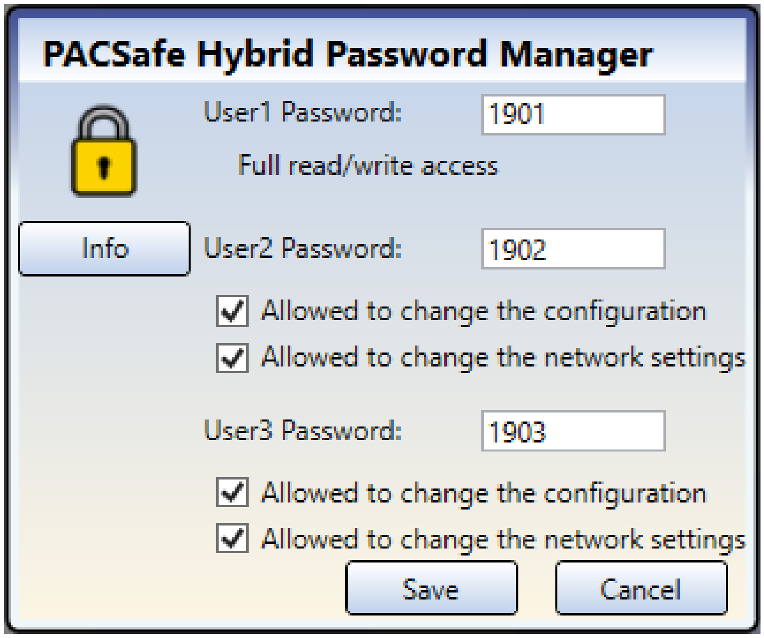
Only User1 can reset the PACSafe 262 back to the factory defaults.

Note: The default passwords for User1, User2, and User3, are 1901, 1902, and 1903, respectively. It is highly recommended to change the default passwords to new values.

9.13 PACSafe 102 Password Manager

Password Manager is available when a Safety Controller is connected to the PC via USB. The information shown in **Password Manager** comes from the Safety Controller.

Figure 85. PACSafe 102 Password Manager



Click **Password Manager** on the Software toolbar to edit the configuration access rights. The Safety Controller stores up to three user passwords to manage different levels of access to the configuration settings. The password for User1 provides full read/write access and the ability to set access levels for User2 and User3 (user names cannot be changed). The configuration, network settings, wiring diagrams, and diagnostic information are accessible without a password. A configuration stored on a PC or an IC225ACC001 drive is not password-protected.

User2 or User3 can write the configuration to the Safety Controller when **Allowed to change the configuration** is enabled. They can change the network settings when **Allowed to change the network settings** is enabled. Their respective passwords will be required.

Click **Save** to apply the password information to the current configuration in the Software and to write the password information to the Safety Controller.

> **Note:** The default passwords for User1, User2, and User3, are 1901, 1902, and 1903, respectively. It is highly recommended to change the default passwords to new values.

Only User1 can reset the PACSafe 102 back to the factory defaults.

9.14 Viewing and Importing Controller Data

The PACSafe Studio Software allows viewing or copying current Safety Controller data, such as model number and firmware version, configuration and network settings, and the wiring diagram.

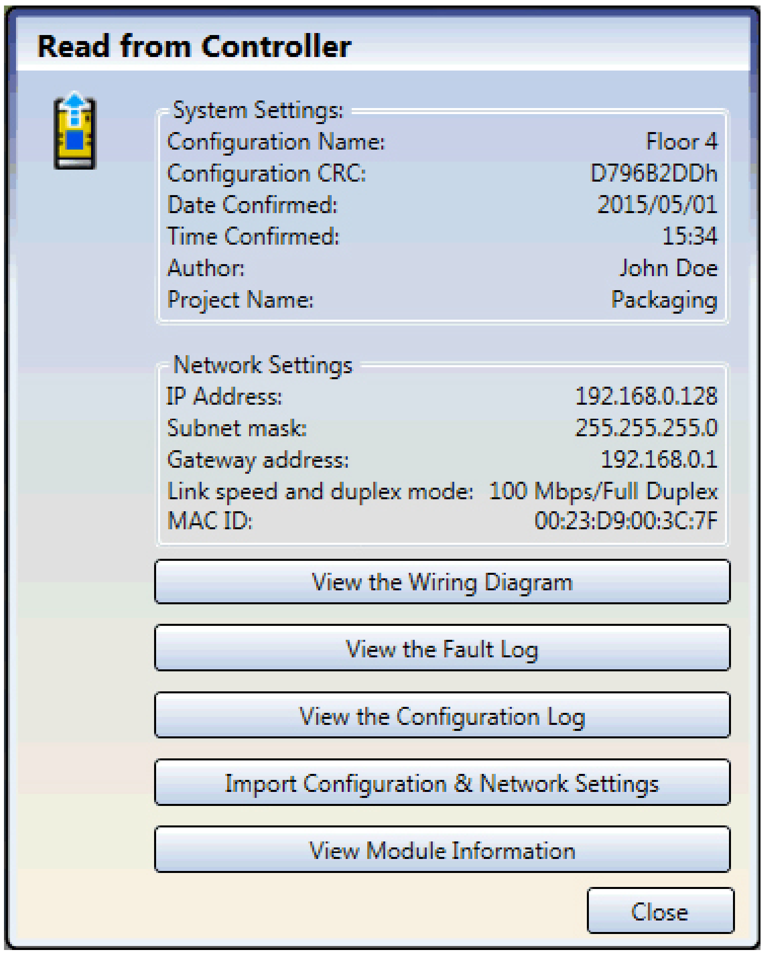
Read from Controller is available when a Safety Controller is connected to the PC via USB.

Viewing System and Network Settings Snapshot

Click **Read from Controller** on the Software toolbar. The current Safety Controller settings are displayed:

- Configuration Name
- Configuration CRC
- Date Confirmed
- Time confirmed
- Author
- Project Name
- IP Address
- Subnet mask
- Gateway address
- Link speed and duplex mode
- MAC ID

Figure 86. Viewing System and Network Settings Snapshot



Viewing and Importing Controller Data

Click **Read from Controller** to view:

- **Wiring Diagram**—Removes all other tabs and worksheets from the Software and displays only **Wiring Diagram** and **Equipment** tabs
- **Fault Log**—History of the last 10 faults

Note: Fault Log numbering increases up to 4,294,967,295 unless the Safety Controller power cycle is performed, in which case the numbering is reset to start at 1. Clearing the Fault Log (either via the Software or the onboard interface) removes the log history but retains the numbering.

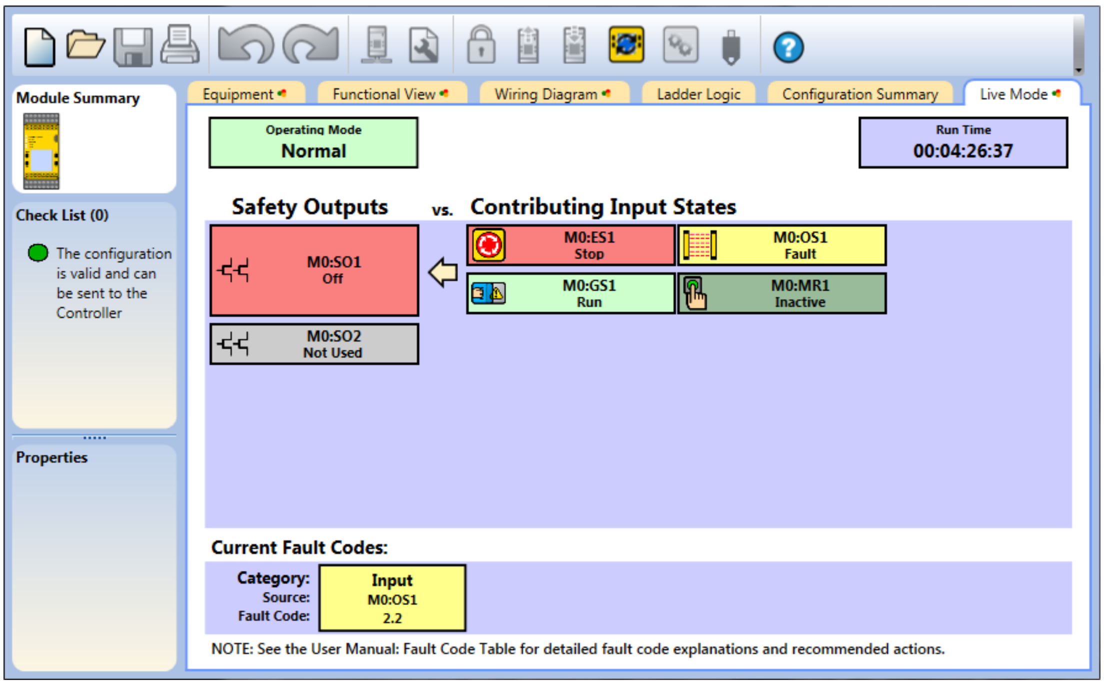
- **Configuration Log**—History of up to 10 most recent configurations (only the current configuration can be viewed or imported)
- **Module Information**

Click **Import Configuration & Network Settings** to access the current Safety Controller configuration and network settings (depends on user access rights, see PACSafe 262 Password Manager on p. 117 or PACSafe 102 Password Manager on p. 118).

9.15 Live Mode

Live Mode is available when a Safety Controller is connected to the PC via USB.

Figure 87. Run Time—PACSafe 262 Live Mode Tab



The **Live Mode** tab becomes accessible when **Live Mode** is clicked on the toolbar. Enabling **Live Mode** disables configuration modification on all other tabs. The **Live Mode** tab provides additional device and fault information, including a fault code (see PACSafe 262 Fault Code Table on p. 216 and PACSafe 102 Fault Code Table on p. 223 for the description and possible remedies). The Run-time data is also updated on the **Functional View**, **Equipment**, and **Wiring Diagram** tabs providing the visual representation of the device states.

Figure 88. Run Time—Equipment Tab

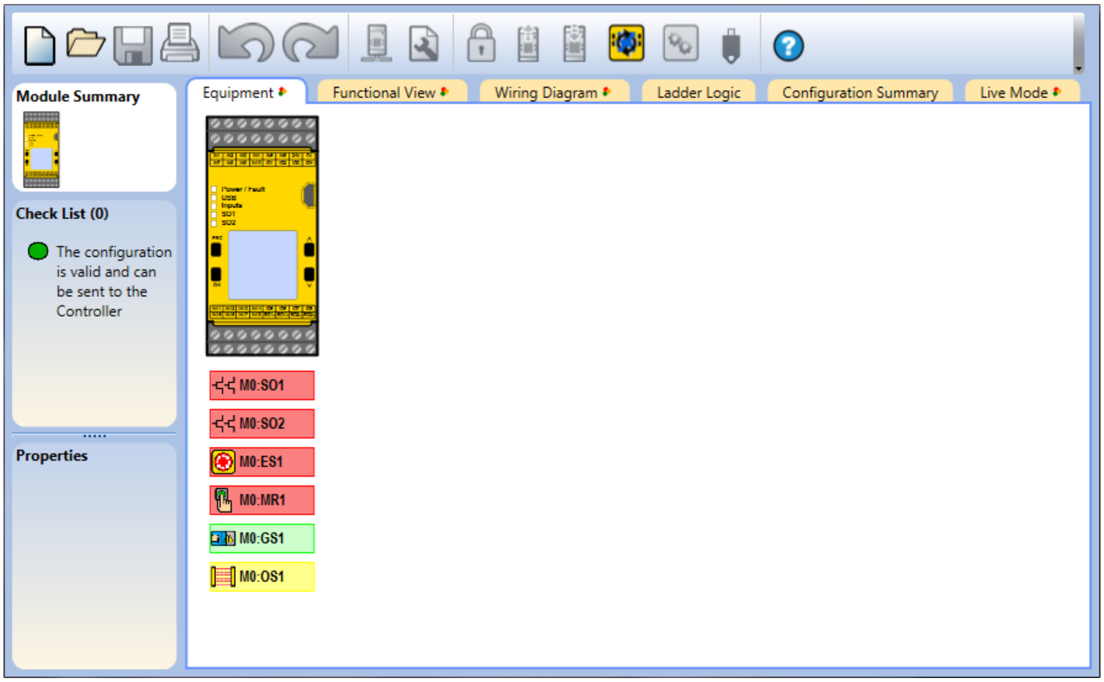


Figure 89. Run Time—Functional View Tab

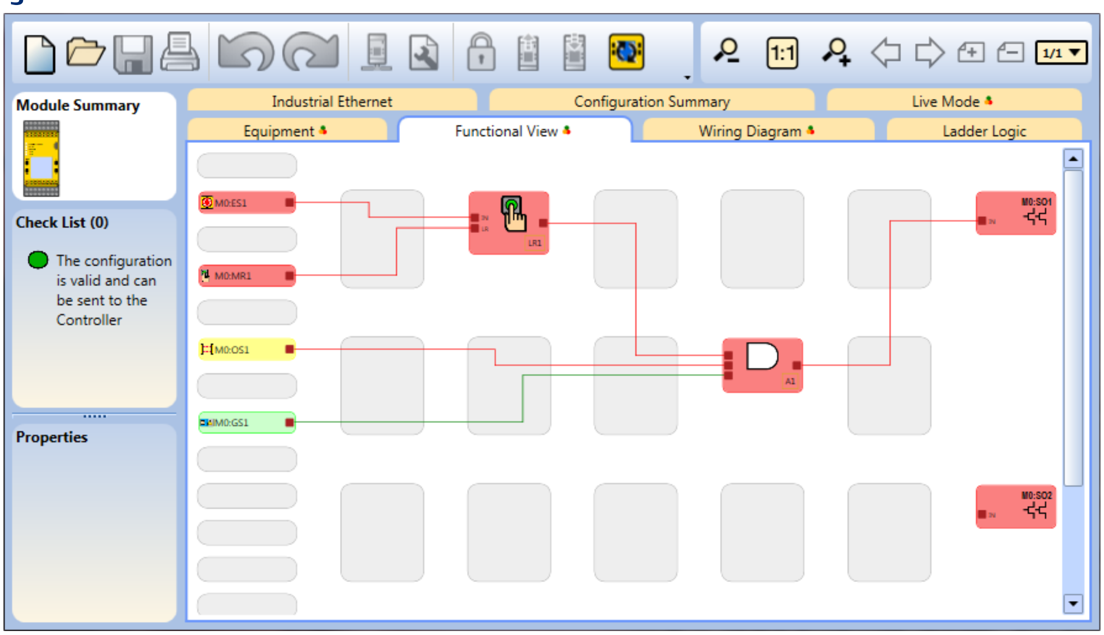
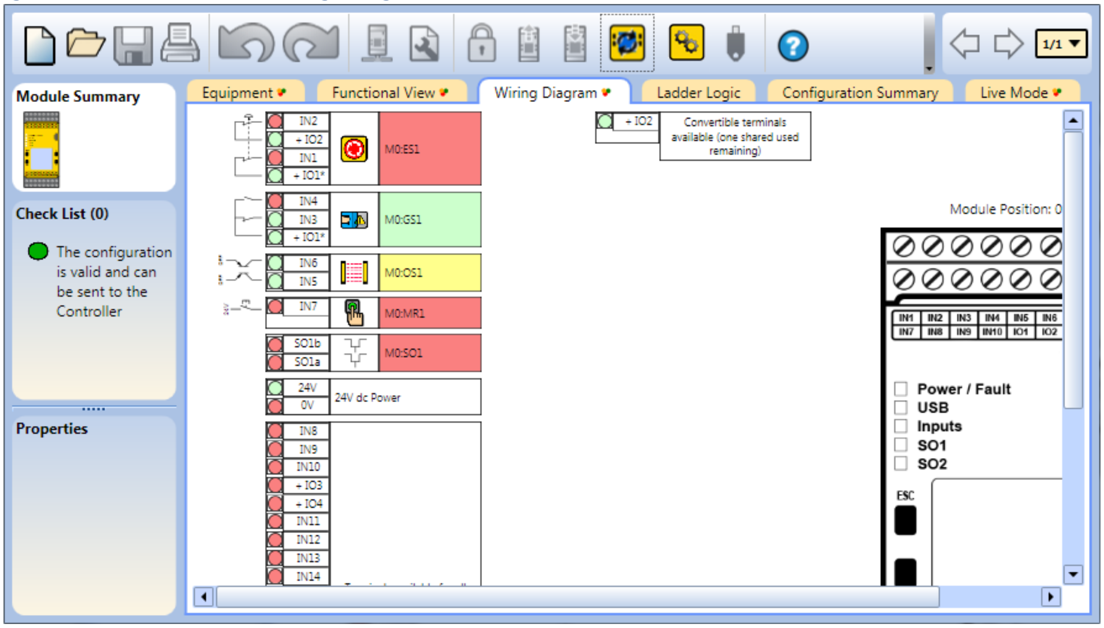
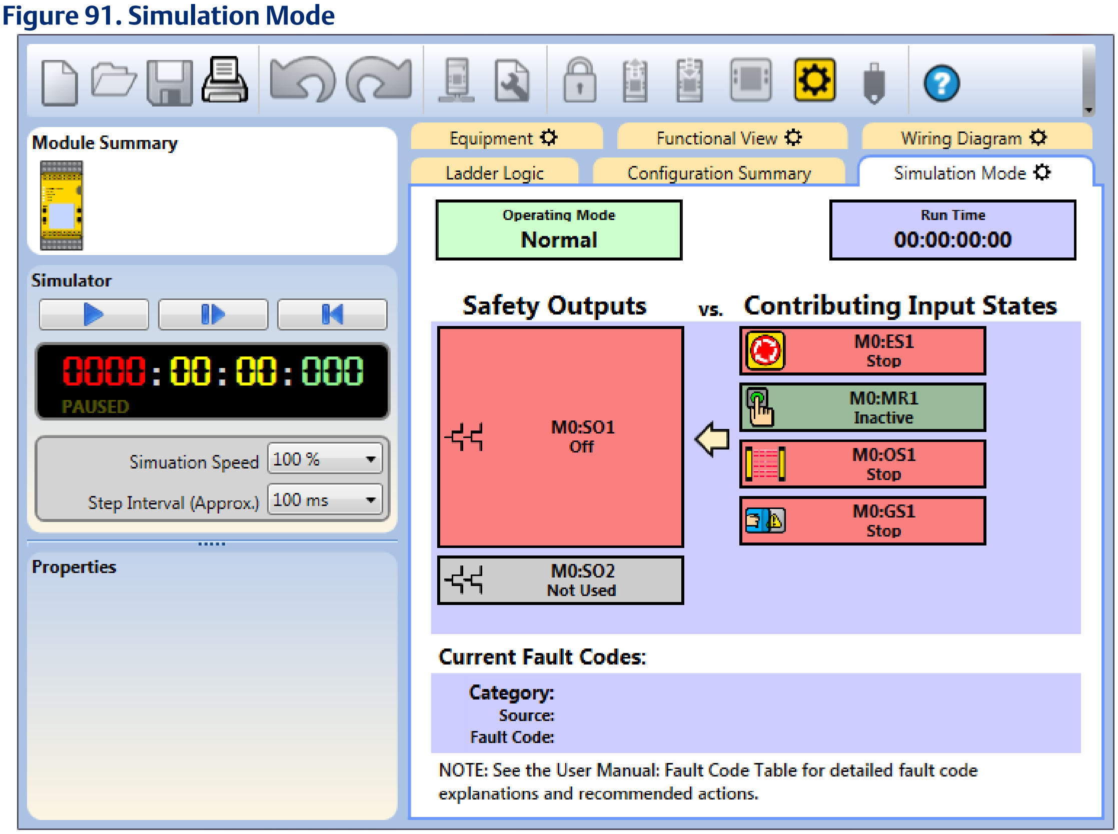


Figure 90. Run Time—Wiring Diagram Tab



9.16 Simulation Mode

Figure 91. Simulation Mode



The **Simulation Mode** tab becomes accessible when **Simulation Mode** is clicked on the toolbar. Simulation Mode options become available on the left side of the screen. The **Simulation Mode** tab contains view only information; you cannot click on the output or input items in this view.


[Play/Pause] Starts the simulation time running at the specified simulation speed or temporarily stops the simulation time.


[Single Step] Advances the simulation time at the specified step interval.


[Reset] Resets the timer to zero and the equipment to the initial stop state.

[Timer] Displays elapsed time in hours, minutes, seconds, and thousandths of a second.

Simulation Speed—Sets the speed of the simulation.

- 1%
- 10%
- 100% (default speed)
- 500%
- 2,000%

Step Interval—Sets the amount of time that the Single Step button advances when pressed. The amount of time is based on the size of the configuration.

Press **Play** to begin the simulation. The timer runs and gears spin to indicate that the simulation is running. The **Functional View**, **Equipment**, and **Wiring Diagram** tabs update, providing visual representation of the simulated device states as well as allowing testing of the configuration. Click on the items to be tested; their color and state change accordingly. Red indicates the Stop or off state. Green indicates the Run or on state. Yellow indicates a Fault state. Orange indicates that the input was turned on before the initial start of the simulation. Due to a start-up off test requirement, the input must be seen as off before it can be recognized as on.

Figure 92. Simulation Mode—Equipment Tab

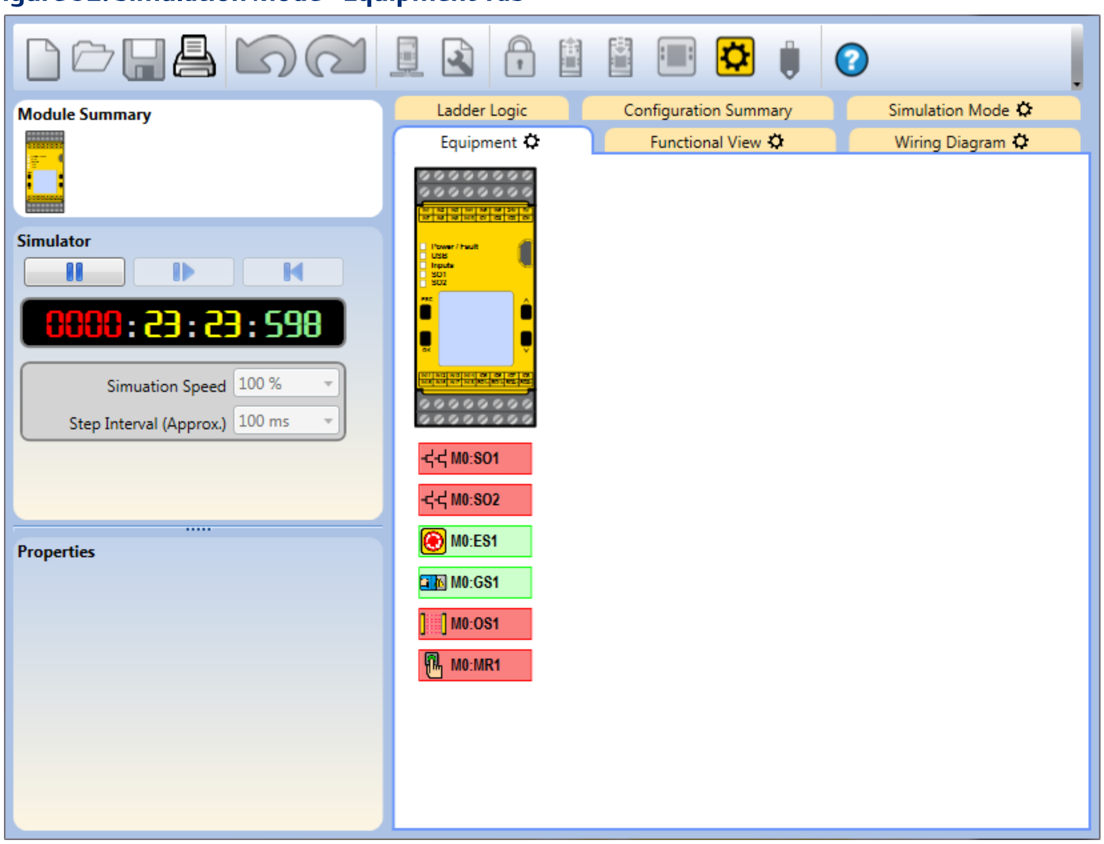


Figure 93. Simulation Mode—Wiring Diagram Tab

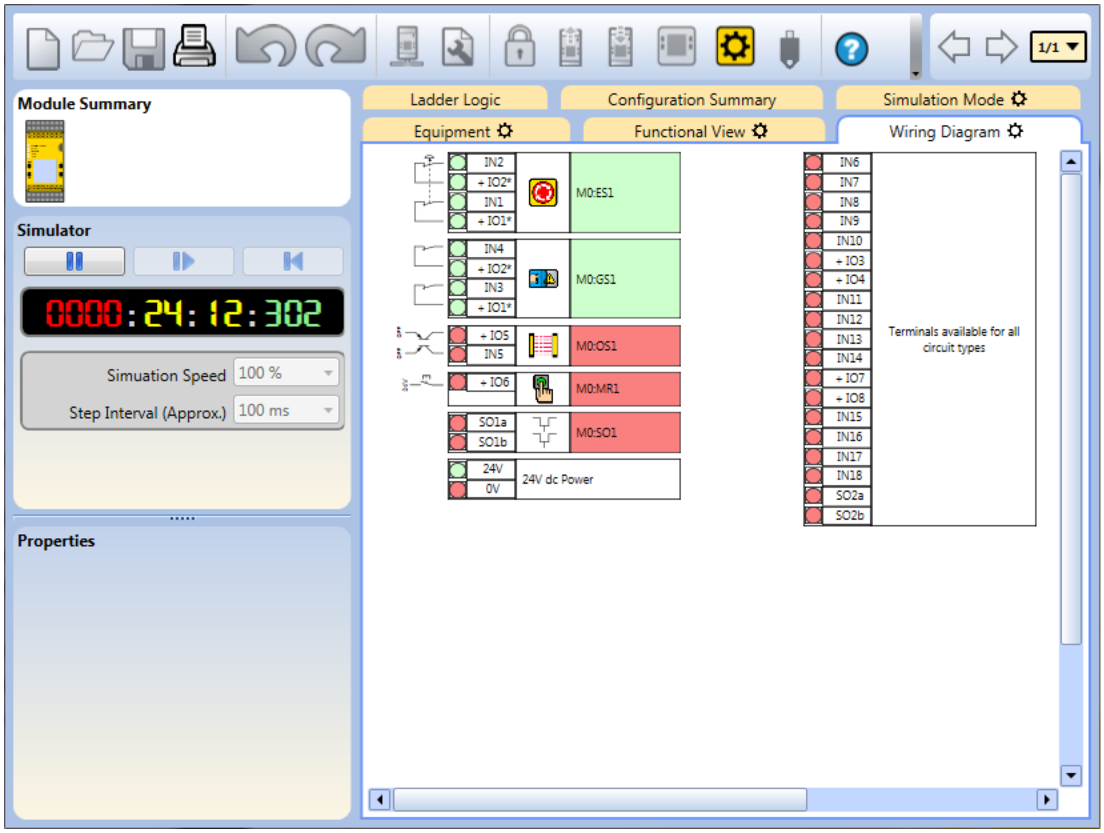
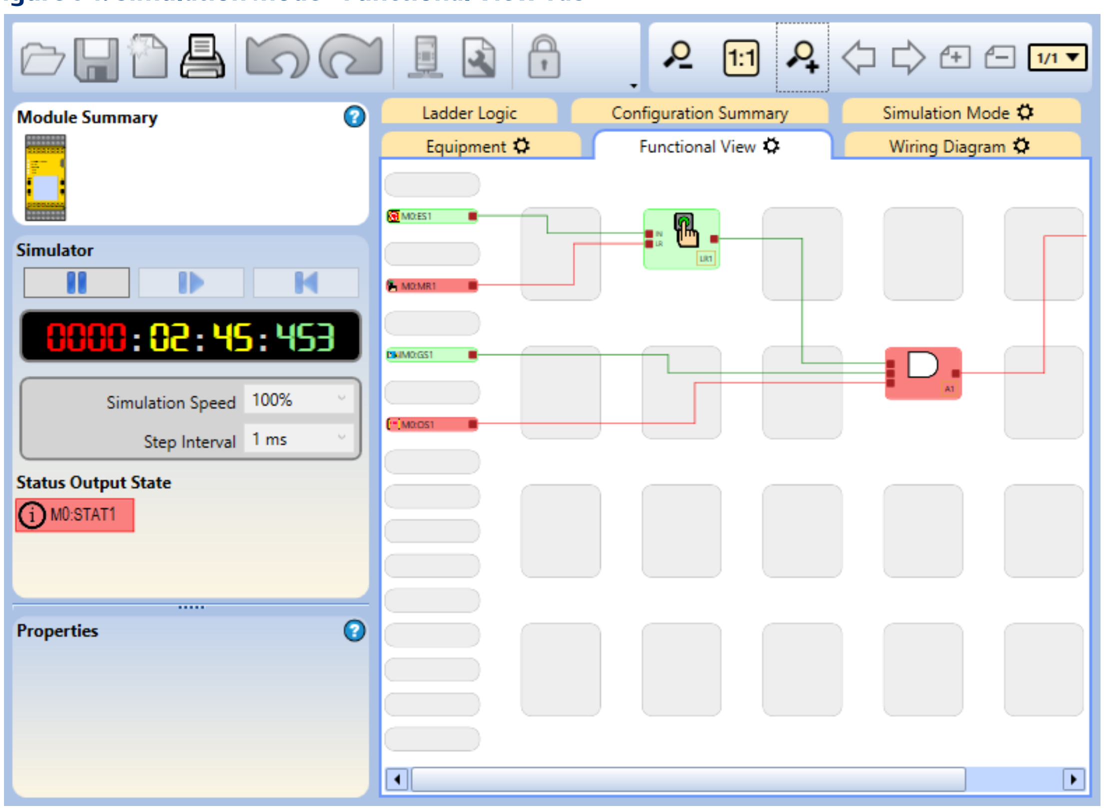


Figure 94. Simulation Mode—Functional View Tab



9.16.1 Timed Action Mode

While in Simulation Mode and on the **Functional View** tab, certain elements which are in delay action modes are indicated in purple. The progress bar shows the countdown of the associated timer for that element.

The following figures show the different element states:

Figure 95. Safety output in Delay Off Timing mode

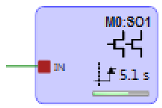
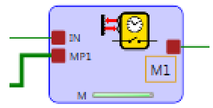


Figure 96. Muting Block in Timed Muting mode



Note: The M next to the progress bar indicates Timer Muting.

Figure 97. Bypass Block in Timed Bypass mode

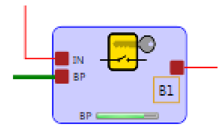


Figure 98. Delay Block

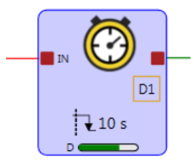
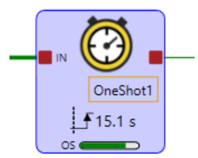


Figure 99. One Shot Block—PACSafe 262

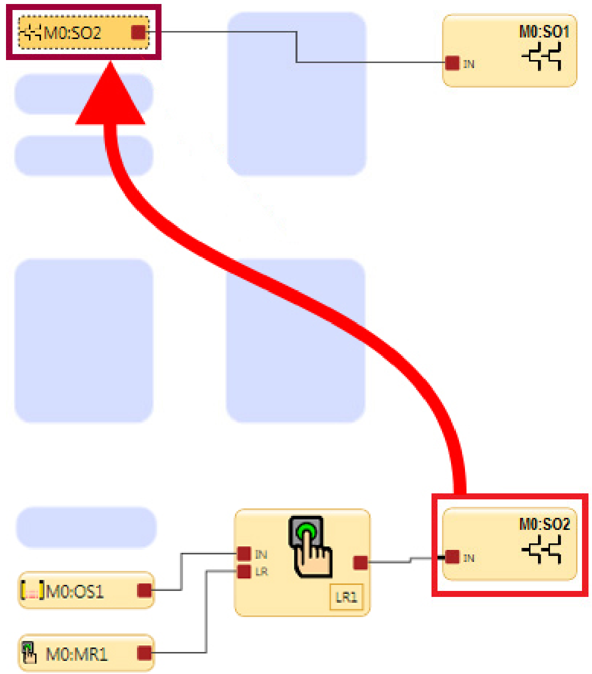


9.17 Reference Signals

Important: The configuration software incorporates Reference Signals that represent the state of Safety Controller outputs, input devices and both Function and Logic Blocks. A Safety Output reference signal can be used to control another Safety Output. In this type of configuration, the physical On state of the controlling Safety Output is not known. If the Safety Output On state is critical for the application safety, an external feedback mechanism is required. Note that the safe state of this Safety Controller is when the outputs are turned Off. If it is critical that Safety Output 1 is On before Safety Output 2 turns On, then the device that is being controlled by the Safety Output 1 needs to be monitored to create an input signal that can be used to control Safety Output 2. The Safety Output 1 reference signal may not be adequate in this case.

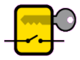
Figure 100 on p. 126 shows how one Safety Output can control another Safety Output. When Manual Reset **M0:MR1** is pressed, it turns On Safety Output **M0:SO2**, which, in turn, turns On Safety Output **M0:SO1**.

Figure 100. Safety Output controlled by another Safety Output



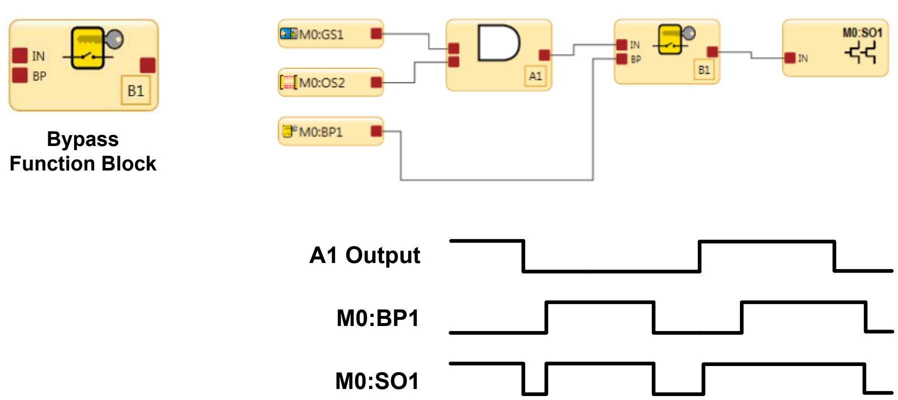
10 Function Block Descriptions

The following sections describe the available Function Blocks in detail.

10.1  Bypass Block

Default Nodes	Additional Nodes	Notes
IN BP	-	When the BP node is inactive, the safety signal simply passes through the Bypass Block. When the BP node is active, the output of the block is On regardless of the state of the IN node (if the **Output turns Off when both inputs (IN&BP) are On** checkbox is clear). The Bypass Block output turns Off when the bypass timer expires.

Figure 101. Timing Diagram—Bypass Block



Bypass Time Limit

A bypass function time limit must be established to limit how long the safety input device bypass is active. The time limit can be adjusted from 1 second (default) to 12 hours and cannot be disabled. Only one time limit can be set, and this limit will apply to all safety devices that are bypassed. At the end of the time limit, the safety output control authority is transferred back to the bypassed safety input devices.

Two-Hand Control Bypassing

The Safety Controller issues a Stop signal if a Two-Hand Control input is actuated while the input is being bypassed. This ensures that the operator does not mistakenly assume that the Two-Hand Control is functional; unaware that the Two-Hand Control is bypassed and no longer providing the safeguarding function.

10.1.1 Lockout/Tagout

Hazardous energy must be controlled (lockout/tagout) in machine maintenance and servicing situations in which the unexpected energization, start up, or release of stored energy could cause injury.

Refer to OSHA 29CFR 1910.147, ANSI 2244.1, ISO 14118, ISO 12100 or other relevant standards to ensure that bypassing a safeguarding device does not conflict with the requirements that are contained within the standards.

WARNING:

- **Limit the use of the bypass and/or override function**
- Failure to follow these instructions could result in serious injury or death.
- The bypass and/or override function is not intended for production purposes; use it only for temporary or intermittent actions, such as to clear the defined area of a safety light curtain if material becomes stuck. When bypass and/or override is used, the user must install and use it according to applicable standards (such as NFPA 79 or IEC/EN60204-1).

Safe Working Procedures and Training

Safe work procedures provide the means for individuals to control exposure to hazards through the use of written procedures for specific tasks and the associated hazards. The user must also address the possibility that an individual could bypass the safeguarding device and then either fail to reinstate the safeguarding or fail to notify other personnel of the bypassed condition of the safeguarding device; both cases could result in an unsafe condition. One possible method to prevent this is to develop a safe work procedure and ensure personnel are trained and correctly follow the procedure.

10.2 Delay Block

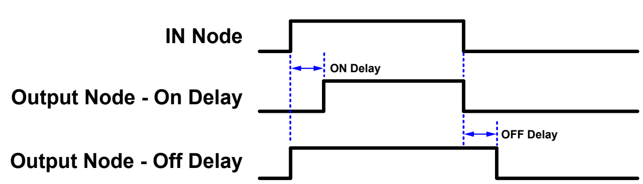
The Delay Block allows a user-configurable ON- or OFF-Delay of a maximum of 5 minutes, in 1 ms increments.

Default Nodes	Additional Nodes	Notes
IN	CD	Depending on the selection, a signal/state transition on the input node will be delayed by the output delay time by either holding the output OFF (ON-Delay) or holding the output ON (OFF-Delay) after a signal transition.

Note: The actual delay time of a delay function block or a safety output with a delay can be up to 1 scan time longer than the delay setting. Multiple delay blocks or delay outputs in series will increase the final delay time by up to 1 scan for each delay function. For example, three 100 ms off delay function blocks in series and a scan time of 15 ms may result in an actual delay time of up to 345 ms (300 ms + 45 ms).

The Cancel Delay Node is a configurable node if OFF-Delay is selected.

Figure 102. Delay Block Timing Diagram

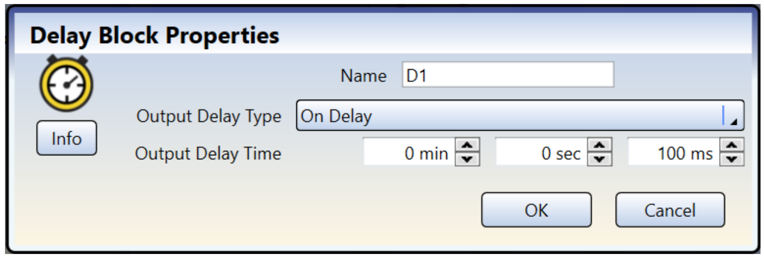


CAUTION: Delay time effect on response time

The OFF-Delay time may significantly increase the safety control response time. This will affect the positioning of safeguards whose installation is determined by the safety (minimum) distance formulas or are otherwise influenced by the amount of time to reach a non-hazardous state. The installation of safeguards must account for the increase in response time.

Note: The response time provided on the **Configuration Summary** tab is a maximum time that can change depending on the use of delay blocks and other logic blocks (such as OR functions). It is the user's responsibility to determine, verify, and incorporate the appropriate response time.

Figure 103. Delay Block Properties



The **Delay Block Properties** window allows the user to configure the following:

Name

The input designation.

Output Delay Type

This is the Output Delay Type

- None
- OFF-Delay
- ON-Delay

Output Delay Time

Available when the Safety Output Delay is set to either OFF-Delay or ON-Delay

Delay time: 1 ms to 5 minutes, in 1 ms increments. The default setting is 100 ms.

Cancel Type

Available when the Safety Output Delay is set to OFF-Delay.

- Do Not Cancel
- Control Input (The delay block output stays on if the input turns ON again before the end of the delay.)
- Cancel Delay Node

End Logic

Available when the Cancel Type is set to Cancel Delay Node.

- Keep Output ON
- Turn Output OFF

10.3 Enabling Device Block

Default Nodes	Additional Nodes	Notes
ED IN RST	ES JOG	An Enabling Device Block must be connected directly to an Output Block. This method assures that the final control of the outputs is given to the operator holding the Enabling Device (ED). Use the ES node for safety signals that should not be bypassed by the ED node. If no other inputs of the function block are configured, using an Enabling Device function block is not required.

Figure 104. Timing Diagram—Enabling Device, Simple Configuration

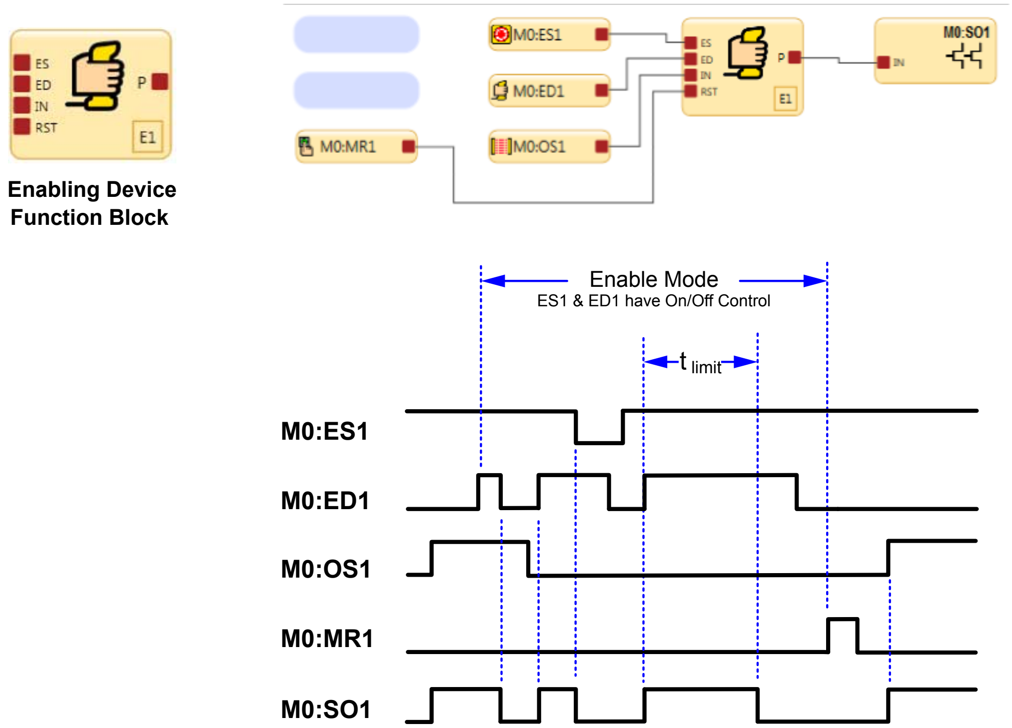
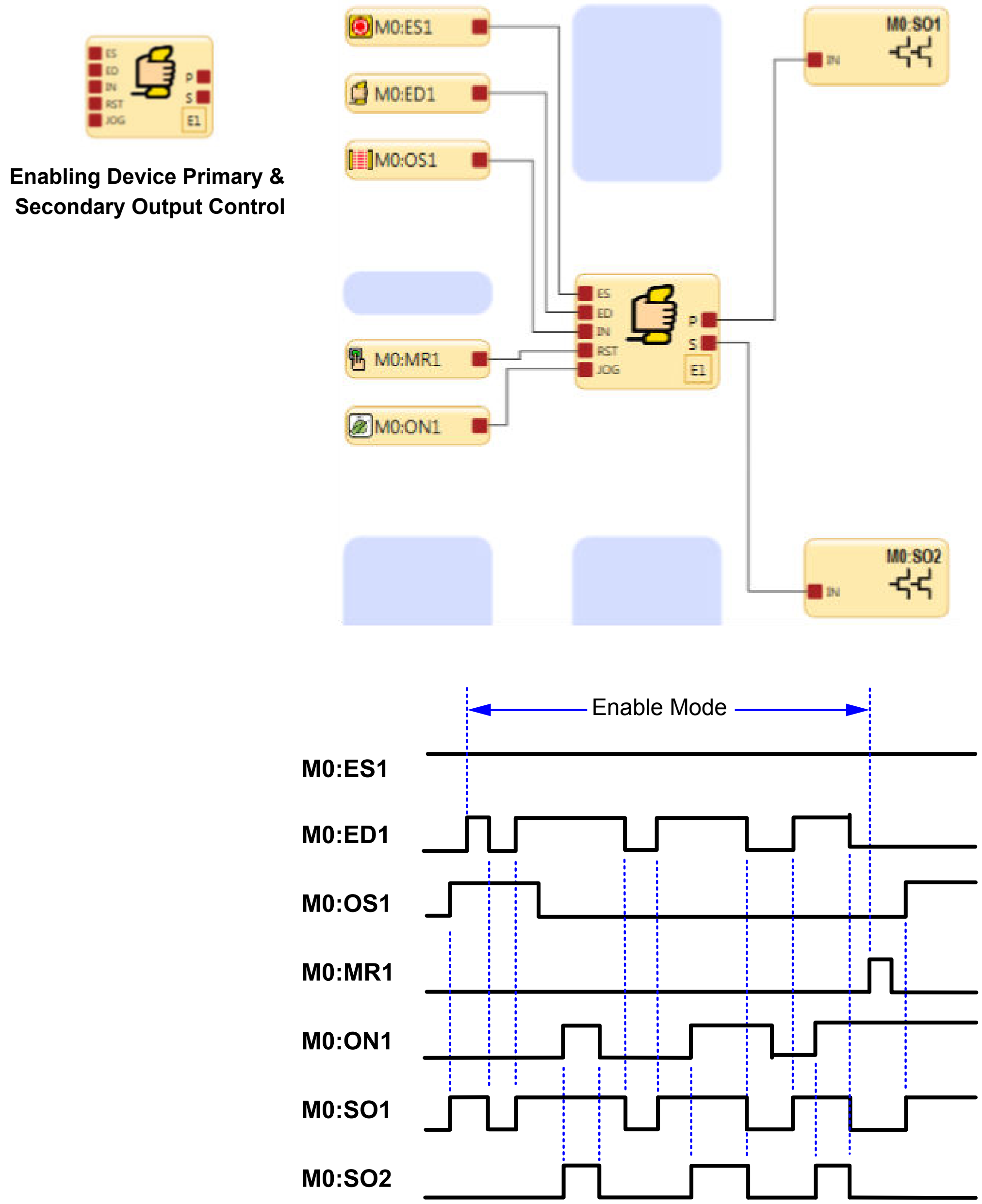


Figure 105. Timing Diagram—Enabling Device



E1 enabling mode starts when the Enabling Device ED1 is switched to the Run state. ED1 and ES input devices have On/Off control authority while in Enable mode. When MR1 is used to perform a reset, the normal Run mode is re-established and OS1 and ES1 have the On/Off control authority.

To exit the Enable mode, the enabling device must be in the OFF state, and an Enabling Device Block reset must be performed.

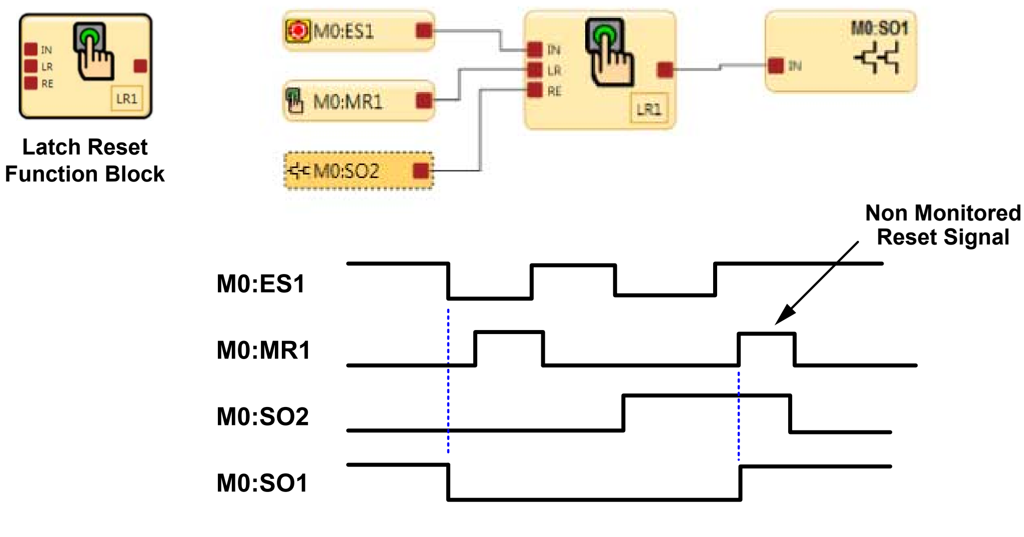
The enabling device time limit may be adjusted between 1 second (default) and 30 minutes and cannot be disabled. When the time limit expires, the associated safety outputs turn OFF. To start a new Enable mode cycle, with the time limit reset to its original value, the enabling device must switch from ON to OFF, and then back to ON.

All ON- and OFF-delay time limits associated with the safety outputs that are controlled by the enabling device function are followed during the Enable mode.

10.4 Latch Reset Block

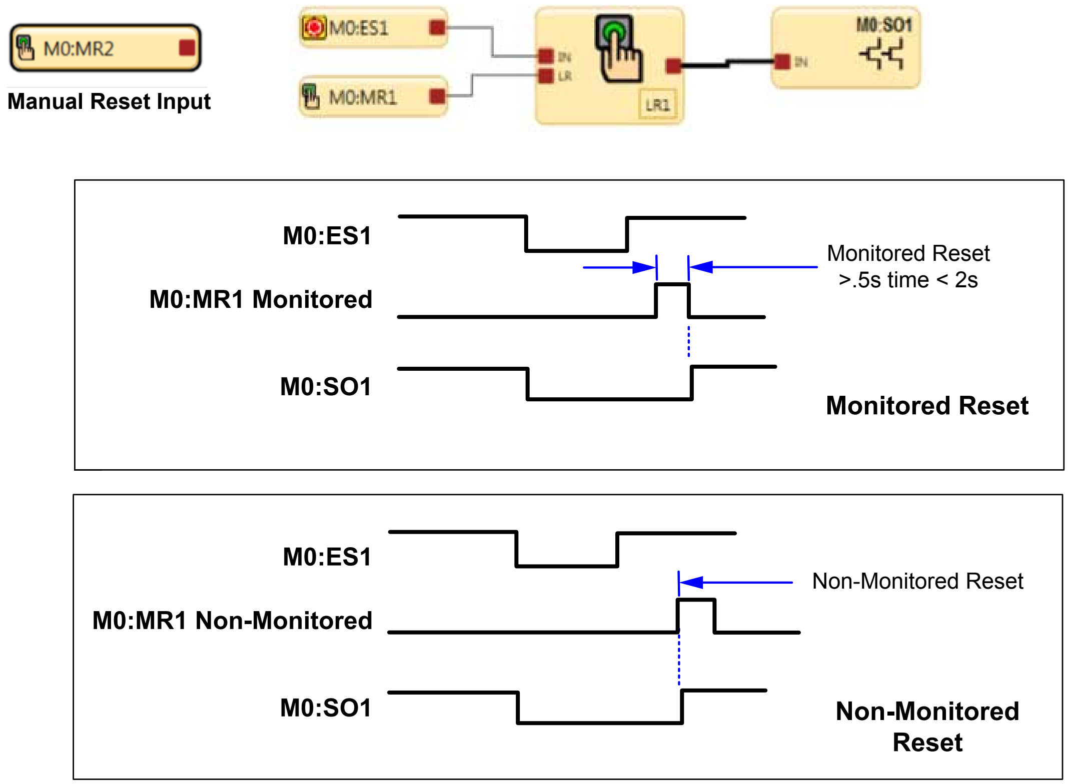
Default Nodes	Additional Nodes	Notes
IN LR	RE	The RE (Reset Enable) node can be used to enable or disable the Latch Reset function. If the input devices connected to the IN node are all in the Run state and the RE input signal is high, the LR function block can be manually reset to have its output turn ON. See Figure 106 on p. 132 with Reference Signal SO2 connected to the RE node.

Figure 106. Timing Diagram—Latch Reset Block



The Latch Reset function block LR1 will turn its output and the safety output SO1 Off when the E-Stop button changes to the Stop state.
The latch off condition can be reset when the Reset Enable RE of LR1 detects that the SO2 reference signal is in the Run state & MR1 is used to perform a reset.

Figure 107. Timing Diagram—Latch Reset Block, Monitored/Non-Monitored Reset

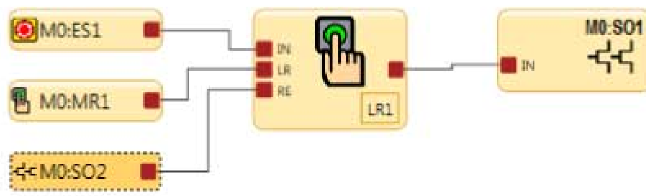


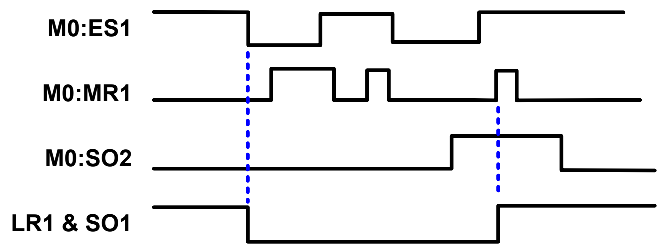
The Manual Reset input device can be configured for one of two types of reset signals: Monitored & Non-Monitored

Figure 108. Timing Diagram—Latch Reset Block and Referenced Safety Output

Reference Signals

A Reference Signal is used to:
- Control an output based on the state of another output
- Represent the state of an output, input, safety function or logic block on another page.





When output SO2 is On, the SO2 reference signal state is On or High. The function block above shows reference signal SO2 connected to the Reset Enable node RE of Latch Reset Block LR1.

LR1 can only be reset (turned On) when ES1 is in the Run state and SO2 is On.

See Reference Signals on p. 125 for use of referenced Safety Outputs.

Figure 109. Latch Reset and Referenced Safety Output and AND block

Reference Signals

In the figure below, reference signal A3 is on page 1 of the function block diagram and the A3 AND block is on page 2. The output node on the A3 AND block can also be used on page 2 for other safety control logic.

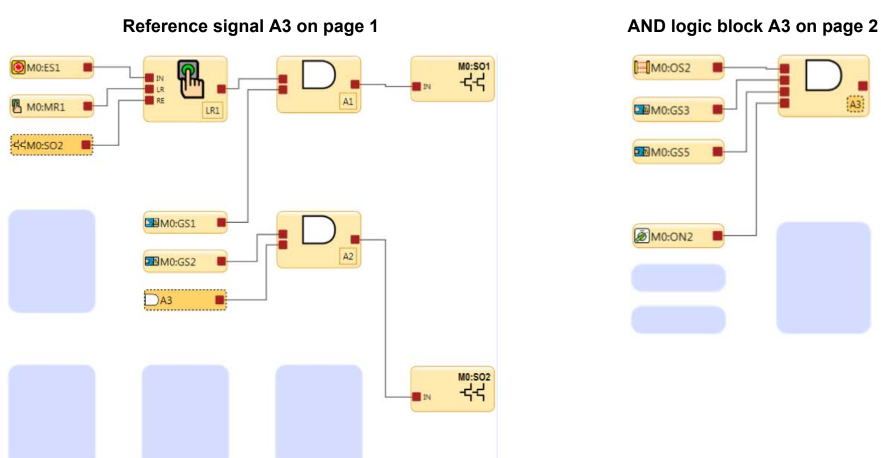
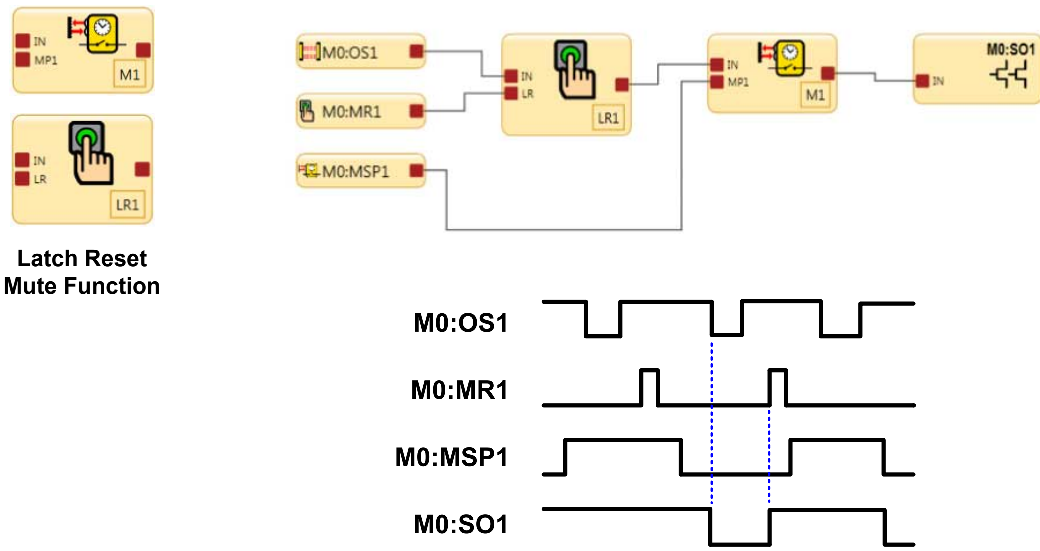


Figure 110. Timing Diagram—Latch Reset Block and Muting Block

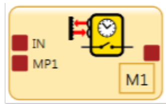


When a safeguarding device OS1 transitions to a Stop state in a valid muting cycle, the latch reset function block will latch and require a reset signal to keep SO1 on after muting ends.
If OS1 switches to the Stop state in a valid muting cycle and no reset signal is seen, SO1 turns off after muting ends.

10.5 Muting Block

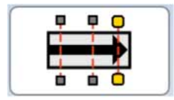
Default Nodes	Additional Nodes	Notes
IN MP1	ME BP MP2	Muting Sensor Pair input blocks must be connected directly to the Muting function block.

Figure 111. Muting Block—Function Types

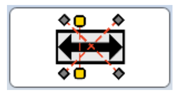


Mute Function Block

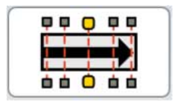
There are five Mute Function types listed below. The following timing diagrams show the function detail and sensor/safeguarding state change order for each mute function type.



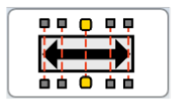
One Way - 1 Mute Sensor Pair



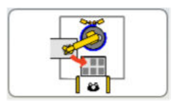
Two Way - 1 Mute Sensor Pair



One Way - 2 Mute Sensor Pair

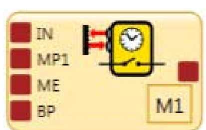


Two Way - 2 Mute Sensor Pair



Two Way - 1 Mute Sensor Pair

Figure 112. Muting Block—Bypass/Override Mode Options



There are 2 types of Mute Bypass:

- Mute Dependent Override
- Bypass (normal)

In the Mute Block Properties menu in the Advanced settings, if the Bypass check box is checked, the option to select a Bypass or a Mute Dependent Override is possible.

The Mute Dependent Override is used to temporarily restart an incomplete mute cycle (for example after the mute time limit expires). In this case, one or more mute sensors must be activated while the safeguard is in the Stop state.

The normal Bypass is used to temporarily bypass the safeguarding device to keep on or turn on the output of the function block.

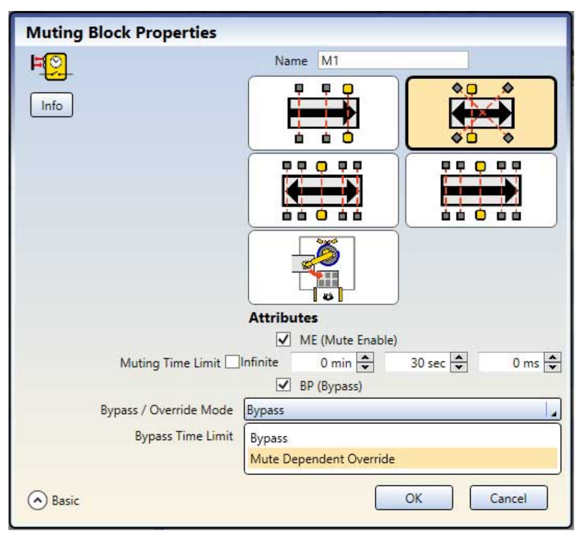


Figure 113. Mute-Dependent Override

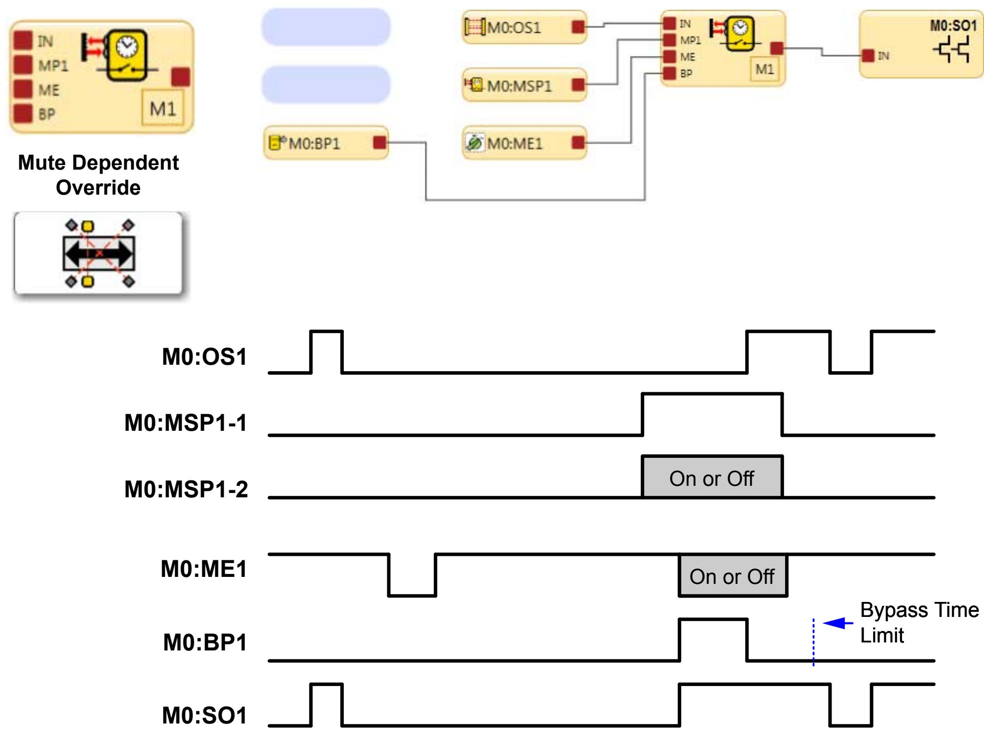


Figure 114. Mute Bypass

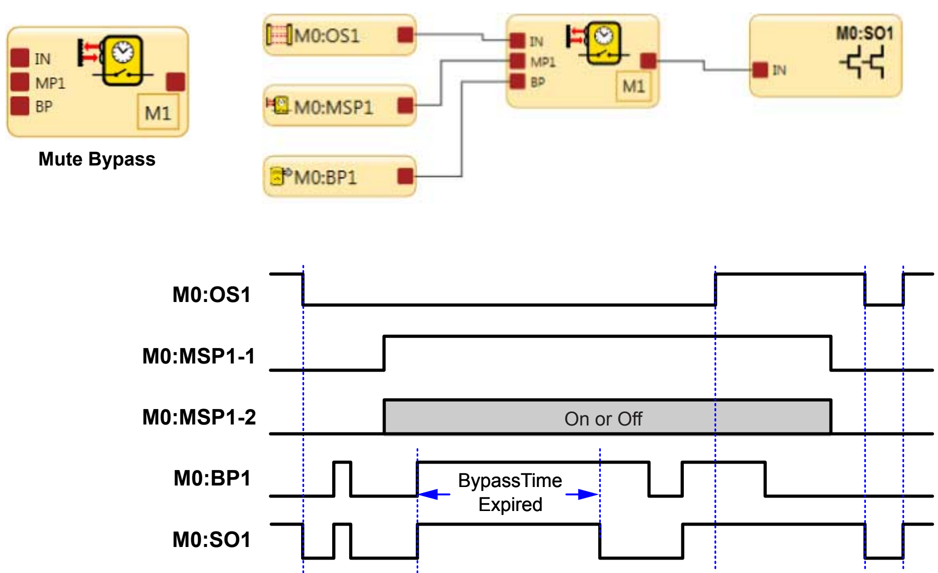
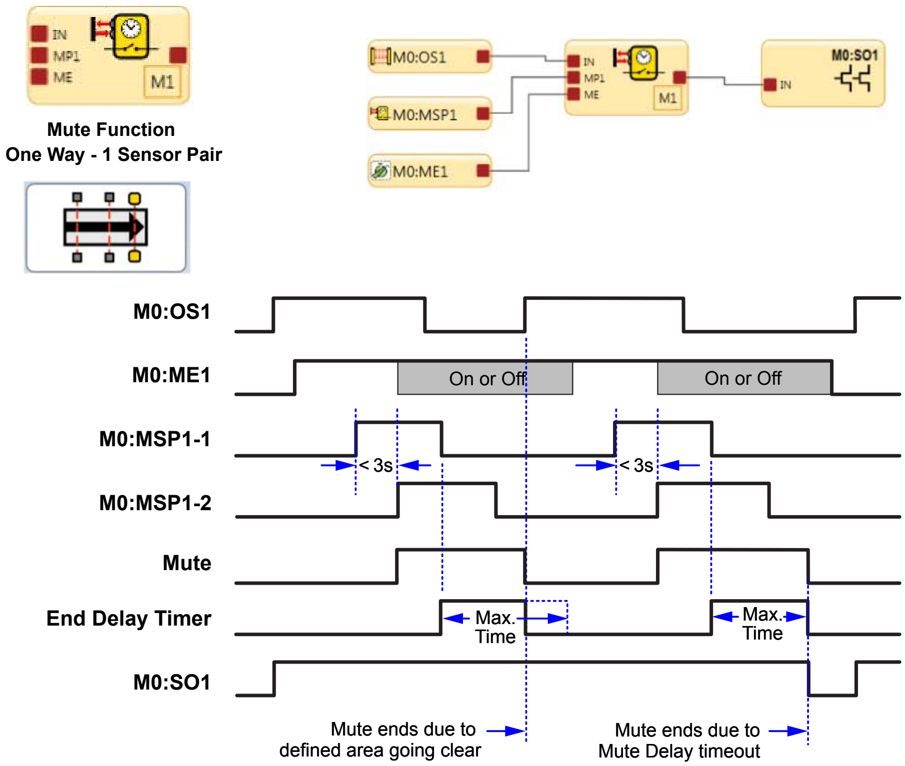


Figure 115. Timing Diagram—One-Way Muting Block, One Muting Sensor Pair



Note: MO:OS1 must be blocked before either MSP1-1 or MSP1-2 clears.

Figure 116. Timing Diagram—One-Way Muting Block, Two Muting Sensor Pairs

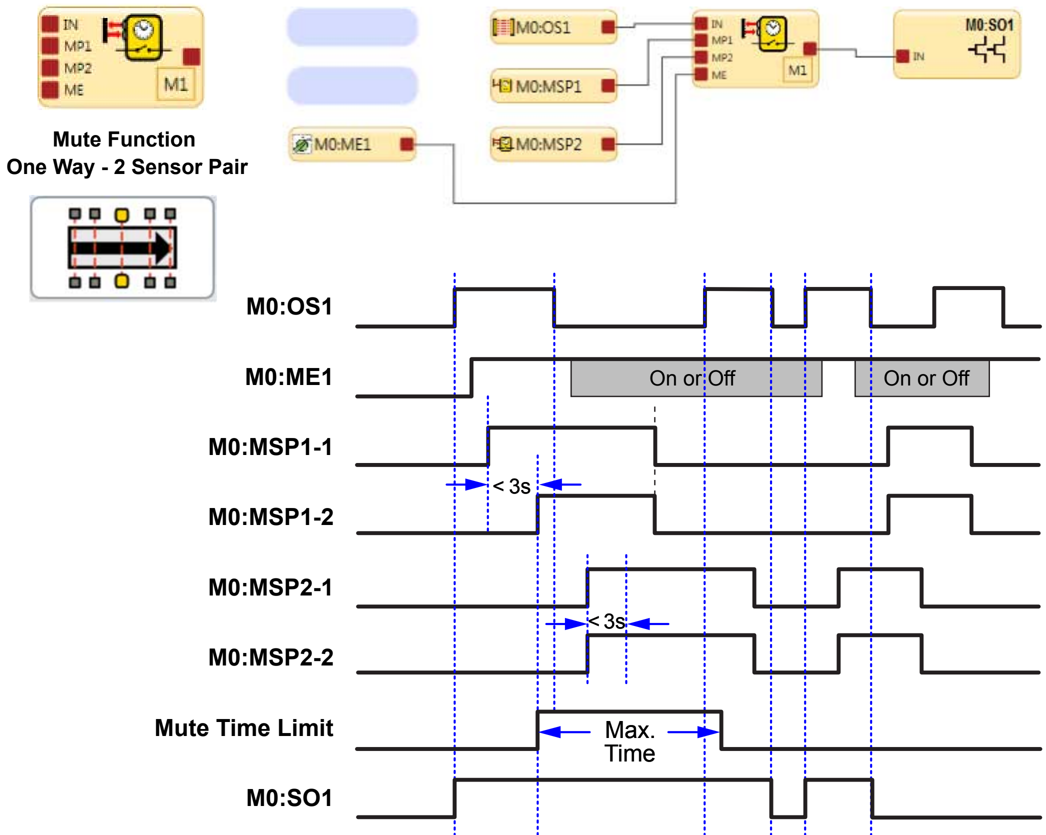


Figure 117. Timing Diagram—Two-Way Muting Block, One Muting Sensor Pair

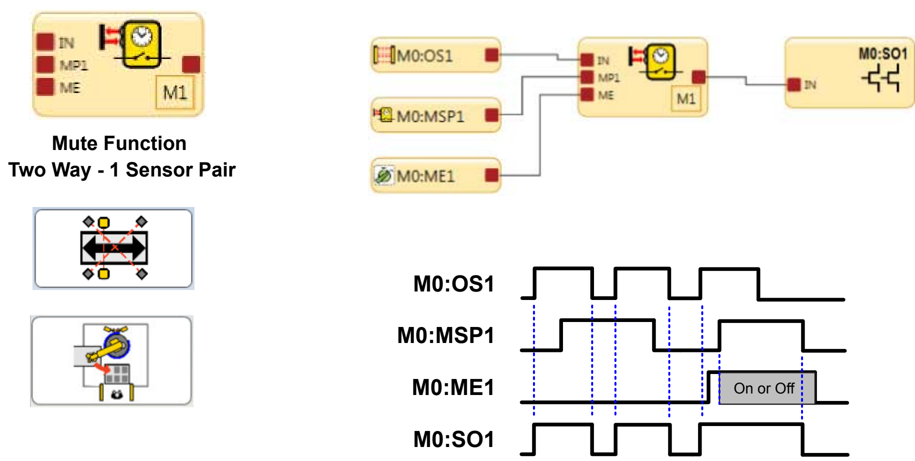
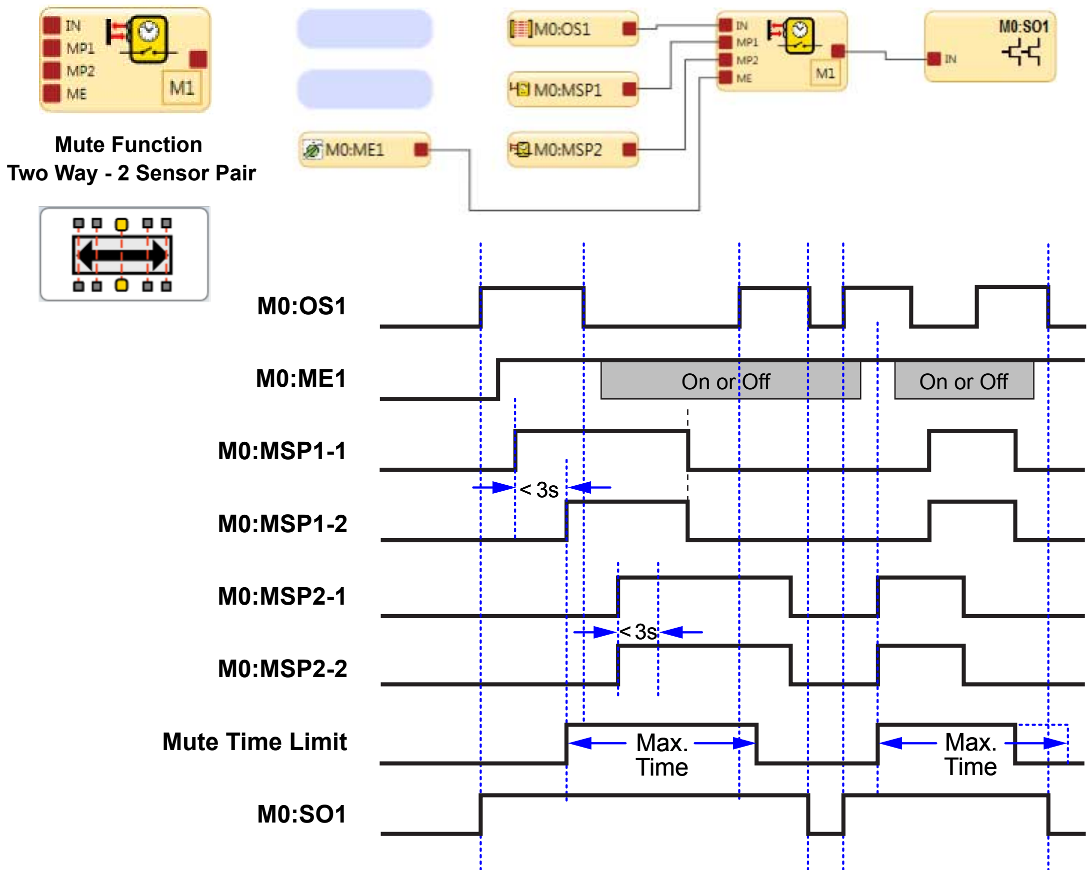


Figure 118. Timing Diagram—Two-Way Muting Block, Two Muting Sensor Pairs

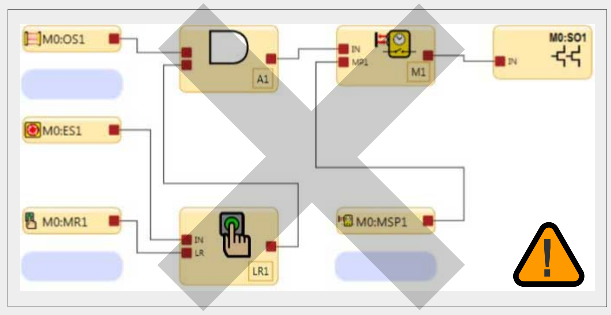


WARNING:

E-Stop Button control authority when using the Mute function

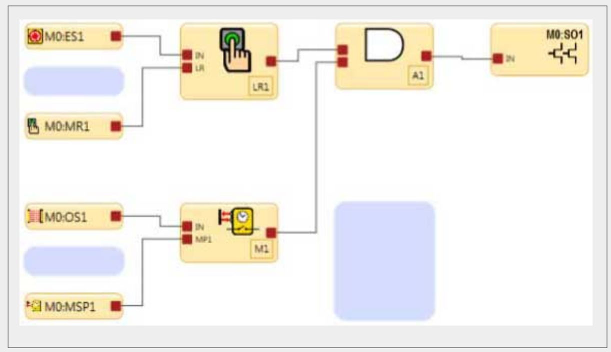
Improper E-Stop Control
NOT RECOMMENDED
The configuration top right shows OS1 and E-Stop button ES1 with a Latch Reset LR1 connected to a mute function via the AND function. In this case both ES1 and OS1 will be muted.

If there is an active mute cycle in progress and the E-Stop button is pressed (switched to the Stop state), SO1 will not turn Off. This will result in a loss of safety control and may lead to a potential hazardous condition.



Proper E-Stop Control
The configuration to the right shows OS1 connected directly to the Mute block M1. M1 and ES1 are both inputs to AND A1. In this case both M1 and ES1 control SO1.

If there is an active mute cycle in progress and the E-Stop button is pressed (switched to the Stop state), SO1 will turn Off.



E-stop buttons, rope pulls, enabling devices, external device monitoring, and bypass switches are non-mutable devices or functions.

To mute the primary safeguard appropriately, the design of a muting system must:

1. Identify the non-hazardous portion of the machine cycle.
2. Involve the selection of the proper muting devices.
3. Include proper mounting and installation of those devices.

WARNING:

- Use Mute and Bypass operations in a way that minimizes personnel risk.
- Failure to follow these rules could cause an unsafe condition that could result in serious injury or death.
- Guard against unintended stop signal suspension by using one or more diverse-redundant mute sensor pairs or a dual-channel key-secured bypass switch.
- Set reasonable time limits for the mute and bypass functions.

The Safety Controller can monitor and respond to redundant signals that initiate the mute. The mute then suspends the safeguarding function by ignoring the state of the input device to which the muting function has been assigned. This allows an object or person to pass through the defined area of a safety light curtain without generating a stop command. This should not be confused with blanking, which disables one or more beams in a safety light curtain, resulting in larger resolution.

The mute function may be triggered by a variety of external devices. This feature provides a variety of options to design the system to meet the requirements of a specific application.

A pair of muting devices must be triggered simultaneously (within 3 seconds of one another). This reduces the chance of common mode failures or defeat. Directional muting, in which sensor pair 1 is required to be blocked first, also may reduce the possibility of defeat.

At least two mute sensors are required for each muting operation. The muting typically occurs 100 ms after the second mute sensor input has been satisfied. One or two pairs of mute sensors can be mapped to one or more safety input devices so that their assigned safety outputs can remain On to complete the operation.

WARNING:
- Muting is allowed only during the non-hazardous portion of the machine cycle
- Failure to follow these instructions could result in serious injury or death.
- Design the muting application so that no single component failure can prevent the stop command or allow subsequent machine cycles until the failure is corrected (per ISO 13849-1 and ANSI B11.19).

WARNING:
- Muting inputs must be redundant
- A single device, with multiple outputs, can fail so that the system is muted at an inappropriate time, causing a hazardous situation.
- Do not use a single switch, device, or relay with two normally open contacts for the mute inputs.

10.5.1 Optional Muting Attributes

The Muting Sensor Pair Input and the Muting Block have several optional functions that can be used to minimize an unauthorized manipulation and the possibility of an unintended mute cycle.

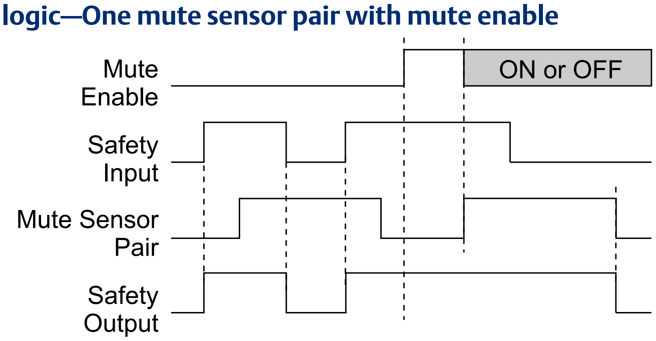
Mute Enable (ME)

The Mute Enable input is a non-safety-rated input. When the input is closed, or active for virtual input, the Safety Controller allows a mute condition to occur; opening this input while the System is muted will have no effect.

Typical uses for Mute Enable include:
- Allowing the machine control logic to create a period of time for muting to begin
- Inhibiting muting from occurring
- Reducing the chance of unauthorized or unintended bypass or defeat of the safety system

The optional Mute Enable function may be configured to ensure that a mute function is permitted only at the appropriate time. If a Mute Enable input device has been mapped to a Muting Block, the safety input device can be muted only if the mute enable switch is in the enable (24 V DC) state, or active state for virtual input, at the time the mute cycle is started. A mute enable input device can be mapped to one or more Muting Blocks.

Figure 119. Timing logic—One mute sensor pair with mute enable



Simultaneity Timer Reset Function

The Mute Enable input can also be used to reset the simultaneity timer of the mute sensor inputs. If one input is active for longer than 3 seconds before the second input becomes active, the simultaneity timer prevents a mute cycle from occurring. This could be due to a normal stoppage of an assembly line that may result in blocking one mute device and the simultaneity time running out.

If the ME input is cycled (closed-open-closed or active-inactive-active for virtual input) while one mute input is active, the simultaneity timer is reset, and if the second mute input becomes active within 3 seconds, a normal mute cycle begins. The function can reset the timer only once per mute cycle (all mute inputs M1–M4 must open before another reset can occur).

Bypass

An optional **Bypass/Override Mode** may be enabled by checking the **BP (Bypass)** box in the **Muting Block** properties window. There are two available Bypass/Override Modes—**Bypass** and **Mute Dependent Override**. The **Bypass** mode is used to temporarily bypass the safeguarding device to keep On or turn On the output of the function block. The **Mute Dependent Override** mode is used to manually override an incomplete mute cycle (for example after the mute time limit expires). In this case, one or more mute sensors must be activated while the safeguard is in the Stop state to initiate the override.

Mute Lamp Output (ML)

Depending on a risk assessment and relevant standards, some applications require that a lamp (or other means) be used to indicate when the safety device, such as a light curtain, is muted. The Safety Controller provides a signal that the protective function is suspended through the Mute status output.

Important: Mute Status Indication

Indication that the safety device is muted must be provided and be readily observable from the location of the muted safety device. Operation of the indicator may need to be verified by the operator at suitable intervals.

Muting Time Limit

The muting time limit allows the user to select a maximum period of time that muting is allowed to occur. This feature hinders the intentional defeat of the muting devices to initiate an inappropriate mute. It is also useful for detecting a common mode failure that would affect all mute devices in the application. The time limit can be adjusted from 1 second to 30 minutes, in increments of 100 milliseconds (the default is 30 s). The mute time limit may also be set to **Infinite** (disabled).

The timer begins when the second muting device meets the simultaneity requirement (within 3 seconds of the first device). After the timer expires, the mute ends despite what the signals from the mute devices indicate. If the input device being muted is in an Off state, the corresponding Muting Block output turns off.

WARNING: Muting Time Limit. Select an infinite time for the Muting Time Limit only if the possibility of an inappropriate or unintended mute cycle is minimized, as determined, and allowed by the machine’s risk assessment. The user is responsible to make sure that this does not create a hazardous situation.

Mute OFF-Delay Time

A delay time may be established to extend the Mute state up to the selected time (1, 2, 3, 4, or 5 seconds) after the Mute Sensor Pair is no longer signaling a muted condition. OFF-delay is typically used for Safety Light Curtain/Grid workcell "Exit Only" applications with mute sensors located only on one side of the defined area. The Muting Block output will remain ON for up to 5 seconds after the first mute device is cleared, or until the muted Safety Input device (Mute Block In) returns to a Run state, whichever comes first.

Mute on Power-Up

This function initiates a mute cycle after power is applied to the Safety Controller. If selected, the Mute on Power-Up function initiates a mute when:

- The Mute Enable input is On (if configured)
- The safety device inputs are active (in Run mode)
- Mute sensors M1-M2 (or M3-M4, if used, but not all four) are closed

If **Auto Power-Up** is configured, the Safety Controller allows approximately 2 seconds for the input devices to become active to accommodate systems that may not be immediately active at power-up.

If **Manual Power-Up** is configured and all other conditions are satisfied, the first valid Power-Up Reset after the muted safety inputs are active (Run state or closed) will result in a mute cycle. The Mute On Power-up function should be used only if safety can be assured when the mute cycle is expected, and the use of this function is the result of a risk assessment and is required by that particular machine operation.

WARNING: The Mute on Power-Up should be used only in applications where:

- Muting the System (MP1 and MP2 closed) when power is applied is required
- Using it does not, in any situation, expose personnel to hazard

Mute Sensor Pair Debounce Times

The input debounce times, accessible under the **Advanced** settings in the **Mute Sensor Pair** properties window, may be used to extend a mute cycle after a mute sensor signal is removed. By configuring the close-to-open debounce time, the mute cycle may be extended up to 1.5 seconds (1500 ms) to allow the Safety Input Device to turn On. The start of the mute cycle can also be delayed by configuring the open-to-close debounce time.

Muting Function Requirements

The beginning and the end of a mute cycle is triggered by signals from a pair of muting devices. The muting device circuit options are configurable and shown in the Mute Sensor Pair **Properties** window. A proper mute signal occurs when both channels of the mute device change to the Mute Active states while the muted safeguard is in the Run state.

The Safety Controller monitors the mute devices to verify that their outputs turn ON within 3 seconds of each other. If the inputs do not meet this simultaneity requirement, a mute condition cannot occur.

Several types and combinations of mute devices can be used, including, but not limited to photoelectric sensors, inductive proximity sensors, limit switches, positive-driven safety switches, and whisker switches.

Corner Mirrors, Optical Safety Systems, and Muting

Mirrors are typically used with safety light curtains and single-/multiple-beam safety systems to guard multiple sides of a hazardous area.

If the safety curtain screen is muted, the safeguarding function is suspended on all sides. It must not be possible for an individual to enter the guarded area without being detected and a stop command issued to the machine control. This supplemental safeguarding is normally provided by an additional device(s) that remains active while the Primary Safeguard is muted.

Therefore, mirrors are typically not allowed for muting applications.

Multiple Presence-Sensing Safety Devices

Muting multiple presence-sensing safety devices (PSSDs) or a PSSD with multiple sensing fields is not recommended unless it is not possible for an individual to enter the guarded area without being detected and a stop command issued to the machine control.

As with the use of corner mirrors (see Corner Mirrors, Optical Safety Systems, and Muting on p. 144), if multiple sensing fields are muted, the possibility exists that personnel could move through a muted area or access point to enter the safeguarded area without being detected.

For example, in an entry/exit application where a pallet initiates the mute cycle by entering a cell, if both the entry and the exit PSSDs are muted, it may be possible for an individual to access the guarded area through the “exit” of the cell. An appropriate solution would be to mute the entry and the exit with separate safeguarding devices.

WARNING:

- **Do not safeguard multiple areas with mirrors or multiple sensing fields if personnel can enter the hazardous area while the system is muted and not be detected**
- Entering the hazardous area without being detected is dangerous and could result in serious injury or death.
- Verify all areas are guarded and a stop command is issued to the guarded machine when someone enters the hazardous area.

10.6 Two-Hand Control Block

The Two-Hand Control input performs all the required safety checks for a Two-Hand Control system.

The Two-Hand Control input can be mapped to a Two-Hand Control function block or directly to a Logic Block or Safety Output. The Two-Hand Control function block can also be mapped to a Logic Block or to a Safety Output.

There are configurations that require the use of the Two-Hand Control function block to ensure compliance with Two-Hand Control standards. These situations are:

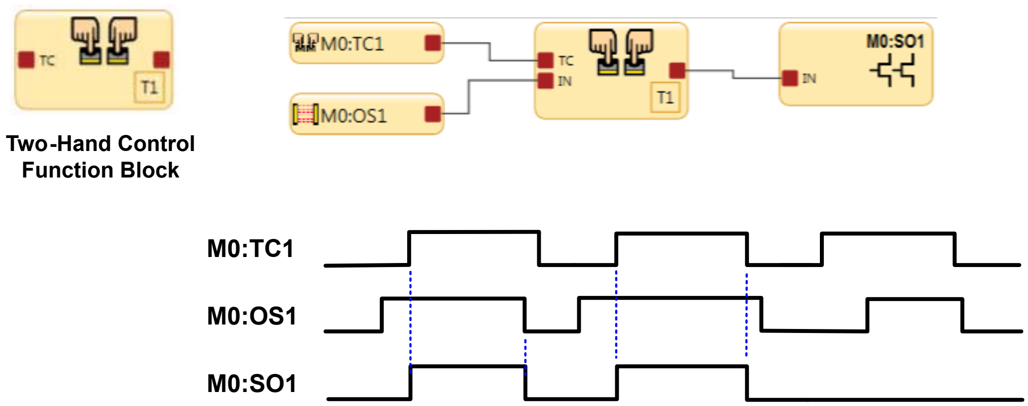
- If the machine has multiple operators and each operator must actuate their two-hand controls, use the Two-Hand Control function block in which multiple TC inputs can be selected (if any TC input turns off all must be cycled to restart the process)
- If the system has a hold function (TC inputs causing an action that makes the process safe, then the operators can remove their hands while the process finishes), use the Two-Hand Control function block with the Muting function selected
- If the machine has certain safety devices that should be satisfied (and must stay satisfied) for the TC input to make the machine operate, use the Two-Hand Control function block with the IN node selected
    - If the IN node is off, engaging the Two-Hand input results in no actions
    - If the Two-Hand Control function block is on and the IN node to the TC block goes off, the output turns off
    - When the IN node goes back high, the output stays off until the TC input(s) go off and back high

WARNING:

- Two-Hand Controls are starting devices (initiate hazardous motion).
- Failure to follow these instructions could result in serious injury or death.
- The Qualified Individual must ensure that activation (going to the ON condition) of a stopping safety device (E-Stop, Rope Pull, Optical Sensor, Safety Mat, Protective Stop, etc.) by a user does not initiate hazardous motion when logically connected to a TC Input or Two-Hand Control function block that is already activated (ON condition).

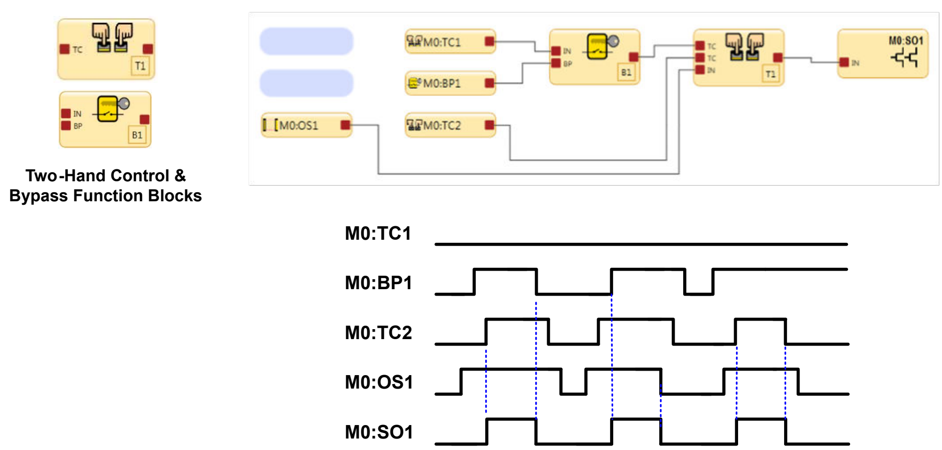
Default Nodes	Additional Nodes	Notes
TC (up to 4 TC nodes)	IN MP1 ME	Two-Hand Control inputs must connect either directly to a Two-Hand Control Block or indirectly through a Bypass Block connected to a Two-Hand Control Block. It is not possible to use a Two-Hand Control input without a Two-Hand Control Block. Use the IN node to connect input devices that must be on before the THC can turn the outputs on.

Figure 120. Timing Diagram—Two-Hand Control Block



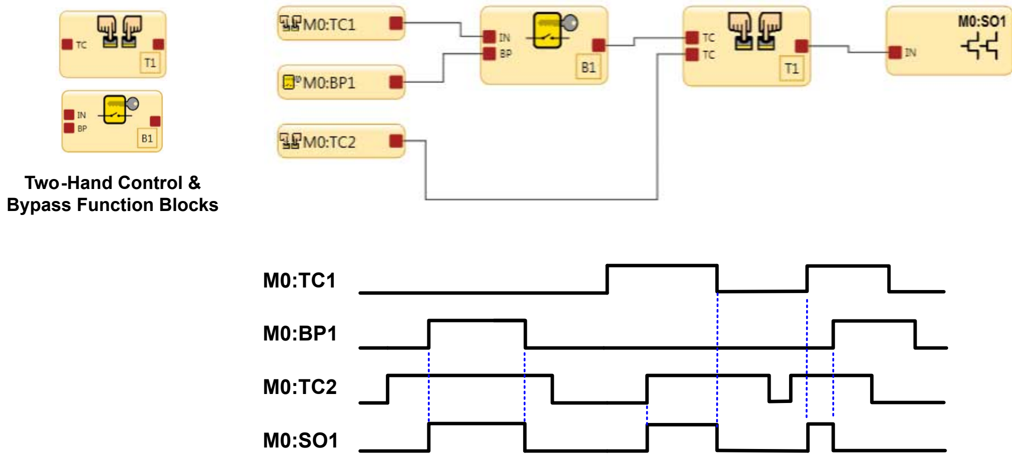
Either the TC1 input or the OS1 input has turn Off authority.
OS1 needs to be in the Run state before TC1 can turn the output of T1 & SO1 On.

Figure 121. Timing Diagram—Two-Hand Control Block and Bypass Blocks



OS1 must transition to the Run state before TC2 transitions to the Run state. BP1 can transition to the Run state before or after OS1. If OS1 is in the Run state the sequence of TC2 or BP1 transition to the Run state does not matter, the last one to transition to the Run state will transition the T1 function block to the Run state.

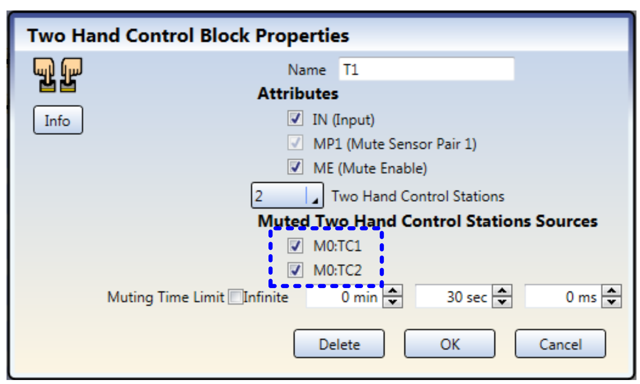
Figure 122. Timing Diagram—Two-Hand Control Block and Bypass Blocks with 2 Two-Hand Control Inputs



The Bypass function can be used with the TC2 actuators to turn the Safety Output On.

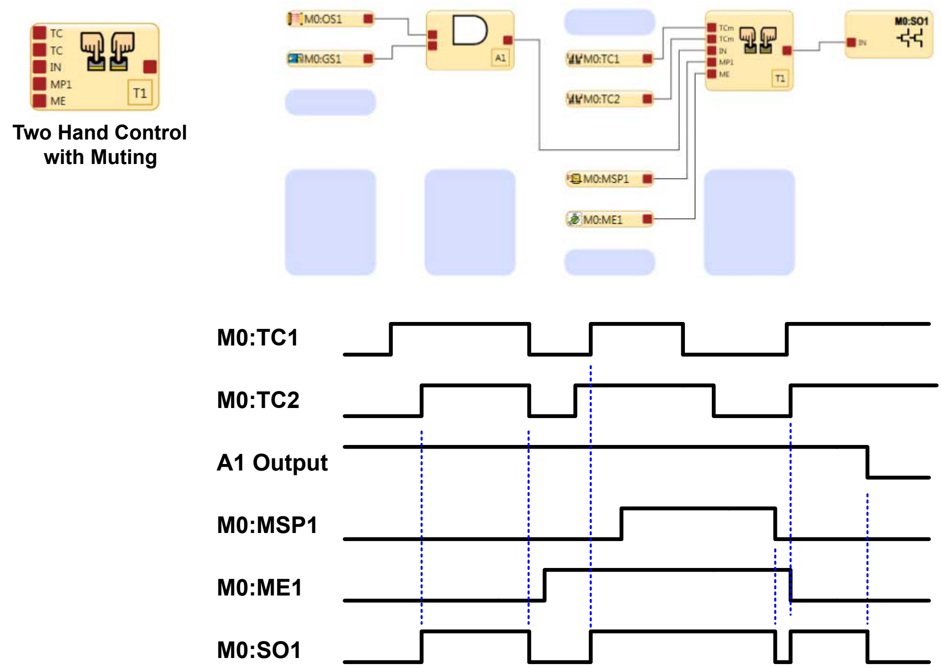
When the TC1 actuators are not bypassed they must be used along with the TC2 actuators to turn the Safety Output On. If the TC1 actuators and the Bypass switch are both in the Run state, TI and SO1 cannot be turned On or will turn Off.

Figure 123. Two-Hand Control Muting Options



To configure the Two-Hand Control mute option, the TC actuators first need to be connected to the Two-Hand Control function block in the Function View. Check boxes (blue square above) in the Properties menu will display the names of all TC actuator input devices. Only those THx station boxes that are checked will be muted.

Figure 124. Timing Diagram—Two-Hand Control Block with Muting



Actuators TC1 and TC2 can initiate a two-hand cycle regardless of the state of the mute enable (ME1) input (on or off). ME1 must be active for the MSP1 mute sensors to keep the SO On after the TC1 and TC2 actuators are in the Stop state.

Two-Hand Control Activation on Power-Up Protection. The Safety Controller's two-hand control logic does not permit the assigned safety output to turn On when power is initially supplied while the THC actuators are in their Run state. The THC actuators must change to their Stop state and return to the Run state before the Safety Output can turn On. A Safety Output associated with a Two-Hand Control device will not have a manual reset option.

10.7 PACSafe 262: One Shot Block

The One Shot block allows the user-configurable pulsed on state of a maximum of 5 minutes, in 1 ms increments.

Default Nodes	Additional Nodes	Notes
IN	CD	A state change of the input signal going from low to high will trigger the output node to go high for the configured time then turn OFF.

Note: The actual length of the One Shot time can be up to 1 scan time longer than the time setting.

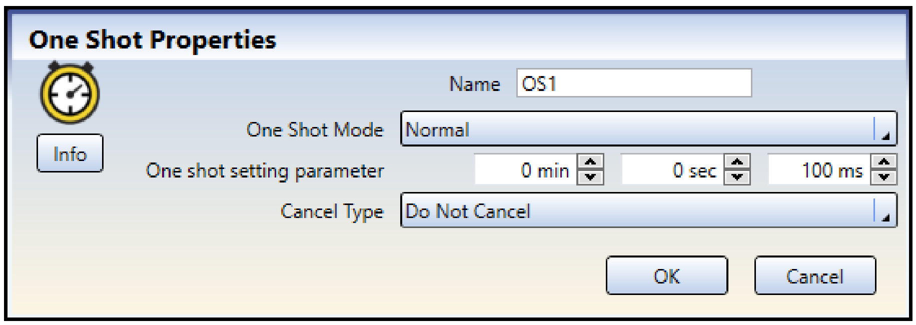
The Cancel Delay Node is a configurable node for the One Shot block. The Cancel Delay input will immediately turn off the output node of the One Shot block after it is recognized (because of human and system delays shorter one shots will most likely end before any cancel delay can be enacted).

CAUTION: One Shot delay time effect on response time

The one shot timing may significantly increase the safety control response time. This will impact the positioning of safeguards whose installation is determined by the safety (minimum) distance formulas or are otherwise influenced by the amount of time to reach a non-hazardous state. The installation of safeguards must account for the increase in response time.

Note: The response time provided on the Configuration Summary tab is a maximum time that can change depending on the use of Delay blocks, One Shot blocks, and other logic blocks (such as OR functions). The user is responsible to determine, verify, and incorporate the appropriate response time.

Figure 125. One Shot Properties



The One Shot Properties window allows the user to configure the following:

Name

Create a name of up to 10 characters for the function block.

One Shot Mode

- Normal
- Heartbeat

One Shot Setting Parameter

One shot time: 1 ms to 5 minutes, in 1 ms increments.

The default setting is 100 ms.

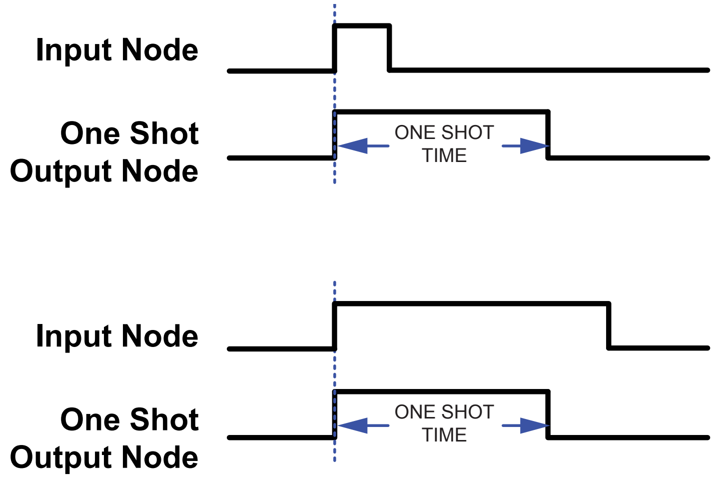
Cancel Type

- Do Not Cancel
- Cancel Delay Node

One Shot Mode

When Normal mode is selected, the output node turns On when the input node turns On. The output stays on for the time set for the One Shot setting regardless of any state changes to the input. (See Figure 126 on p. 150 for typical Normal One Shot timing diagrams.)

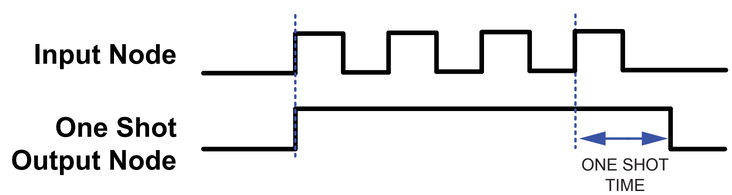
Figure 126. Typical Normal One Shot Timing Diagrams



> **Note:** The Safety Output ON time will be reduced by the turn on delay of the safety output (approximately 60 ms). The shorter the One Shot timing, the more prominent the reduction (greater percentage of the desired pulse).

When Heartbeat mode is selected, the output node turns ON when the input node turns ON. The output stays on for the time set for the One Shot setting. The timer set for the one shot will reset if the input node turns Off then back ON. (See Figure 127 on p. 150 for a typical Heartbeat One Shot timing diagram.)

Figure 127. Heartbeat One Shot Timing Diagram



10.8 Press Control

The Press Control function block is designed for use with simple hydraulic/pneumatic power presses.

The following standards apply:

B11.2-2013, Safety Requirements for Hydraulic and Pneumatic Power Presses
EN ISO 16092-1:2018, Machine Tool Safety Part 1 - General Safety Requirements
EN ISO 16092-3, Machine Tool Safety Part 3 - Safety Requirements for Hydraulic Presses
EN ISO 16092-4, General Safety Requirements Part 4 - Safety Requirements for Pneumatic Presses

The user has the sole responsibility to ensure their application complies with these and any other appropriate standards (including other press standards).

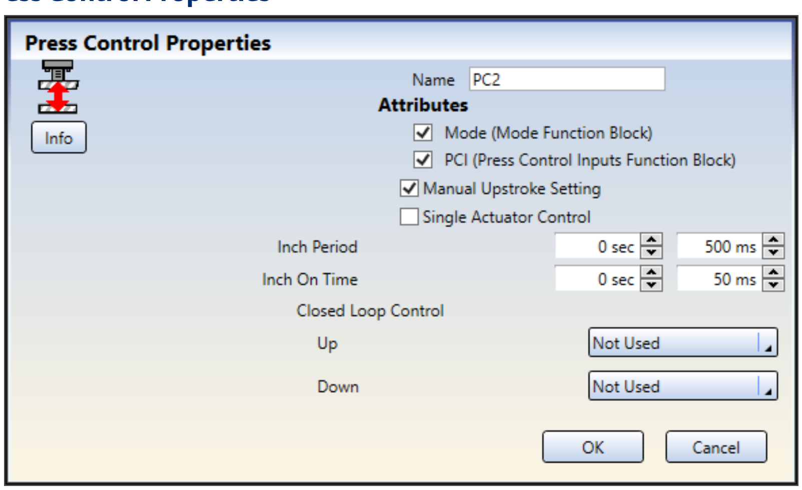
> **WARNING:**
> - The Press Control function block includes a starting device (initiates hazardous motion).
> - Failure to follow these instructions could result in serious injury or death.
> - The Qualified individual must ensure that activation (going to the ON condition) of a stopped safety device (E-stop, rope pull, optical sensor, safety mat, protective stop, etc.) by a user does not initiate hazardous motion when interfaced with a Press Control function block that is already activated (ON condition).

> **WARNING:**
> - Properly install this device.
> - The user has the sole responsibility to ensure that this Emerson device is installed and interfaced to the guarded machine by Qualified Persons, in accordance with this manual and applicable safety regulations. Failure to follow these instructions could result in serious injury or death.
> - If all mounting, installation, interfacing, and checkout procedures are not followed properly, the Emerson device cannot provide the protection for which it was designed. The user is responsible for ensuring that all local, state, and national laws, rules, codes or regulations relating to the installation and use of this control system in any particular application are satisfied. Ensure that all legal requirements have been met and that all technical installation and maintenance instructions contained in this manual are followed.

Default Nodes	Additional Nodes	Notes
GO TOS BOS RST NM Safety	Mode PCI	When selecting the Mode or PCI (Press Control Input) inputs, each generates its own function block of inputs connected to the Press Control function block. For additional information, see Mode Function Block on p. 152 and Press Control Inputs Function Block on p. 153.

The Press Control function block includes attributes that can be enabled or disabled.

Figure 128. Press Control Properties



The additional nodes that can be added to the Press Control function block generate new function blocks of their own. The Mode Function Block is added if the Mode attribute is selected. The Press Control Inputs Function Block is added if the PCI attribute box is selected. The other two attributes, Manual Upstroke Setting and Single Actuator Control cannot both be selected.

When Manual Upstroke Setting is configured, the GO input must be maintained ON during the entire cycle (both down and up). The GO input node can only have a Two-Hand Control input or a Foot Pedal Input connected to it.

When the Single Actuator Control is configured, the GO input acts like a start button so only needs to be maintained on long enough to start the process. The GO input node can only have a Cycle Initiation Input, a Foot Pedal Input or a Two-Hand Control Input connected to it.

WARNING:

- Press upstroke hazard considerations.
- If a hazard exists during the upstroke, not using the Manual Upstroke Setting could result in serious injury or death.
- For Single Actuator Control, the upstroke of the press must not present any hazards because the mutable safety stop input is muted during the upstroke.

The other feature in the Press Control function block is **Closed Loop Control**. Enabling **Closed Loop Control** forces the controller to verify that the devices connected to the noted outputs have turned off when signaled to turn off, before then next output can turn on. For additional information, see Closed Loop Control on p. 156.

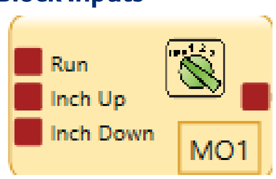
10.8.1 Mode Function Block

The Mode Function Block is added if the Mode attribute is selected in the **Press Control Properties**.

The Mode Function Block selection allows the ability to add a function selector switch. The three inputs to the Press Function Block are Run, Inch Up, and Inch Down.

Note: Per the press Standards, the mode selection switch (or menu) should have these three positions and an Off position, at a minimum. The off position would not be a safety Off state, but a press in a non-run state input (does not get connected to the controller, but would also have the three Mode inputs in the Off state). If all 3 mode inputs are inactive/off, then the Press Mode FB remains Off (red).

Figure 129. Press Control Function Block Inputs



When the Mode Function Block is selected in the Press Control function block, the Inch Period and Inch On Time are added to the Press Control function block. These parameters are user-defined values for their system to ensure that the press does not move too fast when inching (typically used during setup modes).

Note: EN ISO 16092-3:2018 specifies the inch speed cannot be faster than 10 mm/second during inch mode.

- An Inch process is an intermittent motion of the slide to slowly move it up or down, typically for maintenance or die-setting
- The **Inch Period** is the complete cycle time, On and Off, of one intermittent movement of the slide
- The **Inch On Time** is the On portion of the Inch Period (the turning On of the output period to drive the slide movement)
- In setting the period and on times, take into considerations delays in the initiation of movement and the stopping of the movement to ensure proper inch speed if the GO input is held closed for multiple Inch Periods

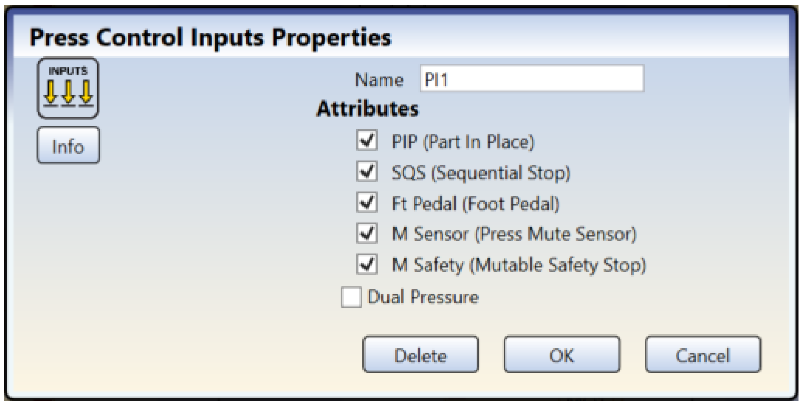
WARNING:
- Speed of the press during Inch Mode.
- Excessive speed of the slide during inch mode could result in serious injury or death.
- Care must be taken in the setting of the Inch Period and Inch On Time to ensure the slide moves at a safe speed during inch mode.

10.8.2 Press Control Inputs Function Block

The Press Control Inputs Function Block is added if the PCI attribute box is selected in the **Press Control Properties**.

When the PCI Function Block is selected, other press control attributes can be enabled.

Figure 130. Press Control Inputs Properties



The default nodes of the PCI block are the **PIP** (Part in Place) input, **SQS** (Sequential Stop) input, and the **M Safety** (Mutable Safety Stop) input. If **SQS** is selected, the **Ft Pedal** (Foot Pedal) and **M Sensor** (Press Mute Sensor) inputs are available as options and the Dual Pressure attribute becomes available (this allows the addition of high and low pressure outputs to be added to the standard up and down outputs).

Use the PIP input in press controls where the press should not run if no part is present. The PIP input must be high for the press cycle to start. At the end of a press cycle, the PIP input must go low, then back to high, before the next press cycle can be initiated.

Use the SQS input in press controls where the press slide is lowered to a finger-safe point. At this point, the Mutable Safety Stop input can be muted, the operator can release the Two-Hand control input (configured to the GO input of the Press Control function block) and can grasp the workpiece, if required. Initiating the Ft Pedal input will drive the press slide to the bottom of the stroke, where it will stop.

Note: The above is one method of controlling the Press Control process with SQS configured. There are three allowable processes:

1. TC1 turns on the GO input to drive the ram to the SQS point. Release TC1 and engage the FP1 to turn on the Ft Pedal input to drive the ram to the BOS, release FP1 and engage TC1 to raise the ram.
2. FP1 turns on the GO input to drive the ram to the SQS point. Release FP1. Re-engaging FP1 drives the ram to the BOS point, and then back up to the TOS point. (The Ft Pedal input will disappear when FP1 is connected to the GO node).
3. TC1 turns on the GO input to drive the ram to the SQS point, release TC1. Re-engaging TC1 drives the ram to the BOS point, and then back up to the TOS point. (To set the system up for this method, do NOT select the Ft Pedal node in the Press Control Inputs Function Block.)

The M Sensor input can be used in conjunction with the SQS input to mute the Mutable Safety Stop input when it reaches a finger-safe position.

When the SQS input and Dual Pressure are configured in the Press Control Input function block, two new outputs are added to the Press Control function block. **H** (high) and **L** (low) output nodes are added in addition to the standard **U** (for Up, disengage, or return stroke) and **D** (for Down, engage, or out stroke) outputs. The H is to engage the high pressure to finish the last portion of the stroke. The L is to engage the standard (low) pressure to bring the slide down to the SQS point and to return the slide to the home position.

Figure 131. Press Control Input Block

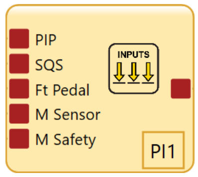
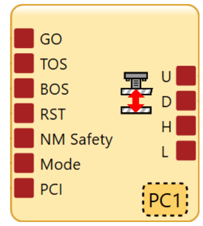


Figure 132. Press Control Function Block

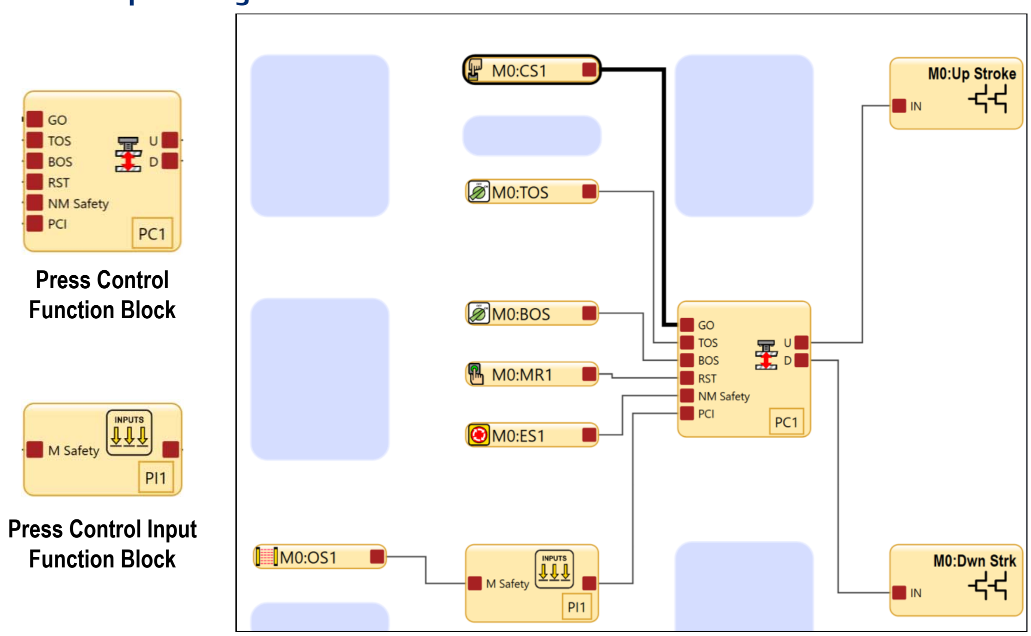


10.8.3 Press Control Function Block Examples

This section includes two example configurations.

The following is an example of a simple configuration for a small press.

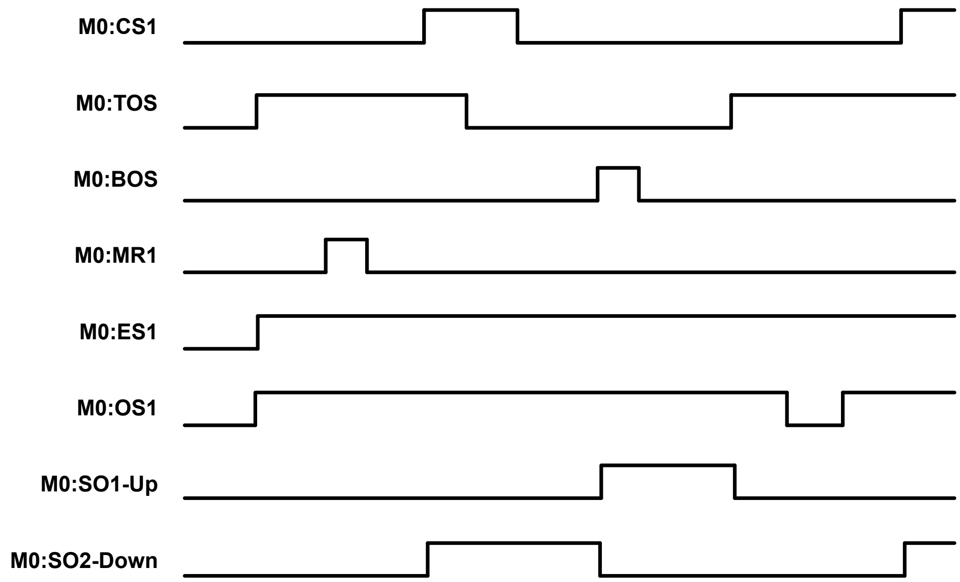
Figure 133. Sample Configuration for a Small Press



The Press Control function block requires the correct sequencing of the input signals for proper operation. ES1, OS1, and TOS must be in the Run state (and have been reset) before the CS1 input can turn on the appropriate output. This configuration is using Single Actuator Control so once the CS1 input has started the process, either the ES1 input, OS1 input or the end of the cycle (TOS turning back on) has turn OFF authority. See the timing chart below or the simulation description in PACSafe 262: Simple Press Control with Mutable Safety Input Sample Configuration on p. 91.

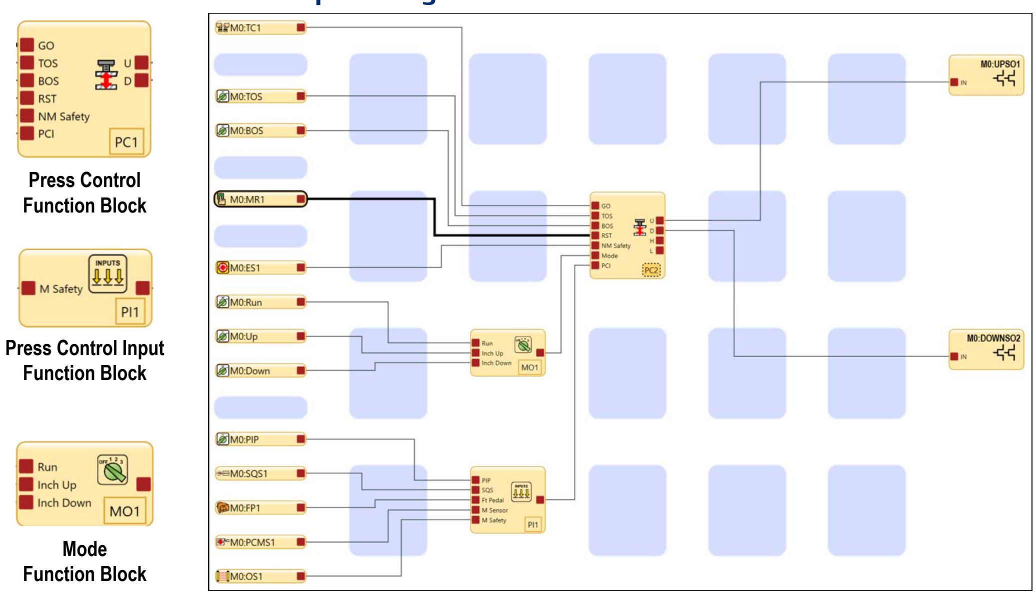
The following timing diagram shows the proper sequencing of the inputs to the Press Control function block resulting in the proper operation of the outputs when Single Actuator Control is enabled.

Figure 134. Press Control—Timing Diagram, Single Actuator Control



The following is a configuration using most of the features of the Press Control function block.

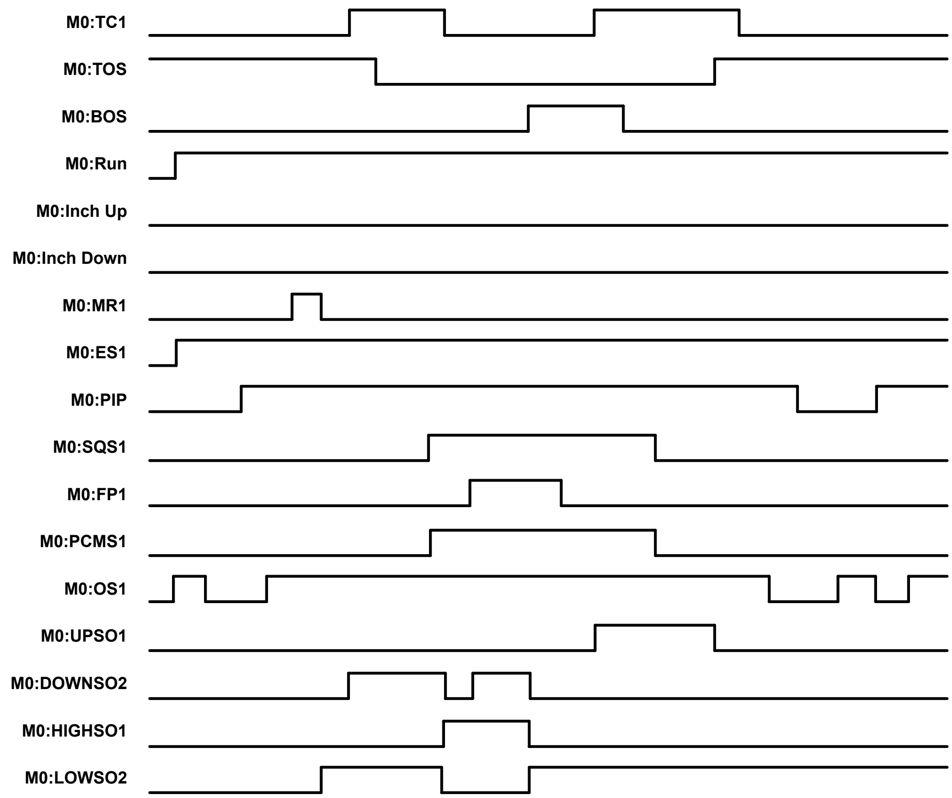
Figure 135. Press Control—Sample Configuration



The Press Control function block requires the correct sequencing of the input signals for proper operation. This configuration uses the Manual Upstroke Setting. ES1, OS1, PIP, and TOS must be in the Run state (and have been reset) before the TC1 input can turn on the appropriate output. During the down stroke, the TC1 input starts the process, and the ES1 input, OS1 input, TC1 input or reaching the sequential stop input (SQS turns on) has turn OFF authority. When the press reaches the SQS point (SQS and PCMS turn on), it stops and the OS1 mutes. The TC1 can be released. To finish the stroke, turn on the FP1 input. During the rest of the down stroke, ES1 input, FP1 input, or the BOS (turning on) has turn OFF authority. When BOS is reached, the FP1 is released and TC1 is used to return the Press to the TOS position. During the upstroke, TC1 input, ES1 input, OS1 input, or reaching the TOS position have turn OFF authority. See the timing chart below or the simulation description in PACSafe 262: Full Feature Press Control Sample Configuration on p. 94.

The following timing diagram shows the proper sequencing of the inputs to the Press Control function block, resulting in the proper operation of the outputs when Manual Upstroke Setting is enabled.

Figure 136. Press Control—Timing Diagram with Manual Upstroke Setting



10.8.4 Closed Loop Control

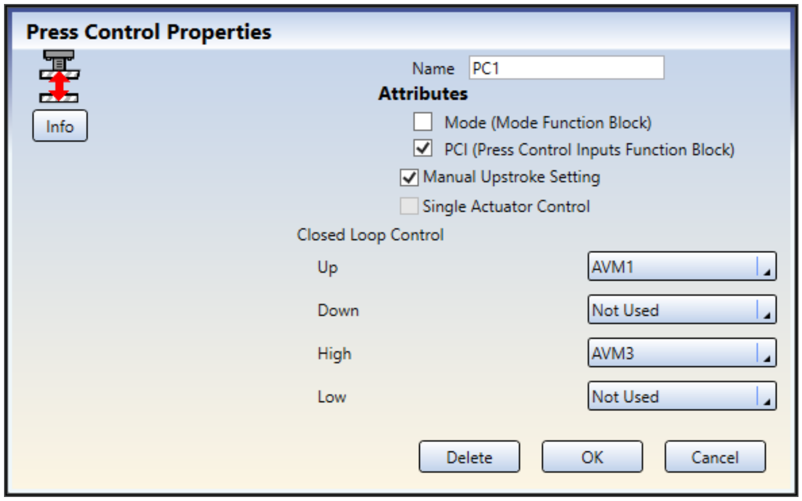
The Press Control function block includes the ability to enable Closed Loop Control.

Enabling Closed Loop Control forces the controller to verify that the devices connected to the noted outputs have turned off when signaled to turn off, before enabling the next output to turn on.

To use Closed Loop Control:

1. An AVM node must be added to the desired safety output driven by the Press Control function block.
2. The AVM Input provides an indication of the state of that Press valve.
3. The Press Control function block must be configured for Closed Loop Control on a per output basis. See the **Press Control Properties** in the following figure.

Figure 137. Closed Loop Control



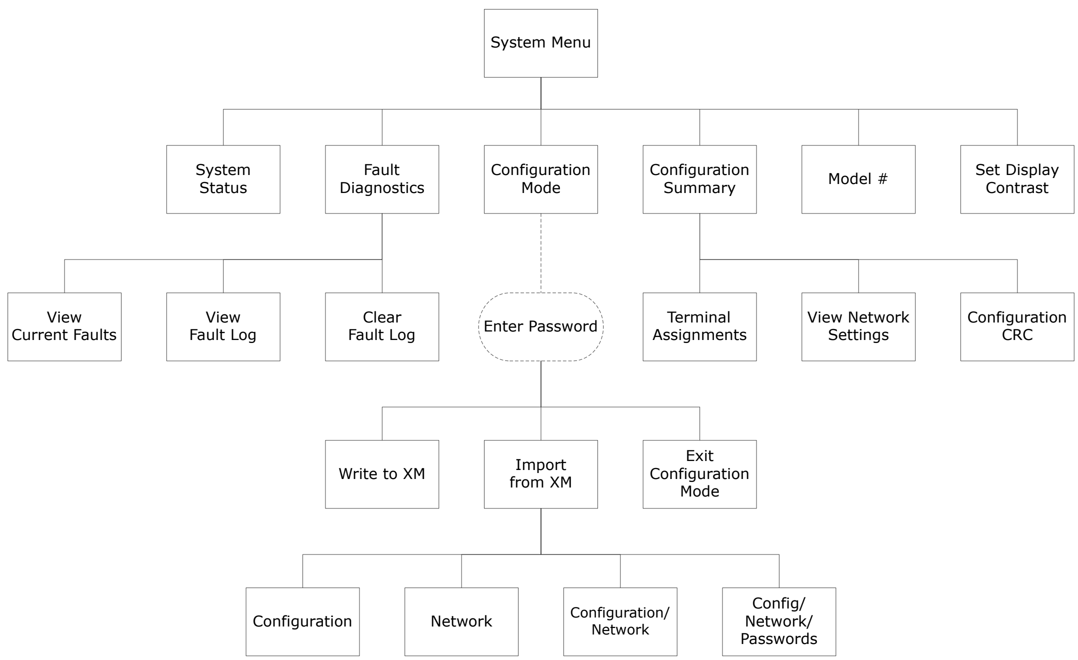
In this example the Closed Loop Control is set up to ensure the Up output valve has turned off before it will allow any other functions. It also ensures that the High valve has closed before engaging the Up output.

11 PACSafe 262 Onboard Interface

Use the PACSafe 262 Safety Controller's onboard interface to access the following:

- **System Status**—displays the current status of Safety Outputs, and, when selected, inputs connected to that output
- **Fault Diagnostics**—displays the current faults, fault log, and an option to clear the fault log (see Finding and Fixing Faults on p. 216)
- **Configuration Mode**—enters the Configuration Mode (password required) and provides access to copy or write the configuration from and to the IC225ACC001 drive (see PACSafe 262 Configuration Mode on p. 158)
- **Configuration Summary**—provides the access to terminal assignments, network settings, and configuration CRC
- **Model #**—displays the current model number and versions of each micro
- **Set Display Contrast**—provides the controls to adjust the display brightness

Figure 138. Onboard Interface Map



11.1 PACSafe 262 Configuration Mode

Configuration Mode provides options to send the current configuration to an IC225ACC001 drive and to receive a configuration from the IC225ACC001 drive.

Note: A password is required to access the **Configuration Mode** menu.

Important: Entering the **Configuration Mode** turns Off Safety Outputs.

To *write* data to the IC225ACC001 drive using the onboard interface:

1. Insert the IC225ACC001 drive into the Safety Controller.

2. From the **System Menu**, select **Configuration Mode**.
3. Enter the password.
4. Hold **OK** until the **Configuration Mode** menu appears.
5. Select **Write to XM**.

> **Note:** The writing to XM process copies all data (configuration, network settings, and passwords) to the IC225ACC001 drive.

6. Wait for the write process to complete.
7. Reset the System.

To *import* data from the IC225ACC001 drive using the onboard interface:

1. Insert the IC225ACC001 drive into the Safety Controller.
2. From the **System Menu**, select **Configuration Mode**.
3. Enter the password.
4. Hold **OK** until the **Configuration Mode** menu appears.
5. Select **Import from XM**:
    - For configuration only, select **Configuration**
    - For network settings only, select **Network Settings**
    - For configuration and network settings, select **Configuration/Network**
    - For all data, which includes configuration, network settings, and user passwords, select **Config/Network/Passwords**
6. Wait for the import process to complete.
7. Reset the System.

12 Industrial Ethernet Overview

An aid for use in establishing Ethernet communications between the Safety Controller and a PLC or HMI.

For PROFINET connections, see PROFINET on p. 173.

12.1 Configuring the Safety Controller

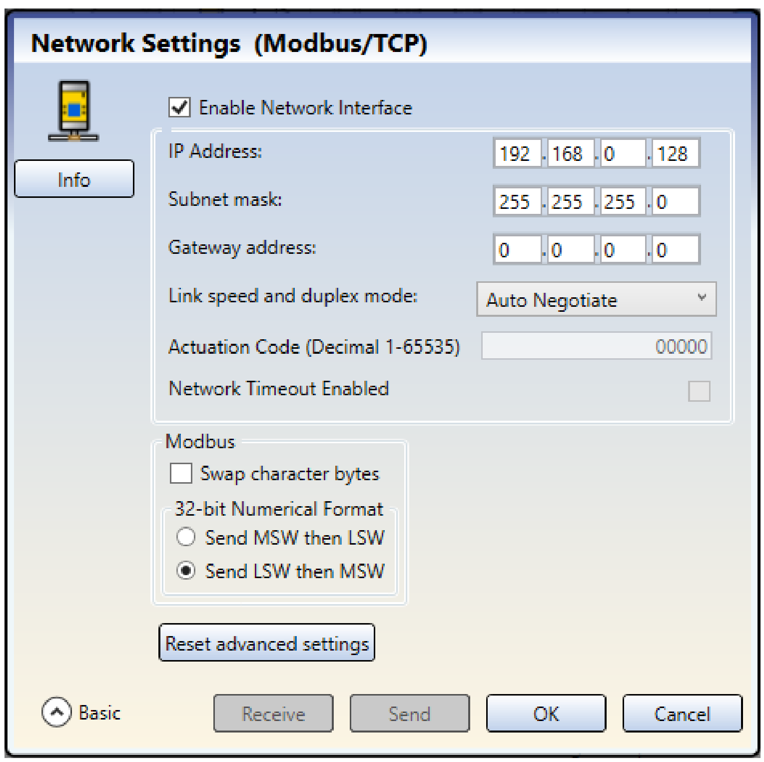
Make sure that **Enable Network Interface** is selected and the network settings are configured as needed by the chosen protocol.

1. Connect the Safety Controller to your PC via the IC225CBL001 USB cable to enable the port.
2. Open the PACSafe Studio Software.
3. Click **Network Settings**.
4. Configure the IP Address and Subnet Mask as needed for your network.

> **Note:** If a Virtual Reset or Cancel Delay is used, an Actuation Code must be defined and then sent to the Safety Controller.

5. Click **Send**.
6. Click on the **Advanced** arrow to configure the Advanced network settings, if desired.
   The following are the default values for the Safety Controller's Ethernet port and Industrial Ethernet options.

Figure 139. Default Values



7. Provide the appropriate password to change the configuration and network settings for the Safety Controller.
8. Make sure the Safety Controller has a valid and confirmed configuration file.

The Ethernet port is enabled.

12.2 Industrial Ethernet Definitions

The following are table row and column descriptions (listed in alphanumeric order) for the register maps found in the **Industrial Ethernet** tab of the Software.

Table 6: Data Types

Data Type	Description
UINT	Unsigned integer—16 bits
UDINT	Unsigned double integer—32 bits
Word	Bit string—16 bits
Dword	Bit string—32 bits
String	Two ASCII characters per Word (see protocol-based String information below)
Octet	Reads as each byte translated to decimal separated by a dot
Hex	Reads as each nibble translated to hex, paired, and then separated by a space
Byte	Bit string—8 bits

Byte:Bit

Indicates the byte offset followed by the specific bit.

Fault Flag

If the particular input or output being tracked causes a lockout, a flag associated with that virtual output will be set to **1**. In Modbus/TCP, this can be read as a discrete input, input register, or holding register.

Fault Index

If the Fault Flag bit is set for a virtual output, the Fault Index will contain a number, which translates to a Fault Code. For example, a Fault Index 41, can contain a number 201, which translates to the Fault Code 2.1; the number 412 would translate to the Fault Code 4.12 (see PACSafe 262 Fault Code Table on p. 216 and PACSafe 102 Fault Code Table on p. 223 for more information).

Function

The function that determines the state of that virtual output.

Operating Mode

Operating Mode Value	Description
1 (0x01)	Normal Operating Mode (including I/O faults, if present)
2 (0x02)	Configuration Mode
4 (0x04)	System Lockout
65 (0x41)	Waiting For System Reset/Exiting Configuration Mode
129 (0x81)	Entering Configuration Mode

Reg:Bit

Indicates the offset from 30000 or 40000 followed by the specific bit in the register.

Reserved

Registers that are reserved for internal use.

Seconds Since boot

The time, in seconds, since power was applied to the Safety Controller. May be used in conjunction with the Timestamp in the Fault Log and a real time clock reference to establish the time when a fault occurred.

String (Modbus/TCP Protocol)

The string format is packed ASCII (two characters per word). In some systems, the character order may appear reversed or out of order. For example, the word “System” may read out as “yStsme”. Use "*Swap character bytes*" option under the **Advanced** menu in the **Network Settings** window to swap characters so words read correctly.

Timestamp

The time, in seconds, when the fault occurred since power up.

Virtual Status Output

The reference designator associated with a particular Virtual Status Output, for example, VO10 is Virtual Status Output 10.

VO Status

This identifies the location of a bit indicating the status of a Virtual Status Output. In the case of Modbus/TCP, the state of the Virtual Status Output can be read as a discrete input, as part of an input register, or holding register. The register given is the offset from 30000 or 40000 followed by the bit location within the register.

12.3 Retrieving Current Fault Information

Follow the steps below to retrieve information via network communications about a fault that currently exists:

1. Read the *Fault Index* location to retrieve the fault index value.
2. Find the index value in the PACSafe 262 Fault Code Table on p. 216 or PACSafe 102 Fault Code Table on p. 223 to access a fault description and steps to resolve the fault.

12.4 Modbus/TCP

The Modbus/TCP protocol provides device information using register and coil banks defined by the slave device.

This section defines the register and coil banks. By specification, Modbus/TCP uses TCP port 502. The Safety Controller does not support a Unit ID of 0 (sometimes called Slave ID or Device ID).

The following registers are used to send output values from the Safety Controller to the PLC. These can be read as Input Registers (30000) using Modbus function code 04 (Read Input Registers). The same values can also be read as Holding Registers (40000) using Modbus function code 03 (Read Holding Registers). The status information for all the virtual outputs and their fault flags, contained in the first eight registers, can also be read as Inputs (10000) using Modbus function code 02 (Read Input Status).

The First 64 Virtual Outputs and Virtual Output Faults (Inputs 10001–10128)

Table 7: 02: Read Input Status

Input #	NAME
10001	VO1
10002	VO2
10003	VO3
...	...
10063	VO63
10064	VO64

Input #	NAME
10065	VO1 Fault bit
10066	VO2 Fault bit
10067	VO3 Fault bit
...	...
10127	VO63 Fault bit
10128	VO64 Fault bit

All 256 Virtual Outputs and Virtual Output Faults (Inputs 11001–11256, 12001–12256)

Table 8: 02: Read Input Status

Input #	NAME
11001	VO1
11002	VO2
11003	VO3
...	...
11255	VO255
11256	VO256

Input #	NAME
12001	VO1 Fault bit
12002	VO2 Fault bit
12003	VO3 Fault bit
...	...
12255	VO255 Fault bit
12256	VO256 Fault bit

Virtual Input, Virtual Reset/Cancel Delay Control and Feedback (Coils 3001–3064, 4001–4016, Inputs 15001–15016)

See Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58.

Table 9: 05: Write Single Coil; 02: Read Input Status

Input #	NAME
3001	VI1 On/Off
3002	VI2 On/Off
...	...
3064	VI 64 On/Off
4001	VRCD1 On/Off
4002	VRCD2 On/Off
...	
4016	VRCD16 On/Off

Input #	NAME
15001	VRCD1 Feedback
15002	VRCD2 Feedback
...	...
15016	VRCD16 Feedback

Safety Controller Output Registers (Modbus/TCP Input or Holding Registers)

Input REG #	Holding REG #	WORD NAME	DATA TYPE
1	1	VO1 – VO16 (see Flags on p. 171)	16-bit integer
2	2	VO17 – VO32 (see Flags on p. 171)	16-bit integer
3	3	VO33 – VO48 (see Flags on p. 171)	16-bit integer
4	4	VO49 – VO64 (see Flags on p. 171)	16-bit integer
5	5	Fault bits for VO1 – VO16 (see Flags on p. 171)	16-bit integer
6	6	Fault bits for VO17 – VO32 (see Flags on p. 171)	16-bit integer
7	7	Fault bits for VO33 – VO48 (see Flags on p. 171)	16-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
8	8	Fault bits for VO49 – VO64 (see Flags on p. 171)	16-bit integer
	9	Virtual Input On/Off (1-16)	16-bit integer
	10	Virtual Input On/Off (17-32)	16-bit integer
	11	Virtual Input On/Off (33-48)	16-bit integer
	12	Virtual Input On/Off (49-64)	16-bit integer
13–16	13–16	*reserved*	16-bit integer
	17	Virtual Reset/Cancel Delay (1–16) [RCD Register Bits] (see Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58)	16-bit integer
18	18	reserved	16-bit integer
	19	RCD Actuation Code [RCD Enable Register] (see Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58)	16-bit integer
20	20	Virtual Reset/Cancel Delay (1–16) Feedback [RCD Feedback Register Bits] (see Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58)	16-bit integer
21	21	*reserved*	16-bit integer
22	22	RCD Actuation Code Feedback [RCD Enable Feedback Register] (see Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58)	16-bit integer
23–40	23–40	reserved	16-bit integer
41	41	VO1 Fault Index	16-bit integer
42	42	VO2 Fault Index	16-bit integer
43	43	VO3 Fault Index	16-bit integer
44	44	VO4 Fault Index	16-bit integer
45	45	VO5 Fault Index	16-bit integer
46	46	VO6 Fault Index	16-bit integer
47	47	VO7 Fault Index	16-bit integer
48	48	VO8 Fault Index	16-bit integer
49	49	VO9 Fault Index	16-bit integer
50	50	VO10 Fault Index	16-bit integer
51	51	VO11 Fault Index	16-bit integer
52	52	VO12 Fault Index	16-bit integer
53	53	VO13 Fault Index	16-bit integer
54	54	VO14 Fault Index	16-bit integer
55	55	VO15 Fault Index	16-bit integer
56	56	VO16 Fault Index	16-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
57	57	VO17 Fault Index	16-bit integer
58	58	VO18 Fault Index	16-bit integer
59	59	VO19 Fault Index	16-bit integer
60	60	VO20 Fault Index	16-bit integer
61	61	VO21 Fault Index	16-bit integer
62	62	VO22 Fault Index	16-bit integer
63	63	VO23 Fault Index	16-bit integer
64	64	VO24 Fault Index	16-bit integer
65	65	VO25 Fault Index	16-bit integer
66	66	VO26 Fault Index	16-bit integer
67	67	VO27 Fault Index	16-bit integer
68	68	VO28 Fault Index	16-bit integer
69	69	VO29 Fault Index	16-bit integer
70	70	VO30 Fault Index	16-bit integer
71	71	VO31 Fault Index	16-bit integer
72	72	VO32 Fault Index	16-bit integer
73	73	VO33 Fault Index	16-bit integer
74	74	VO34 Fault Index	16-bit integer
75	75	VO35 Fault Index	16-bit integer
76	76	VO36 Fault Index	16-bit integer
77	77	VO37 Fault Index	16-bit integer
78	78	VO38 Fault Index	16-bit integer
79	79	VO39 Fault Index	16-bit integer
80	80	VO40 Fault Index	16-bit integer
81	81	VO41 Fault Index	16-bit integer
82	82	VO42 Fault Index	16-bit integer
83	83	VO43 Fault Index	16-bit integer
84	84	VO44 Fault Index	16-bit integer
85	85	VO45 Fault Index	16-bit integer
86	86	VO46 Fault Index	16-bit integer
87	87	VO47 Fault Index	16-bit integer
88	88	VO48 Fault Index	16-bit integer
89	89	VO49 Fault Index	16-bit integer
90	90	VO50 Fault Index	16-bit integer
91	91	VO51 Fault Index	16-bit integer
92	92	VO52 Fault Index	16-bit integer
93	93	VO53 Fault Index	16-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
94	94	VO54 Fault Index	16-bit integer
95	95	VO55 Fault Index	16-bit integer
96	96	VO56 Fault Index	16-bit integer
97	97	VO57 Fault Index	16-bit integer
98	98	VO58 Fault Index	16-bit integer
99	99	VO59 Fault Index	16-bit integer
100	100	VO60 Fault Index	16-bit integer
101	101	VO61 Fault Index	16-bit integer
102	102	VO62 Fault Index	16-bit integer
103	103	VO63 Fault Index	16-bit integer
104	104	VO64 Fault Index	16-bit integer
105–106	105–106	VO1 Complete Fault Code	32-bit integer
107–108	107–108	VO2 Complete Fault Code	32-bit integer
109–110	109–110	VO3 Complete Fault Code	32-bit integer
111–112	111–112	VO4 Complete Fault Code	32-bit integer
113–114	113–114	VO5 Complete Fault Code	32-bit integer
115–116	115–116	VO6 Complete Fault Code	32-bit integer
117–118	117–118	VO7 Complete Fault Code	32-bit integer
119–120	119–120	VO8 Complete Fault Code	32-bit integer
121–122	121–122	VO9 Complete Fault Code	32-bit integer
123–124	123–124	VO10 Complete Fault Code	32-bit integer
125–126	125–126	VO11 Complete Fault Code	32-bit integer
127–128	127–128	VO12 Complete Fault Code	32-bit integer
129–130	129–130	VO13 Complete Fault Code	32-bit integer
131–132	131–132	VO14 Complete Fault Code	32-bit integer
133–134	133–134	VO15 Complete Fault Code	32-bit integer
135–136	135–136	VO16 Complete Fault Code	32-bit integer
137–138	137–138	VO17 Complete Fault Code	32-bit integer
139–140	139–140	VO18 Complete Fault Code	32-bit integer
141–142	141–142	VO19 Complete Fault Code	32-bit integer
143–144	143–144	VO20 Complete Fault Code	32-bit integer
145–146	145–146	VO21 Complete Fault Code	32-bit integer
147–148	147–148	VO22 Complete Fault Code	32-bit integer
149–150	149–150	VO23 Complete Fault Code	32-bit integer
151–152	151–152	VO24 Complete Fault Code	32-bit integer
153–154	153–154	VO25 Complete Fault Code	32-bit integer
155–156	155–156	VO26 Complete Fault Code	32-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
157–158	157–158	VO27 Complete Fault Code	32-bit integer
159–160	159–160	VO28 Complete Fault Code	32-bit integer
161–162	161–162	VO29 Complete Fault Code	32-bit integer
163–164	163–164	VO30 Complete Fault Code	32-bit integer
165–166	165–166	VO31 Complete Fault Code	32-bit integer
167–168	167–168	VO32 Complete Fault Code	32-bit integer
169–170	169–170	VO33 Complete Fault Code	32-bit integer
171–172	171–172	VO34 Complete Fault Code	32-bit integer
173–174	173–174	VO35 Complete Fault Code	32-bit integer
175–176	175–176	VO36 Complete Fault Code	32-bit integer
177–178	177–178	VO37 Complete Fault Code	32-bit integer
179–180	179–180	VO38 Complete Fault Code	32-bit integer
181–182	181–182	VO39 Complete Fault Code	32-bit integer
183–184	183–184	VO40 Complete Fault Code	32-bit integer
185–186	185–186	VO41 Complete Fault Code	32-bit integer
187–188	187–188	VO42 Complete Fault Code	32-bit integer
189–190	189–190	VO43 Complete Fault Code	32-bit integer
191–192	191–192	VO44 Complete Fault Code	32-bit integer
193–194	193–194	VO45 Complete Fault Code	32-bit integer
195–196	195–196	VO46 Complete Fault Code	32-bit integer
197–198	197–198	VO47 Complete Fault Code	32-bit integer
199–200	199–200	VO48 Complete Fault Code	32-bit integer
201–202	201–202	VO49 Complete Fault Code	32-bit integer
203–204	203–204	VO50 Complete Fault Code	32-bit integer
205–206	205–206	VO51 Complete Fault Code	32-bit integer
207–208	207–208	VO52 Complete Fault Code	32-bit integer
209–210	209–210	VO53 Complete Fault Code	32-bit integer
211–212	211–212	VO54 Complete Fault Code	32-bit integer
213–214	213–214	VO55 Complete Fault Code	32-bit integer
215–216	215–216	VO56 Complete Fault Code	32-bit integer
217–218	217–218	VO57 Complete Fault Code	32-bit integer
219–220	219–220	VO58 Complete Fault Code	32-bit integer
221–222	221–222	VO59 Complete Fault Code	32-bit integer
223–224	223–224	VO60 Complete Fault Code	32-bit integer
225–226	225–226	VO61 Complete Fault Code	32-bit integer
227–228	227–228	VO62 Complete Fault Code	32-bit integer
229–230	229–230	VO63 Complete Fault Code	32-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
231–232	231–232	VO64 Complete Fault Code	32-bit integer
233–234	233–234	Fault #1 Time Stamp	32-bit integer
235–242	235–242	Fault #1 Name of I/O or System	2-word length + 12-ASCII characters
243	243	Fault #1 Error Code	16-bit integer
244	244	Fault #1 Advanced Error Code	16-bit integer
245	245	Fault #1 Error Message Index	16-bit integer
246–247	246–247	*reserved*	16-bit integer
248–249	248–249	Fault #2 Time Stamp	32-bit integer
250–257	250–257	Fault #2 Name of I/O or System	2-word length + 12-ASCII characters
258	258	Fault #2 Error Code	16-bit integer
259	259	Fault #2 Advanced Error Code	16-bit integer
260	260	Fault #2 Error Message Index	16-bit integer
261–262	261–262	*reserved*	16-bit integer
263–264	263–264	Fault #3 Time Stamp	32-bit integer
265–272	265–272	Fault #3 Name of I/O or System	2-word length + 12-ASCII characters
273	273	Fault #3 Error Code	16-bit integer
274	274	Fault #3 Advanced Error Code	16-bit integer
275	275	Fault #3 Error Message Index	16-bit integer
276–277	276–277	*reserved*	16-bit integer
278–279	278–279	Fault #4 Time Stamp	32-bit integer
280–287	280–287	Fault #4 Name of I/O or System	2-word length + 12-ASCII characters
288	288	Fault #4 Error Code	16-bit integer
289	289	Fault #4 Advanced Error Code	16-bit integer
290	290	Fault #4 Error Message Index	16-bit integer
291–292	291–292	*reserved*	16-bit integer
293–294	293–294	Fault #5 Time Stamp	32-bit integer
295–302	295–302	Fault #5 Name of I/O or System	2-word length + 12-ASCII characters
303	303	Fault #5 Error Code	16-bit integer
304	304	Fault #5 Advanced Error Code	16-bit integer
305	305	Fault #5 Error Message Index	16-bit integer
306–307	306–307	*reserved*	16-bit integer
308–309	308–309	Fault #6 Time Stamp	32-bit integer
310–317	310–317	Fault #6 Name of I/O or System	2-word length + 12-ASCII characters

Input REG #	Holding REG #	WORD NAME	DATA TYPE
318	318	Fault #6 Error Code	16-bit integer
319	319	Fault #6 Advanced Error Code	16-bit integer
320	320	Fault #6 Error Message Index	16-bit integer
321–322	321–322	*reserved*	16-bit integer
323–324	323–324	Fault #7 Time Stamp	32-bit integer
325–332	325–332	Fault #7 Name of I/O or System	2-word length + 12-ASCII characters
333	333	Fault #7 Error Code	16-bit integer
334	334	Fault #7 Advanced Error Code	16-bit integer
335	335	Fault #7 Error Message Index	16-bit integer
336–337	336–337	*reserved*	16-bit integer
338–339	338–339	Fault #8 Time Stamp	32-bit integer
340–347	340–347	Fault #8 Name of I/O or System	2-word length + 12-ASCII characters
348	348	Fault #8 Error Code	16-bit integer
349	349	Fault #8 Advanced Error Code	16-bit integer
350	350	Fault #8 Error Message Index	16-bit integer
351–352	351–352	*reserved*	16-bit integer
353–354	353–354	Fault #9 Time Stamp	32-bit integer
355–362	355–362	Fault #9 Name of I/O or System	2-word length + 12-ASCII characters
363	363	Fault #9 Error Code	16-bit integer
364	364	Fault #9 Advanced Error Code	16-bit integer
365	365	Fault #9 Error Message Index	16-bit integer
366–367	366–367	*reserved*	16-bit integer
368–369	368–369	Fault #10 Time Stamp	32-bit integer
370–377	370–377	Fault #10 Name of I/O or System	2-word length + 12-ASCII characters
378	378	Fault #10 Error Code	16-bit integer
379	379	Fault #10 Advanced Error Code	16-bit integer
380	380	Fault #10 Error Message Index	16-bit integer
381–382	381–382	*reserved*	16-bit integer
383–384	383–384	Seconds Since Boot	32-bit integer
385	385	Operating Mode	16-bit integer
386–395	386–395	ConfigName	2-word length + 16-ASCII characters
396–397	396–397	Config CRC	32-bit integer
398–900	398–900	*reserved*	16-bit integer
901	901	VO1 – VO16 (see Flags on p. 171)	16-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
902	902	VO17 – VO32 (see Flags on p. 171)	16-bit integer
903	903	VO33 – VO48 (see Flags on p. 171)	16-bit integer
904	904	VO49 – VO64 (see Flags on p. 171)	16-bit integer
905	905	VO65 – VO80 (see Extended Flags on p. 173)	16-bit integer
906	906	VO81 – VO96 (see Extended Flags on p. 173)	16-bit integer
907	907	VO97 – VO112 (see Extended Flags on p. 173)	16-bit integer
908	908	VO113 – VO128 (see Extended Flags on p. 173)	16-bit integer
909	909	VO129 – VO144 (see Extended Flags on p. 173)	16-bit integer
910	910	VO145 – VO160 (see Extended Flags on p. 173)	16-bit integer
911	911	VO161 – VO176 (see Extended Flags on p. 173)	16-bit integer
912	912	VO177 – VO192 (see Extended Flags on p. 173)	16-bit integer
913	913	VO193 – VO208 (see Extended Flags on p. 173)	16-bit integer
914	914	VO209 – VO224 (see Extended Flags on p. 173)	16-bit integer
915	915	VO225 – VO240 (see Extended Flags on p. 173)	16-bit integer
916	916	VO241 – VO256 (see Extended Flags on p. 173)	16-bit integer
917	917	Fault bits for VO1 – VO16 (see Flags on p. 171)	16-bit integer
918	918	Fault bits for VO17 – VO32 (see Flags on p. 171)	16-bit integer
919	919	Fault bits for VO33 – VO48 (see Flags on p. 171)	16-bit integer
920	920	Fault bits for VO49 – VO64 (see Flags on p. 171)	16-bit integer
921	921	Fault bits for VO65 – VO80 (see Extended Flags on p. 173)	16-bit integer
922	922	Fault bits for VO81 – VO96 (see Extended Flags on p. 173)	16-bit integer
923	923	Fault bits for VO97 – VO112 (see Extended Flags on p. 173)	16-bit integer
924	924	Fault bits for VO113 – VO128 (see Extended Flags on p. 173)	16-bit integer
925	925	Fault bits for VO129 – VO144 (see Extended Flags on p. 173)	16-bit integer

Input REG #	Holding REG #	WORD NAME	DATA TYPE
926	926	Fault bits for VO145 – VO160 (see Extended Flags on p. 173)	16-bit integer
926	926	Fault bits for VO161 – VO176 (see Extended Flags on p. 173)	16-bit integer
928	928	Fault bits for VO177 – VO192 (see Extended Flags on p. 173)	16-bit integer
929	929	Fault bits for VO193 – VO208 (see Extended Flags on p. 173)	16-bit integer
930	930	Fault bits for VO209 – VO224 (see Extended Flags on p. 173)	16-bit integer
931	931	Fault bits for VO225 – VO240 (see Extended Flags on p. 173)	16-bit integer
932	932	Fault bits for VO241 – VO256 (see Extended Flags on p. 173)	16-bit integer
933–934	933–934	RCD bits feedback (see Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58)	32-bit integer
935	935	RCD Enable feedback (see Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58)	16-bit integer
936	936	VO1 Fault Index	16-bit integer
937	937	VO2 Fault Index	16-bit integer
938	938	VO3 Fault Index	16-bit integer
...	...	...	...
1190	1190	VO256 Fault Index	16-bit integer
1191–1192	1191–1192	VO1 Complete Fault Code	32-bit integer
1193–1194	1193–1194	VO2 Complete Fault Code	32-bit integer
1195–1196	1195–1196	VO3 Complete Fault Code	32-bit integer
1197–1198	1197–1198	VO4 Complete Fault Code	32-bit integer
...	...	...	...
1702–1703	1702–1703	VO256 Complete Fault Code	32-bit integer

12.4.1 Flags

Registers 1 through 8, defined below, appear as the first eight words in register map.

This represents the first 64 virtual outputs and the associated fault flags. The information in these registers can be read as Input Registers (30000) using Modbus function code 04 (Read Input Registers). The same values can also be read as Holding Registers (40000) using Modbus function code 03 (Read Holding Registers).

Table 10: Virtual Output 1–16

PLC Input register 30001 or Holding Register 40001, also Inputs 10001–16 or Coils 00001–16

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO16	VO15	VO14	VO13	VO12	VO11	VO10	VO9	VO8	VO7	VO6	VO5	VO4	VO3	VO2	VO1

Table 11: Virtual Output 17–32

PLC Input register 30002 or Holding Register 40002, also Inputs 10017–32 or Coils 00017–32

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO32	VO31	VO30	VO29	VO28	VO27	VO26	VO25	VO24	VO23	VO22	VO21	VO20	VO19	VO18	VO17

Table 12: Virtual Output 33–48

PLC Input register 30003 or Holding Register 40003, also Inputs 10033–48 or Coils 00033–48

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO48	VO47	VO46	VO45	VO44	VO43	VO42	VO41	VO40	VO39	VO38	VO37	VO36	VO35	VO34	VO33

Table 13: Virtual Output 49–64

PLC Input register 30004 or Holding Register 40004, also Inputs 10049–64 or Coils 00049–64

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO64	VO63	VO62	VO61	VO60	VO59	VO58	VO57	VO56	VO55	VO54	VO53	VO52	VO51	VO50	VO49

Table 14: Virtual Output Fault 1–16

PLC Input register 30005 or Holding Register 40005, also Inputs 10033–48 or Coils 00033–48

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO16 fault	VO15 fault	VO14 fault	VO13 fault	VO12 fault	VO11 fault	VO10 fault	VO9 fault	VO8 fault	VO7 fault	VO6 fault	VO5 fault	VO4 fault	VO3 fault	VO2 fault	VO1 fault

Table 15: Virtual Output Fault 17–32

PLC Input register 30006 or Holding Register 40006, also Inputs 10049–64 or Coils 00049–64

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO32 fault	VO31 fault	VO30 fault	VO29 fault	VO28 fault	VO27 fault	VO26 fault	VO25 fault	VO24 fault	VO23 fault	VO22 fault	VO21 fault	VO20 fault	VO19 fault	VO18 fault	VO17 fault

Table 16: Virtual Output Fault 33–48

PLC Input register 30007 or Holding Register 40007, also Inputs 10033–48 or Coils 00033–48

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO48 fault	VO47 fault	VO46 fault	VO45 fault	VO44 fault	VO43 fault	VO42 fault	VO41 fault	VO40 fault	VO39 fault	VO38 fault	VO37 fault	VO36 fault	VO35 fault	VO34 fault	VO33 fault

Table 17: Virtual Output Fault 49–64

PLC Input register 30008 or Holding Register 40008, also Inputs 10049–64 or Coils 00049–64

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
VO64 fault	VO63 fault	VO62 fault	VO61 fault	VO60 fault	VO59 fault	VO58 fault	VO57 fault	VO56 fault	VO55 fault	VO54 fault	VO53 fault	VO52 fault	VO51 fault	VO50 fault	VO49 fault

12.4.2 Extended Flags

All 256 Virtual Outputs can be accessed in a way similar to that seen in Flags on p. 171.

Inputs 11001 through 11256 represent all 256 possible Virtual Outputs. These Virtual Outputs can also be read as Input Registers 901-916 or Holding Registers 901-916.

Inputs 12001 through 12256 are all 256 Virtual Output Faults. These Virtual Output Faults can also be read as Input Registers 917-932 or Holding Registers 917-932.

12.5 PROFINET®

PROFINET® [9] is a data communication protocol for industrial automation and processes. PROFINET IO defines how controllers (IO controllers) and peripheral devices (IO devices) exchange data in real time.

The PACSafe Safety Controller supports PROFINET IO. The data communication protocol is TCP/IP; the data transmission medium is copper wire; the PROFINET conformance class is CC-A. [10]

Note: In this document, outputs from the Safety Controller device are referred to as "inputs" to the controller (PLC). Outputs from the controller (PLC) are referred to as "inputs" to the Safety Controller device.

12.5.1 PROFINET and the Safety Controllers

PROFINET real time data is sent and received via slots.

Note: The GSD file is available for download at https://emerson-mas.force.com/communities/en_US/Download/PACSafe-Configuration-Tools .

12.5.2 General Station Description (GSD) File

The General Station Description (GSD) file contains module information, such as:

- Configuration data
- Data information (pass count, inspection status, etc.)
- Diagnostics

12.5.3 PROFINET IO Data Model

The PROFINET IO data model is based on the typical, expandable field device that has a backplane with slots. Modules and submodules have different functionalities.

Modules are plugged into slots; submodules are plugged into subslots. In the PROFINET IO data model, Slot 0 Subslot 1 is reserved for the Device Access Point (DAP) or network interface.

Both modules and submodules are used to control the type and volume of data that is sent to the controller (PLC).

- A submodule is typically designated as input type, output type, or combined input/output type
- An input submodule is used to send data to the controller (PLC)
- An output submodule is used to receive data from the controller (PLC)
- The combined input/output submodule simultaneously receives and sends data in both directions

[9] PROFINET® is a registered trademark of PROFIBUS Nutzerorganisation e.V.
[10] CC-A ensures that the device has the minimum properties regarding functionality and interoperability.

12.5.4 Configuring the Safety Controller for a PROFINET IO Connection

1. Connect the Safety Controller to the PC via the IC225CBL001 USB cable.
2. Open the PACSafe Studio Software, and click the **Industrial Ethernet** tab.
3. From the drop-down list on the left, select **Profinet**.
4. Click ✚ to add information to the PROFINET Submodules.
   Auto Configure can assist in this task.
5. Provide the appropriate password to change the configuration and network settings for the Safety Controller.
6. Make sure the Safety Controller has a valid and confirmed configuration file.

> **Note:** If a Virtual Reset or Cancel Delay is used, an Actuation Code must be created in **Network Settings**. Then the code must be sent to the Safety Controller using **Send** in **Network Settings**.

12.5.5 Description of Modules

Table 18: Assignment of Slots

In this table, the I/O direction is from the point of view of the PLC.

Slot	Module Function	I/O	Module Name	Module Size (Bytes)
1	User Defined Status Bits (0–31)	In	4 Status Bytes, Bits 0..31_1	4
2	User Defined Status Bits (32–63)	In	4 Status Bytes, Bits 0..31_2	4
3	Safety Controller Fault Bits (0–31)	In	4 Status Bytes, Bits 0..31_3	4
4	Safety Controller Fault Bits (32–63)	In	4 Status Bytes, Bits 0..31_4	4
5	Safety Controller Input Status Bits (0–31)	In	4 Status Bytes, Bits 0..31_5	4
6	Safety Controller Input Status Bits (32–63)	In	4 Status Bytes, Bits 0..31_6	4
7	Safety Controller Input Status Bits (64–95)	In	4 Status Bytes, Bits 0..31_7	4
8	Safety Controller Input Status Bits (96–127)	In	4 Status Bytes, Bits 0..31_8	4
9	Safety Controller Input Status Bits (128–159)	In	4 Status Bytes, Bits 0..31_9	4
10	Safety Controller Output Status Bits (0–31)	In	4 Status Bytes, Bits 0..31_10	4
11	Safety Controller Output Status Bits (32–63)	In	4 Status Bytes, Bits 0..31_11	4
12	Safety Controller Output Status Bits (64–95)	In	4 Status Bytes, Bits 0..31_12	4
13	Virtual I/O (On/Off/Mute Enable) Bits (0–63)	Out	8 Bytes Virtual On/Off/ME Data_1	8
14	Virtual Reset, Cancel Delay Bits (0–16)	Out	2 Bytes RCD Data_1	2

Slot	Module Function	I/O	Module Name	Module Size (Bytes)
15	Reset, Cancel Delay Actuation Code	Out	2 Byte RCD Actuation Code_1	2
16	Virtual Reset, Cancel Delay Bits (0–16) Feedback	In	RCD Data Feedback Register_1	2
17	Reset, Cancel Delay Actuation Code Feedback	In	RCD Passcode Feedback Register_1	2
18 [11]	Fault Log	In	Fault Log Buffer Module	300
19 [11]	System Information	In	System Information Module	30

User Defined Status Bits

The first two slots are always filled with User Defined Status Bit modules. These modules include 64 bits worth of virtual status output information of any type.

Table 19: User Defined Status Bits (0–31) Module (Ident 0×100) [fixed in Slot 1]

PLC Input Data Name	Input Data Type
User-Defined Status bits 0–7	Byte
User-Defined Status bits 8–15	Byte
User-Defined Status bits 16–23	Byte
User-Defined Status bits 24–31	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 20: User Defined Status Bits (32–63) Module (Indent 0×100) [fixed in Slot 2]

PLC Input Data Name	Input Data Type
User-Defined Status bits 32–39	Byte
User-Defined Status bits 40–47	Byte
User-Defined Status bits 48–55	Byte
User-Defined Status bits 56–63	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

[11] The Fault Log and System Information Modules are not used by the default connection.

Fault Bits

Slots 3 and 4 are always filled with 64-bits of Fault type virtual status output information from the Safety Controller.

Table 21: Safety Controller Fault Bits (0–31) Module (Ident 0×100) [fixed in Slot 3]

PLC Input Data Name	Input Data Type
Fault bits 0–7	Byte
Fault bits 8–15	Byte
Fault bits 16–23	Byte
Fault bits 24–31	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 22: Safety Controller Fault Bits (32–63) Module (Ident 0×100) [fixed in Slot 4]

PLC Input Data Name	Input Data Type
Fault bits 32–39	Byte
Fault bits 40–47	Byte
Fault bits 48–55	Byte
Fault bits 56–63	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Input Status Bits

Slots 5 through 9 are always reserved for 160 bits of Safety Controller input information. An expandable Safety Controller might have up to 154 inputs, if all of eight possible expansion cards were used as 16-channel inputs (in addition to the 26 inputs built into the Base Controller).

Table 23: Safety Controller Input Status Bits (0–31) Module (Ident 0×100) [fixed in Slot 5]

PLC Input Data Name	Input Data Type
Input Status bits 0–7	Byte
Input Status bits 8–15	Byte
Input Status bits 16–23	Byte
Input Status bits 24–31	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 24: Safety Controller Input Status Bits (32–63) Module (Ident 0×100) [fixed in Slot 6]

PLC Input Data Name	Input Data Type
Input Status bits 32–39	Byte
Input Status bits 40–47	Byte
Input Status bits 48–55	Byte
Input Status bits 56–63	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 25: Safety Controller Input Status Bits (64–95) Module (Ident 0×100) [fixed in Slot 7]

PLC Input Data Name	Input Data Type
Input Status bits 64–71	Byte
Input Status bits 72–79	Byte
Input Status bits 80–87	Byte
Input Status bits 88–95	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 26: Safety Controller Input Status Bits (96–127) Module (Ident 0×100) [fixed in Slot 8]

PLC Input Data Name	Input Data Type
Input Status bits 96–103	Byte
Input Status bits 104–111	Byte
Input Status bits 112–119	Byte
Input Status bits 120–127	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 27: Safety Controller Input Status Bits (128–159) Module (Ident 0×100) [fixed in Slot 9]

PLC Input Data Name	Input Data Type
Input Status bits 128–135	Byte
Input Status bits 136–143	Byte
Input Status bits 144–151	Byte
Input Status bits 152–159	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Output Status Bits

Slots 10 through 12 are reserved for 96 Safety Controller output type virtual status output bits.

Table 28: Safety Controller Output Status Bits (0–31) Module (Ident 0×100) [fixed in Slot 10]

PLC Input Data Name	Input Data Type
Output Status bits 0–7	Byte
Output Status bits 8–15	Byte
Output Status bits 16–23	Byte
Output Status bits 24–31	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 29: Safety Controller Output Status Bits (32–63) Module (Ident 0×100) [fixed in Slot 11]

PLC Input Data Name	Input Data Type
Output Status bits 32–39	Byte
Output Status bits 40–47	Byte
Output Status bits 48–55	Byte
Output Status bits 56–63	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Table 30: Safety Controller Output Status Bits (64–95) Module (Ident 0×100) [fixed in Slot 12]

PLC Input Data Name	Input Data Type
Output Status bits 64–71	Byte
Output Status bits 72–79	Byte
Output Status bits 80–87	Byte
Output Status bits 88–95	Byte

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Virtual On, Off, Mute Enable Bits

Slot 13 is filled with 64 virtual non-safety inputs, to be used as virtual on/off inputs (to the Safety Controller) or virtual mute enable inputs (to the Safety Controller).

Table 31: Virtual On/Off/Mute Enable Bits (0–63) Module (Ident 0×200) [fixed in Slot 13]

PLC Input Data Name	Input Data Type
Not applicable	Not applicable

PLC Output Data Name	Output Data Type
Virtual On/Off/ME bits 0–7	BOOL
Virtual On/Off/ME bits 8–15	BOOL
Virtual On/Off/ME bits 16–23	BOOL
Virtual On/Off/ME bits 24–31	BOOL
Virtual On/Off/ME bits 32–39	BOOL
Virtual On/Off/ME bits 40–47	BOOL
Virtual On/Off/ME bits 48–55	BOOL
Virtual On/Off/ME bits 56–63	BOOL

Virtual Reset, Cancel Delay (VRCD) Bits

Sixteen virtual non-safety inputs can be found in slot 14, to be used in the virtual reset, cancel delay sequence.

See Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58.

Table 32: Virtual Reset, Cancel Delay Bits (0–63) Module (Ident 0×300) [fixed in Slot 14]

PLC Input Data Name	Input Data Type
Not applicable	Not applicable

PLC Output Data Name	Output Data Type
VRCD bits 0-7	BOOL
VRCD bits 8-15	BOOL

Reset, Cancel Delay (RCD) 16-bit Actuation Code

Slot 15 contains the RCD Actuation Code, an important code word used in the virtual reset, cancel delay sequence.

See Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58.

Table 33: Reset, Cancel Delay Actuation Code Module (Ident 0×301) [fixed in Slot 15]

PLC Input Data Name	Input Data Type
Not applicable	Not applicable

PLC Output Data Name	Output Data Type
Reset, Cancel Delay Actuation Code	Unsigned 16

Virtual Reset, Cancel Delay Feedback Bits

Slot 16 includes feedback bits for the 16 virtual non-safety inputs found in slot 14. They are used in the virtual reset, cancel delay sequence.

See Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58.

Table 34: Virtual Reset, Cancel Delay Bits (0–63) Module (Ident 0×400) [fixed in Slot 16]

PLC Input Data Name	Input Data Type
VRCD Feedback bits 0–7	BOOL
VRCD Feedback bits 8–15	BOOL

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Reset, Cancel Delay 16-bit Actuation Code Feedback

Slot 17 includes the RCD Actuation Code feedback value, an important code word used in the virtual reset, cancel delay sequence.

See Virtual Manual Reset and Cancel Delay (RCD) Sequence on p. 58.

Table 35: Reset, Cancel Delay Actuation Code Module (Ident 0×401) [fixed in Slot 17]

PLC Input Data Name	Input Data Type
Reset, Cancel Delay Actuation Code Feedback	Unsigned 16

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Fault Log Entries

Slot 18 can be filled with the Fault Log Buffer Module.

Table 36: Safety Controller Fault Log Buffer Module (Ident 0×500) [fixed in Slot 18]

PLC Input Data Name	Input Data Type
Fault Log entry 1 (most recent)	15 words
Fault Log entry 2	15 words
Fault Log entry 3	15 words
Fault Log entry 4	15 words
Fault Log entry 5	15 words
Fault Log entry 6	15 words
Fault Log entry 7	15 words
Fault Log entry 8	15 words
Fault Log entry 9	15 words
Fault Log entry 10 (oldest)	15 words

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

Fault Log Entry	Type	Length (Words)
Timestamp	UDINT	2
Name Length	DWORD	2
Name String	String	6
Error Code	WORD	1
Advanced Error Code	WORD	1
Error Index Message	WORD	1
reserved	WORD	2

Fault Time Stamp

The relative time, in seconds, when the fault occurred. As measured from time 0, which is the last time the Safety Controller was powered up.

Name Length

The number of ASCII characters in the "Name String".

Name String

An ASCII-string describing the source of the fault.

Error Code, Advanced Error Code, Error Index Message

The Error Code and the Advanced Error Code, taken together, form the Safety Controller Fault Code. The format for the Fault Code is `Error Code 'dot' Advanced Error Code`. For example, a Safety Controller Fault Code of 2.1 is represented by an Error Code of `2` and an Advanced Error Code of `1`. The Error Message Index value is the Error Code and the Advanced Error Code together, and includes a leading zero with the Advanced Error Code, if necessary. For example, a Safety Controller Fault Code of 2.1 is represented by an Error Message Index of `201`. The Error Message Index value is a convenient way to get the complete Fault Code while only reading a single 16-bit register.

System Information Buffer

Slot 19 can be filled with the System Information Buffer Module.

Table 37: Safety Controller System Information Buffer Module (Ident 0×600) [fixed in Slot 19 when used]

PLC Input Data Name	Input Data Type
System Information Buffer	30 words

PLC Output Data Name	Output Data Type
Not applicable	Not applicable

System Information Buffer	Type	Length (Words)
Seconds Since Boot	UDINT	2
Operating Mode	WORD	1
Length of Config Name	DWORD	2
Config Name	String	8
Config CRC	WORD	2

Seconds Since Boot

A 32-bit integer representation of the number of seconds since powering up the Safety Controller.

Operating Mode

The current operational state of the Safety Controller.

Operating Mode Value	Description
1 (0×01)	Normal Operating Mode (including I/O faults, if present)
2 (0×02)	Configuration Mode
4 (0×04)	System Lockout
65 (0×41)	Waiting for System Reset/Exiting Configuration Mode
129 (0×81)	Entering Configuration Mode

Length of Config Name

The number of ASCII characters in the “Config Name”.

Config Name

An ASCII-string describing the source of the fault.

Config CRC

The Cyclic Redundancy Check (CRC) value for the current Safety Controller configuration.

12.5.6 Configuration Instructions

For instructions on configuring the Safety Controller using PROFINET, see document number GFK-2571, *PACSystems RX3i-EP PROFINET IO-Controller User Manual*.

This manual is available at www.emerson.com.

13 System Checkout

13.1 Schedule of Required Checkouts

Verifying the configuration and proper functioning of the Safety Controller includes checking each safety and non-safety input device, along with each output device. As the inputs are individually switched from the Run state to the Stop state, the safety outputs must be validated that they turn On and Off as expected.

Emerson highly recommends performing the checkouts 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 Emerson device and the guarded/controlled machine until the defect or problem has been corrected.

A comprehensive test must be used to verify the operation of the Safety Controller and the functionality of the intended configuration. Initial Setup, Commissioning, and Periodic Checkout Procedures on p. 185 is intended to assist in developing a customized (configuration-specific) checklist for each application. This customized checklist must be made available to maintenance personnel for commissioning and periodic checkouts. A similar, simplified daily checkout checklist should be made for the operator (or Designated Person [12]). It is highly recommended to have copies of the wiring and logic diagrams and the configuration summary available to assist in the checkout procedures.

WARNING:
- **Perform Periodic Checkouts**
- Failure to perform these checks could create a dangerous situation that could result in serious injury or death.
- The appropriate personnel must perform the commissioning, periodic, and daily safety system checks at the suggested times to ensure that the safety system is operating as intended.

Commissioning Checkout: A Qualified Person [12] must perform a safety system commissioning procedure before the safeguarded machine application is placed into service and after each Safety Controller configuration is created or modified.

Periodic (Semi-Annual) Checkout: A Qualified Person [12] must also perform a safety system re-commissioning semi-annually (every 6 months) or at periodic intervals based on the appropriate local or national regulations.

Daily Operational Checks: A Designated Person [12] must also check the effectiveness of the risk reduction measures, per the device manufacturers' recommendation, each day that the safeguarded machine is in service.

[12] See Glossary on p. 235 for definitions.

WARNING:

- **Clear the guarded area before applying power or resetting the system**
- Failure to clear the guarded area before applying power could result in serious injury or death.
- Verify that the guarded area is clear of personnel and any unwanted materials before applying power to the guarded machine or before resetting the system.

13.2 Commissioning Checkout Procedure

Before proceeding, verify that:

- All solid-state and relay output terminals of the complete Safety Controller system are not connected to the machine. Disconnecting all of the Safety Controller's safety output plug-on terminals is recommended
- Power has been removed from the machine, and no power is available to the machine controls or actuators

Permanent connections are made at a later point.

13.2.1 Verifying System Operation

The commissioning checkout procedure must be performed by a Qualified Person[13]. It must be performed only after configuring the Safety Controller and after properly installing and configuring the safety systems and safeguarding devices connected to its inputs (see Safety Input Device Options on p. 35 and the appropriate standards).

The commissioning checkout procedure is performed on two occasions:

1. When the Safety Controller is first installed, to ensure proper installation.
2. Whenever any maintenance or modification is performed on the System or on the machine being guarded by the System, to ensure continued proper Safety Controller function (see Schedule of Required Checkouts on p. 183).

For the initial part of the commissioning checkout, the Safety Controller and associated safety systems must be checked without power being available to the guarded machine. Final interface connections to the guarded machine cannot take place until these systems have been checked out.

Verify that:

- **The Safety Output leads are isolated**—not shorted together, and not shorted to power or ground
- If used, the external device monitoring (EDM) connections have been connected to +24 V DC via the normally closed (NC) monitoring contacts of the device(s) connected to the safety outputs, as described in External Device Monitoring (EDM) on p. 69 and the wiring diagrams
- The proper Safety Controller configuration file for your application has been installed into the Safety Controller
- All connections have been made according to the appropriate sections and comply with NEC and local wiring codes

This procedure allows the Safety Controller and the associated safety systems to be checked out, by themselves, before permanent connections are made to the guarded machine.

[13] See Glossary on p. 235 for definitions.

13.2.2 Initial Setup, Commissioning, and Periodic Checkout Procedures

There are two ways to verify that the Safety Outputs are changing state at the appropriate times in the initial configuration check out phase (open the **Configuration Summary** tab in the Software to view the Start-up test and Power-up configuration settings):

- Monitor the LEDs associated with the inputs and outputs. If the input LED is green, the input is high (or 24 V). If the input LED is red, the input is low (or 0 V). Similarly, if the RO1 or RO2 output contacts are closed, the corresponding LED is green. If the contacts are open, the LED is red.
- Start the **Live Mode** in the Software (the Safety Controller must be powered up and plugged in to the PC via the IC225CBL001 cable).

Start-Up Configuration

Outputs associated with Two-Hand Control, Bypass, Press Control, or Enabling Device functions do not turn on at power-up. After power-up, switch these devices to the Stop state and back to the Run state for their associated outputs to turn ON.

For the Press Control Function follow the process discussed in Press Control on p. 150.

If configured for Normal Power-Up

If latch function is not used: verify that Safety Outputs turn ON after power-up.

If either input devices or outputs use the latch function: verify that Safety Outputs do not turn ON after the power-up until the specific manual latch reset operations are performed.

If configured for Automatic Power-Up

Verify that all Safety Outputs turn ON within approximately 7 seconds (outputs with ON-Delay enabled may take longer to turn ON).

If configured for Manual Power-Up

Verify that all Safety Outputs remain OFF after power up.

Wait at least 10 seconds after power-up and perform the Manual Power-Up reset.

Verify that the Safety Outputs turn ON (outputs with ON-Delay enabled may take longer to turn ON).

CAUTION: Verifying Input and Output Function

The Qualified Person is responsible to cycle the input devices (Run state and Stop state) to verify that the Safety Outputs turn ON and OFF to perform the intended safeguarding functions under normal operating conditions and foreseeable fault conditions. Carefully evaluate and test each Safety Controller configuration to make sure that the loss of power to any safeguarding input device, the Safety Controller, or the inverted input signal from a safeguarding input device, do not cause an unintended Safety Output ON condition, mute condition, or bypass condition.

Note: If an Input or Output indicator is flashing red, see Troubleshooting on p. 211.

Safety Input Device Operation (E-stop, Rope Pull, Optical Sensor, Safety Mat, Protective Stop)

1. While the associated Safety Outputs are ON, actuate each safety input device, one at a time.
2. Verify that each associated Safety Output turns OFF with the proper OFF-Delay, where applicable.
3. With the safety device in the Run state:

- **If a safety input device is configured with a Latch Reset function:**
    1. Verify that the Safety Output remains OFF.
    2. Perform a latch reset to turn the outputs ON.
    3. Verify that each associated Safety Output turns ON.
- **If no Latch Reset functions are used:** Verify that the Safety Output turns ON

> **Important:** Always test the safeguarding devices according to the recommendations of the device manufacturer.

In the sequence of steps below, if a particular function or device is not part of the application, skip that step and proceed to the next checklist item or to the final commissioning step.

Two-Hand Control Function without Muting

1. Make sure the Two-Hand Control actuators are in the Stop state.
2. Make sure that all other inputs associated with Two-Hand Control function are in the Run state and activate the Two-Hand Control actuators to turn the associated Safety Output On.
3. Verify that the associated Safety Output remains Off unless both actuators are activated within 0.5 seconds of each other.
4. Verify that Safety Output turns Off and remains Off when any single hand is removed and replaced (while maintaining the other actuator in the Run state).
5. Verify that switching a safety input (non-Two-Hand Control actuator) to the Stop state causes the associated Safety Output to turn Off or stay Off.
6. If more than one set of Two-Hand Control actuators are used, the additional actuators need to be activated before the Safety Output turns On. Verify that the Safety Output turns Off and remains Off when any single hand is removed and replaced (while maintaining the other actuators in the Run state).

Two-Hand Control Function with Muting

1. Follow the verification steps in Two-Hand Control function above.
2. Activate the Two-Hand Control actuators then activate the Mute Sensor Pair 1 (MSP1) sensors.
3. With the MSP1 sensors active, remove your hands from the Two-Hand Control and verify that the Safety Output stays On.
4. Verify that the Safety Output turns Off when either:
    - MSP1 sensors are switched to the stop state
    - Mute time limit expires
5. For multiple Two-Hand Control actuators with at least one set of non-mutable actuators: verify that while in an active mute cycle, removing one or both hands from each non-muted actuators causes the Safety Outputs to turn Off.

Bidirectional (Two-Way) Muting Function (Also valid for Zone Control Mute Functions)

1. With the muted safeguard in the Run state, activate the Mute Enable input (if used) and then activate each mute sensor, in sequential order, within 3 seconds.
2. Generate a stop command from the muted safeguarding device:
    a) Verify that the associated Safety Outputs remain On.
    b) If a mute time limit has been configured, verify that the associated Safety Outputs turn Off when the mute timer expires.
3. Repeat above steps for each Muting Sensor Pair (MSP).
4. Verify proper operation of each muted safeguarding device.
5. While in the mute cycle, one at a time, generate a stop command from any non-muted safeguarding devices and verify that the associated Safety Outputs turn Off.
6. Verify the mute process in the opposite direction, repeating the process above, activating the mute sensors in the reverse order.

Unidirectional (One Way) Muting Function

1. With the mute sensors not activated, the muted safeguarding devices in the Run state, and the Safety Outputs On:
   a) Activate Muting Sensor Pair 1 (MSP1).
   b) Change the muted safeguarding device to the Stop state.
   c) Activate Muting Sensor Pair 2 (MSP2).
   d) Deactivate MSP1.
2. Verify the associated Safety Output remains On throughout the process.
3. Repeat the test in the *wrong direction* (MSP2, then the safeguarding device, then MSP1).
4. Verify that when the safeguard changes to the Stop state the output turns Off.

If a mute time limit has been configured

Verify that the associated Safety Outputs turn Off when the mute timer expires.

Mute Function with Power-Up Operation (not applicable for Two-Hand Control)

1. Turn the Safety Controller power off.
2. Activate the Mute Enable input, if used.
3. Activate an appropriate Muting Sensor Pair for starting a mute cycle.
4. Make sure that all mutable safeguarding devices are in the Run state.
5. Apply power to the Safety Controller.
6. Verify that the Safety Output turns ON and that a mute cycle begins.
7. Repeat this test with the mutable safeguard device in the Stop state.
8. Verify that the Safety Output stays OFF.

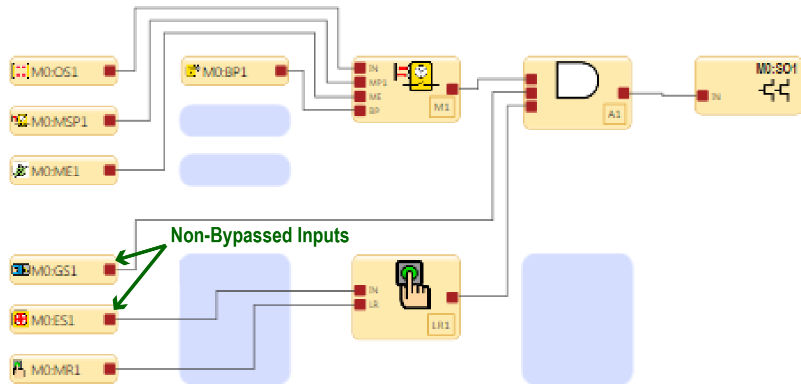
Mute Function with Mute-Dependent Override

1. Make sure mute sensors are not activated and mute safeguarding devices are in the Run state.
2. Verify that the Safety Outputs are On.
3. Switch the safeguarding device to the Stop state.
4. Verify that the Safety Output turns Off.
5. Activate one of the mute sensors.
6. Verify the optional mute lamp is flashing.
7. Start the mute dependent override by activating the Bypass Switch.
8. Verify that the Safety Output turns On.
9. Verify that the Safety Output turns Off under any of the following conditions:
   - Bypass (Override) Time limit expires
   - Mute sensors are deactivated
   - The Bypass device is deactivated

Mute Function with Bypass

1. Verify that each safety input, that can be both muted and bypassed, is in the Stop state.
2. Verify that when the Bypass Switch is in the Run state:
   a) The associated Safety Outputs turn On.
   b) The associated Safety Outputs turn Off when the bypass timer expires.
3. Change the Bypass Switch to the Run state and verify that the associated Safety Outputs turn On.
4. One at a time, switch the associated non-bypassed input devices to their Stop state and verify that associated Safety Outputs turn Off while the Bypass Switch is in the Run state.

Figure 140. Mute Function with Bypass



Bypass Function

1. Verify that the associated Safety Outputs are OFF when the safety inputs to be bypassed are in the Stop state.
2. Verify that when the Bypass Switch is in the Run state:
   a) The associated Safety Outputs turn ON.
   b) The associated Safety Outputs turn OFF when the bypass timer expires.
3. Change the Bypass Switch to the Run state and verify that the associated Safety Outputs turn ON.
4. One at a time, switch the non-bypassed input devices to the Stop state and verify that the associated Safety Outputs turn OFF while the Bypass Switch is in the Run state.

Safety Output OFF-Delay Function

1. With any one of the controlling inputs in the Stop state and the delayed Safety Output in an OFF-Delay state, verify that the Safety Output turns OFF after the time delay is over.
2. With any one of the controlling inputs in the Stop state and the OFF-Delay timer is active, switch the input to the Run state and verify that the Safety Output is ON and remains ON.

Safety Output OFF-Delay Function—Cancel Delay Input

With the associated inputs in the Stop state and the delayed Safety Output in an OFF-Delay state, activate the Cancel Delay input and verify that the Safety Output turns OFF immediately.

Safety Output OFF-Delay Function—Controlling Inputs

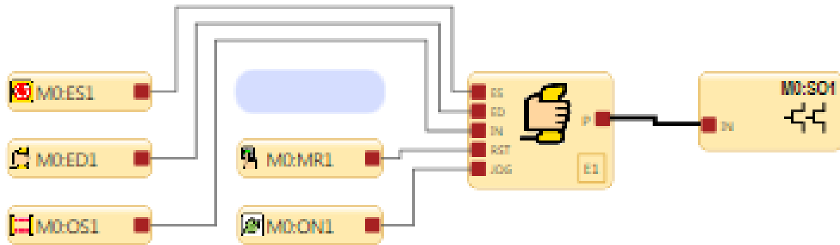
1. With any one of the controlling inputs in the Stop state and the delayed Safety Output is in an OFF-Delay state, switch the input to the Run state.
2. Verify that the Safety Output is ON and remains ON.

Safety Output OFF-Delay Function and Latch Reset

1. Make sure the associated input devices are in the Run state so that the delayed Safety Output is ON.
2. Start the OFF-Delay time by switching an input device to the Stop state.
3. Switch the input device to the Run state again during the OFF-Delay time and push the Reset button.
4. Verify that the delayed output turns OFF at the end of the delay and remains OFF (a latch reset signal during the delay time is ignored).

Enabling Device Function without Secondary Jog Output

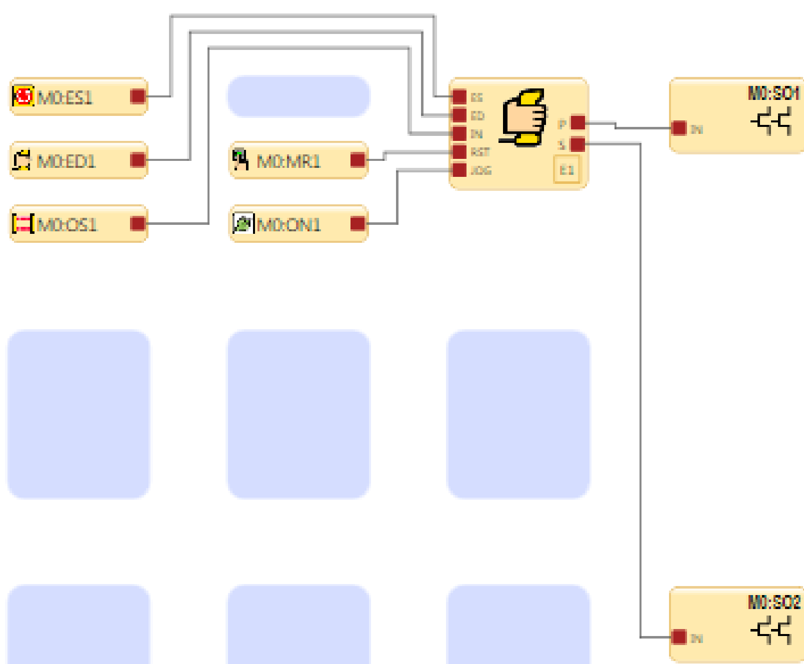
Figure 141. Device Function without Secondary Jog Output



1. With the associated inputs in the Run state and the Enabling Device in the Stop state, verify that the Safety Output is On.
2. With the Enabling Device still in the Run state and the associated Safety Output On, verify that the Safety Output turns Off when the Enabling Device timer expires.
3. Return the Enabling Device to the Stop state and then back to the Run state, and verify that the Safety Outputs turns On.
4. Switch the Enabling Device to the Stop state, and verify that the associated Safety Outputs turn Off.
5. Switch each E-stop and Rope Pull device associated with the Enabling Device function to the Stop state, and verify, one at a time, that the associated Safety Outputs are On and in the Enable mode.
6. With the Enabling Device in the Stop state, perform a reset.
7. Verify that control authority is now based on associated input devices of the Enabling device function:
   a) If one or more input devices are in the Stop state, verify that the output is Off.
   b) If all of the input devices are in the Run state, verify that the output is On.

Enabling Device Function—With Jog feature on the Secondary Output

Figure 142. Device Function—With Jog feature on the Secondary Output



1. With the Enabling Device and the Jog button in the Run state in control of the primary Safety Output, verify that the output turns Off when either the Enabling Device or the Jog button is switched to the Stop state.
2. With the Enabling Device in control of the primary Safety Output and the Jog button in control of the secondary output verify that the primary Output turns:
   a) ON when the Enabling Device is in the Run state.
   b) OFF when the Enabling Device is in the Stop state and the Jog button is in the Run state.
3. Verify that the output turns On only when the Enabling Device is in the Run state while the Jog button is in the Run state.
4. Verify that the secondary Output turns:
   a) ON when the Enabling Device and the Jog button are in the Run state.
   b) OFF when the either the Enabling Device or the Jog button are in the Stop state.

Press Control Function Block with Single Actuator Control Configured

1. Make sure the Non-Mutable Safety input, Mutable Safety Stop input (if configured), and the TOS are ON.
2. Perform a reset cycle.
3. Momentarily turn ON the GO input. Verify the down motion starts.
4. Use a test piece to block the Mutable Safety Stop input. Verify the down motion stops.
5. Clear the Mutable Safety Stop input and perform a reset cycle.
6. Momentarily turn ON the GO input. Verify the ram moves up to the TOS position and stops.
7. Momentarily turn ON the GO input. Verify the ram moves down.
8. When the ram reaches the BOS point and starts its upward motion, block the Mutable Safety Stop input with the test piece. Verify that the ram continues to move up to the TOS position.

Press Control Function Block with the Manual Upstroke Setting Configured

1. Make sure the Non-Mutable Safety input, Mutable Safety input, and TOS are ON.
2. Perform a reset cycle, turn on PIP (if used), and then engage the GO input. Verify the Down output turns ON.
3. Disengage the GO input. Verify the Down output turns OFF.
4. Engage the GO input. The Down output should turn back ON.
5. Use a test piece to block the Mutable Safety Stop input. Verify the down motion stops.
6. Clear the Mutable Safety Stop input and perform a reset cycle.
7. Engage the GO input. Verify the ram moves up to the TOS position and stops.
8. Engage the GO input. After the RAM reaches the BOS point, verify the Down output turns OFF and the Up output turns ON.
9. With the test piece, block the Mutable Safety Stop input. Verify the up motion stops.
10. Release the GO input.
11. Clear the Mutable Safety Stop input.
12. Perform a reset cycle.
13. Engage the GO input to drive the ram back to the TOS position.

Press Control Mode Function Block Checks

If the Dual Pressure setting is selected, verify all outputs are working correctly. The high-pressure output should only turn on in Run mode.

1. Make sure the Non-Mutable Safety input, Mutable Safety input, and TOS are ON (but all Mode inputs are OFF).
2. Perform a reset cycle, turn on PIP (if used), and then engage the GO input. Verify no output turns ON.
3. Turn off the GO input.
4. Select the RUN state, perform a reset cycle, then engage the GO input. The Down output should turn ON. (Run a complete cycle then stop, including cycling the PIP input.)

5. Turn off the Run input and turn on the Inch Down input.
6. Perform a reset cycle and then engage the GO input. Verify the Down output cycles on and off (and verify the ram speed is within inch specifications).
7. At the BOS point of the process, turn off the Inch Down input and turn on the Inch Up input.
8. Perform a reset cycle and then engage the GO input. Verify the Up output cycles on and off (and verify the ram speed is within inch specifications).

Press Control SQS (or SQS & PCMS) Checks

If the Dual Pressure setting is selected, verify the high-pressure output only turns ON when the ram is moving down from SQS to BOS.

See Press Control Inputs Function Block on p. 153 for specific GO, SQS and Ft Pedal configurations and behaviors.

1. Make sure the Non-Mutable Safety input, Mutable Safety input, and TOS are ON.
2. Perform a reset cycle, turn on PIP (if used), and then engage the GO input. Verify the Down output turns ON.
3. Verify that the ram stops at the SQS sensor(s) (or SQS & PCMS sensors).
4. Release (turn off) the GO input. Verify that the gap of the tools is less than 6 mm (finger-safe). Verify that the Mutable Safety Stop input is now muted.
5. Engage the Ft Pedal input. Verify that the ram moves from the SQS point to the BOS point and stops.
6. Release the Ft Pedal input.
7. Engage the GO input. Verify the RAM returns to the TOS point and stops.
8. Release the GO input.

14 Status and Operating Information

Operate the PACSafe 262 Safety Controller using either the onboard interface or Software to monitor ongoing status.

Operate the PACSafe 102 Safety Controller using the Software to monitor ongoing status.

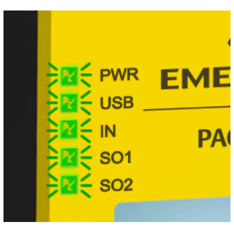
14.1 PACSafe 262 LED Status

LED	Status	Meaning
All	OFF	Initialization Mode
	Sequence: Green ON for 0.5 s Red ON for 0.5 s OFF for 0.5 s minimum	Power applied
Power/Fault	OFF	Power OFF
	Green: Solid	Run mode
	Green: Flashing	Configuration Mode OR Manual Power-Up mode
	Red: Flashing	Non-operating Lockout condition
USB	OFF	No link established and configured Safety Controller
	Green: Solid	USB cable connected to a configured Safety Controller
	Green: Flashing	No link established and factory default Safety Controller OR USB cable connected and factory default Safety Controller
	Green: Flashing for 4 s, then Green ON	Configured IC225ACC001 (locked or unlocked) plugged into a factory default Safety Controller
	Green: Flashing for 5 s, then OFF	Configured and unlocked IC225ACC001 plugged into a configured Safety Controller with a matching configuration, matching passwords, and matching or mismatched network settings
	Green: Flashing for 5 s, then Red flashing	Configured and locked IC225ACC001 plugged into a configured Safety Controller with a matching configuration and matching passwords but mismatched network settings
	Red: Flashing	Configured IC225ACC001 (locked or unlocked) plugged into a configured Safety Controller with a mismatched configuration, a mismatched password, or a blank IC225ACC001 plugged in OR Blank IC225ACC001 plugged into a factory default Safety Controller or a configured Safety Controller
Inputs	Green: Solid	No input faults
	Red: Flashing	One or more inputs is in the Lockout condition
SO1, SO2	OFF	Output not configured
	Green: Solid	Safety Output ON
	Red: Solid	Safety Output OFF
	Red: Flashing	Safety Output fault detected or EDM fault detected or AVM fault detected

LED Status for Split Outputs	Meaning
Green: Solid	Both outputs are ON
Red: Solid	SO1 and/or SO2 is OFF
Red: Flashing	SO1 and/or SO2 fault detected

Ethernet Diagnostic LEDs		
Amber LED	Green LED	Description
ON	Varies with traffic	Link established/normal operation
OFF	OFF	Hardware failure

Amber LED and Green LED Flash in Unison	Description
5 flashes followed by several rapid flashes	Normal power up
1 flash every 3 seconds	Contact Emerson. See the contact information at the end of this manual.
2 flash repeating sequence	In the past 60 seconds, a cable was unplugged while active
3 flash repeating sequence	A cable is unplugged
4 flash repeating sequence	Network not enabled in the configuration
5+ flash repeating sequence	Contact Emerson. See the contact information at the end of this manual.

PROFINET Flash Command	Meaning
The Base Controller LEDs flash for 4 seconds 	The flashing LEDs indicate that the Base Controller is connected. It is the result of the "Flash LED" command from the PROFINET network.

14.2 Input Module Status Indicators

The following information is for models IC225SDD841 and IC225SDD842.

LED	Status	Meaning
All	Sequence: Green ON for 0.5 s Red ON for 0.5 s OFF for 0.5 s minimum	Power Applied
	OFF	Initialization Mode
Power Indicator	Green: ON	Power ON
	OFF	Power OFF

LED	Status	Meaning
	Red: Flashing	Non-Operating Lockout Condition
Transmit / Receive Indicator	Green: ON	Transmitting or receiving data
	Red: ON	No communication
	Red: Flashing	Communication fault detected OR Safety Bus communication issue
Input Indicator	Green: ON	No input faults
	Red: Flashing	Input fault detected

14.3 Output Module (Solid-State or Relay) Status Indicators

The following information is for models IC225SDL720, IC225SDL740, IC225SDL910, and IC225SDL920.

LED	Status	Meaning
All	Sequence: Green ON for 0.5 s Red ON for 0.5 s OFF for 0.5 s minimum	Power Applied
	OFF	Initialization Mode
Power Indicator	OFF	Power OFF
	Green: ON	Power ON
	Red: Flashing	Non-Operating Lockout Condition
Transmit / Receive Indicator	Green: ON	Transmitting or receiving data
	Red: ON	No communication
	Red: Flashing	Communication fault detected OR Safety Bus communication issue
Safety Output Indicators	OFF	Output not configured
	Green: ON	Two single-channel Safety Outputs (both ON) OR Dual-channel or One single-channel Safety Output ON
	Red: ON	Two single-channel Safety Outputs (1 ON and 1 OFF)
	Red: ON	Two single-channel Safety Outputs (both OFF) OR Dual-channel or One single-channel Safety Output OFF (other channel not used)
	Red: Flashing	Safety Output fault detected

14.4 PACSafe 102 LED Status

Use the following table to determine the status of the Safety Controller.

The LEDs are always on unless the Safety Controller is off.

LED	Status	Meaning
All	OFF	Initialization Mode
	Sequence: Green ON for 0.5 s Red ON for 0.5 s OFF for 0.5 s minimum	Power applied
Power/Fault (1)	Green: Solid	24 V DC connected
	Green: Flashing	Configuration or Manual Power-Up mode Configuration via IC225ACC001: Cycle Power
	Red: Flashing	Non-operating Lockout condition
USB (1)	Green: Solid	USB cable connected or IC225ACC001 plugged in
	Green: Flashing	Factory default Safety Controller; no USB cable connected or IC225ACC001 plugged in
	Green: Fast flashing for 3 s, then solid	Configured (locked or unlocked) IC225ACC001 plugged into a factory default Safety Controller; the configuration, network settings, and passwords transfer from the IC225ACC001 to the Safety Controller
	Green: Flashing for 3 s, then solid	Configured and unlocked IC225ACC001 plugged into a configured Safety Controller with a matching configuration and matching passwords **Note:** If there are mismatched network settings, the network settings transfer from the Safety Controller to an unlocked IC225ACC001. Network settings do not transfer to a locked IC225ACC001.
	Green: Flashing for 3 s, then Red flashing	Configured and locked IC225ACC001 plugged into a configured Safety Controller with a matching configuration and matching passwords, but mismatched network settings
	Red: Solid	Configured Safety Controller; no USB cable connected or IC225ACC001 plugged in
	Red: Flashing	Configured (locked or unlocked) IC225ACC001 plugged into a configured Safety Controller with a mismatched configuration, a mismatched password, or a blank IC225ACC001 plugged into any Safety Controller
Inputs (10)	Green: Solid	Configured as an input circuit: 24 V DC and no fault
	Green: Solid	Configured as a status output: Active
	Red: Solid	Configured as an input circuit: 0 V DC and no fault
	Red: Solid	Configured as a status output: Inactive
	Red: Flashing	All terminals of a faulted input (includes shared terminals)
RO1, RO2 (2)	Green: Solid	ON (contacts closed)
	Red: Solid	OFF (contacts open) or not configured
	Red: Flashing	Safety Output fault detected or EDM fault detected or AVM fault detected

Ethernet Diagnostic LEDs		
Amber LED	Green LED	Description
ON	Varies with traffic	Link established/normal operation
OFF	OFF	Hardware failure

Amber LED and Green LED Flash in Unison	Description
5 flashes followed by several rapid flashes	Normal power up
1 flash every 3 seconds	Contact Emerson. See the contact information at the end of this manual.
2 flash repeating sequence	In the past 60 seconds, a cable was unplugged while active
3 flash repeating sequence	A cable is unplugged
4 flash repeating sequence	Network not enabled in the configuration
5+ flash repeating sequence	Contact Emerson. See the contact information at the end of this manual.

PROFINET Flash Command	Meaning
All LEDs flash for 4 seconds 	The flashing LEDs indicate that the PACSafe 102 is connected. It is the result of the "Flash LED" command from the PROFINET network.

14.5 Live Mode Information: Software

To display real-time Run mode information on a PC, the Safety Controller must be connected to the computer via the IC225CBL001 cable. Click **Live Mode** to access the **Live Mode** tab. This feature continually updates and displays data, including Run, Stop, and Fault states of all inputs and outputs, as well as the Fault Codes table. The **Equipment** tab and the **Functional View** tab also provide device-specific visual representation of the data. See Live Mode on p. 120 for more information.

The **Live Mode** tab provides the same information that can be viewed on the Safety Controller display (models with display).

14.6 Live Mode Information: Onboard Interface

To display real-time Run mode information on the Safety Controller display (models with display), select **System Status** [14] from the **System Menu** (see PACSafe 262 Onboard Interface on p. 158 for navigation map). **System Status** shows input device and Safety Output states; **Fault Diagnostics**

[14] **System Status** is the first screen that displays when the Safety Controller turns On after a reset. Click **ESC** to view the **System Menu**.

shows current Fault information (a brief description, remedial step(s), and the Fault Code) and provides access to the **Fault Log**.

The Safety Controller display provides the same information that can be viewed via the **Live Mode** function in the Software.

14.7 Lockout Conditions

Input lockout conditions are generally resolved by repairing the fault and cycling the input Off and then back On.

Output lockout conditions (including EDM and AVM faults) are resolved by repairing the fault and then cycling the Reset Input connected to the FR node on the Safety Output.

System faults, such as low supply voltage, overtemperature, voltage detected on unassigned inputs, or Press Control faults may be cleared by cycling the System Reset input (any Reset Input assigned to be the System Reset). Only one reset button, either physical or virtual, can be configured to perform this operation.

A system reset is used to clear lockout conditions not related to safety inputs or outputs. A lockout condition is a response where the Safety Controller turns Off all affected Safety Outputs when a safety-critical fault is detected. Recovery from this condition requires all faults to be remedied and a system reset to be performed. A lockout will recur after a system reset unless the fault that caused the lockout has been corrected.

A system reset is necessary under the following conditions:

- Recovering from a system lockout condition
- Starting the Safety Controller after a new configuration has been downloaded
- Recovering from a Press Control fault

For internal faults, the System Reset likely will not work. The power will have to be cycled in an attempt to run again.

WARNING:

- **Non-monitored resets**
- Failure to follow these instructions could result in serious injury or death.
- If a non-monitored reset (either latch or system reset) is configured and if all other conditions for a reset are in place, a short from the reset terminal to +24 V will turn on the safety output(s) immediately.

WARNING:

- **Clear the guarded area before applying power or resetting the system**
- Failure to clear the guarded area before applying power could result in serious injury or death.
- Verify that the guarded area is clear of personnel and any unwanted materials before applying power to the guarded machine or before resetting the system.

14.8 Recovering from a Lockout

To recover from a lockout condition:

- Follow the recommendation in the fault display (models with display)
- Follow the recommended steps and checks listed in the PACSafe 262 Fault Code Table on p. 216 or PACSafe 102 Fault Code Table on p. 223
- Perform a system reset
- Cycle the power and perform a system reset, if needed

If these steps do not remedy the lockout condition, contact Emerson (see Repairs and Warranty Service on p. 228).

14.9 PACSafe 102 Using Automatic Terminal Optimization

Follow these steps for an example configuration that uses the Automatic Terminal Optimization (ATO) feature.

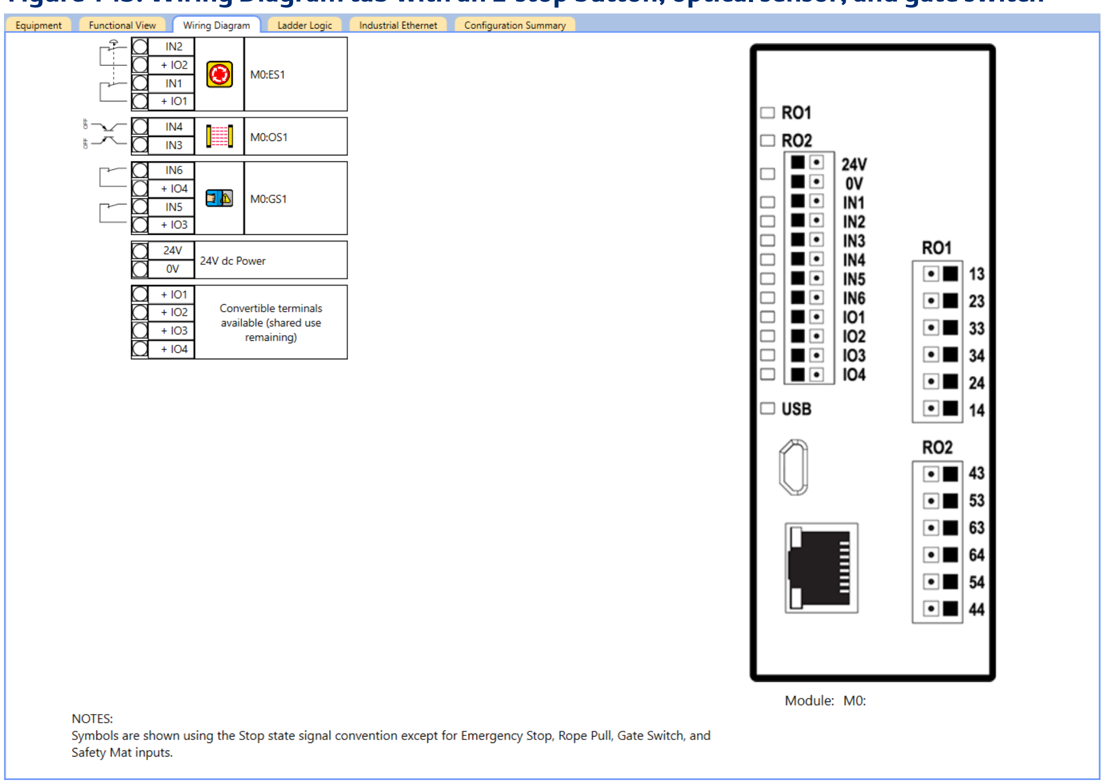
> **Note:** This procedure is an example only.

1. Click **New Project** to start a new project.
2. Select PACSafe 102 **Series**.
3. Define the project settings and click **OK**.

   > **Note:** Make sure that **Disable Automatic Terminal Optimization Feature** checkbox is clear.

   The project is created.
4. On the **Equipment** tab, click below the Safety Controller.
   The **Add Equipment** window opens.
5. Add an Emergency Stop button, and click **OK** to accept the default settings.
6. Click .
7. Add an Optical Sensor, and click **OK** to accept the default settings.
8. Click .
9. Add a Gate Switch, and click **OK** to accept the default settings.
10. Go to the **Wiring Diagram** tab, and notice the terminals that are used.

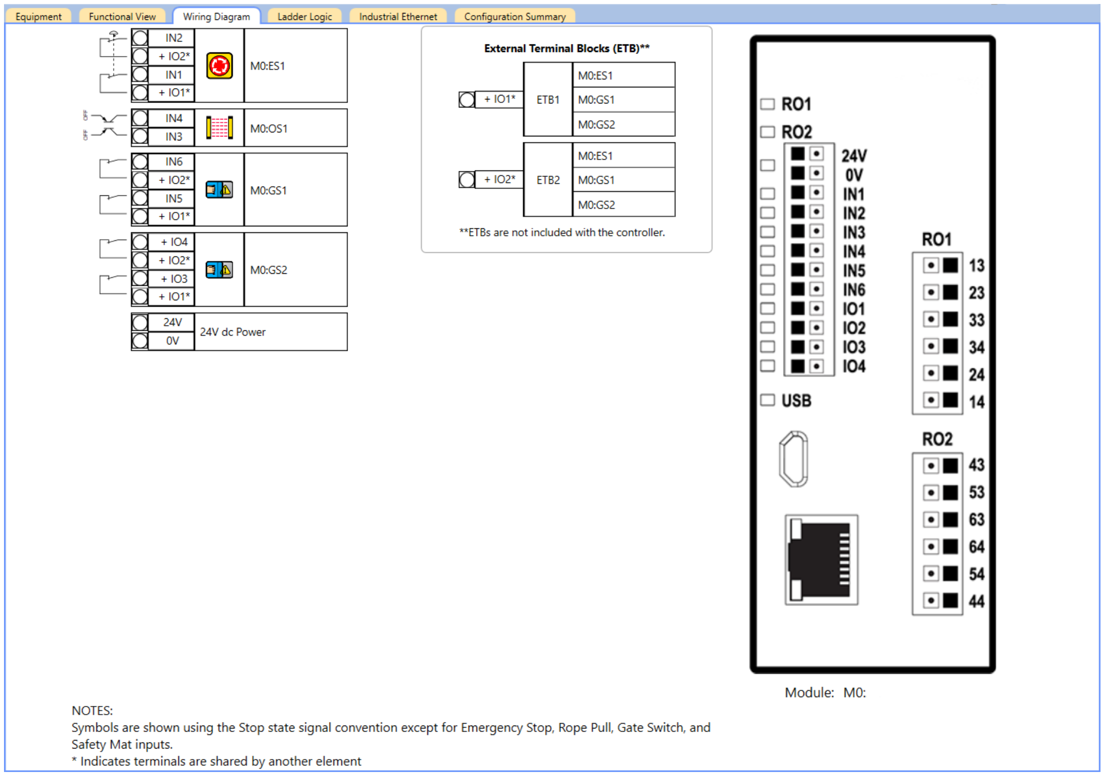
Figure 143. Wiring Diagram tab with an E-stop button, optical sensor, and gate switch



11. Go to the **Equipment** tab and click .
12. Add a second Gate Switch, and click **OK** to accept the default settings.
13. Go to the **Wiring Diagram** tab, and notice that external terminal blocks (ETB) have been added to accommodate the second Gate Switch.

Note: External terminal blocks are user-provided.

Figure 144. Wiring Diagram Tab with Three E-stop Buttons and ETBs



14.10 PACSafe 102 Example Configuration without Automatic Terminal Optimization

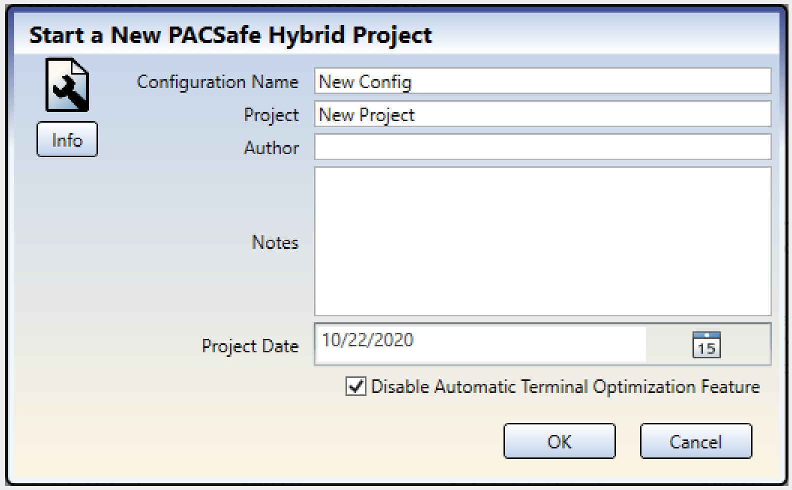
Follow these steps for an example configuration where the Automatic Terminal Optimization (ATO) feature is disabled.

Note: This procedure is an example only.

1. Click **New Project** to start a new project.
2. Select PACSafe 102 **Series**.
3. Define the project settings, select the **Disable Automatic Terminal Optimization Feature** checkbox, and click **OK**.

Note: Make sure that **Disable Automatic Terminal Optimization Feature** checkbox is selected.

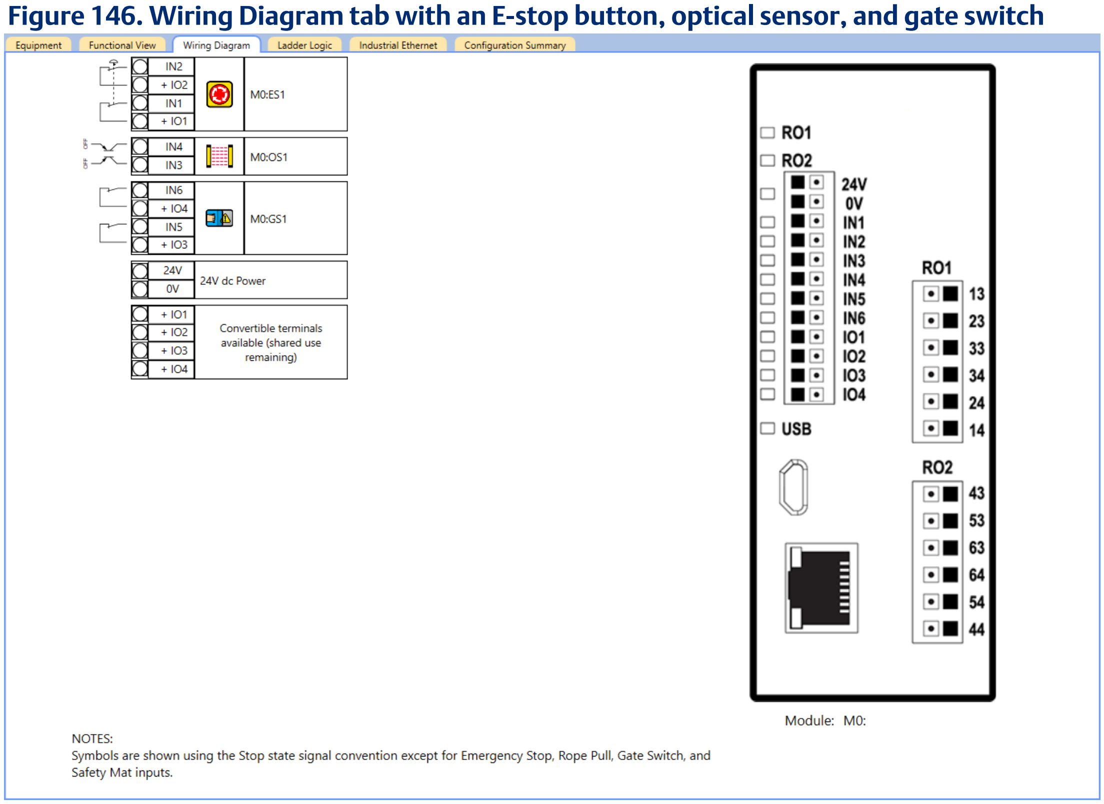
Figure 145. Disable Automatic Terminal Optimization Feature Selected



The project is created.

4. On the **Equipment** tab, click ✚ below the Safety Controller.
   The **Add Equipment** window opens.
5. Add an Emergency Stop button, and click **OK** to accept the default settings.
6. Click ✚.
7. Add an Optical Sensor, and click **OK** to accept the default settings.
8. Click ✚.
9. Add a Gate Switch, and click **OK** to accept the default settings.
10. Go to the **Wiring Diagram** tab, and notice the terminals that are used.

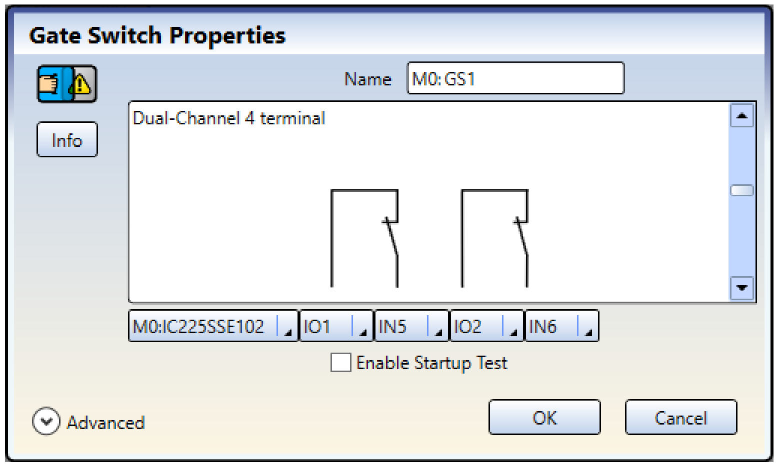
Figure 146. Wiring Diagram tab with an E-stop button, optical sensor, and gate switch



11. Go to the **Equipment** tab and and try to add another Gate Switch.

    No other equipment can be added (does not appear) because the ATO feature is disabled and there are not enough terminals to support more equipment.
12. Go to the **Functional View** tab and try to add another Gate Switch.
    No other equipment can be added here either because the ATO feature is disabled.
13. Click **Cancel**.
14. On the **Functional View** tab, click on the Gate Switch and then click **Edit** to change the properties.
    a) Change the IO3 and IO4 terminals to IO1 and IO2 respectively.

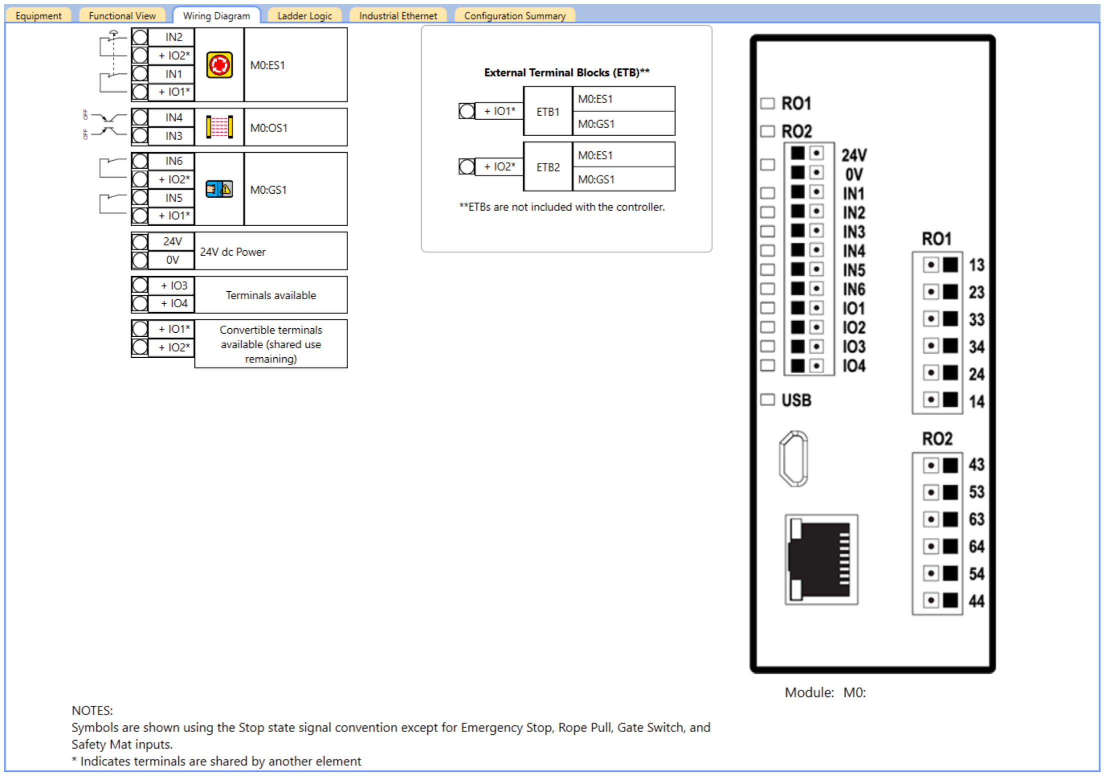
Figure 147. Gate Switch Properties



    b) Click **OK**.
15. Go to the **Wiring Diagram** tab and notice that external terminal blocks (ETB) have been added to accommodate the change in terminal assignments of the Gate Switch.

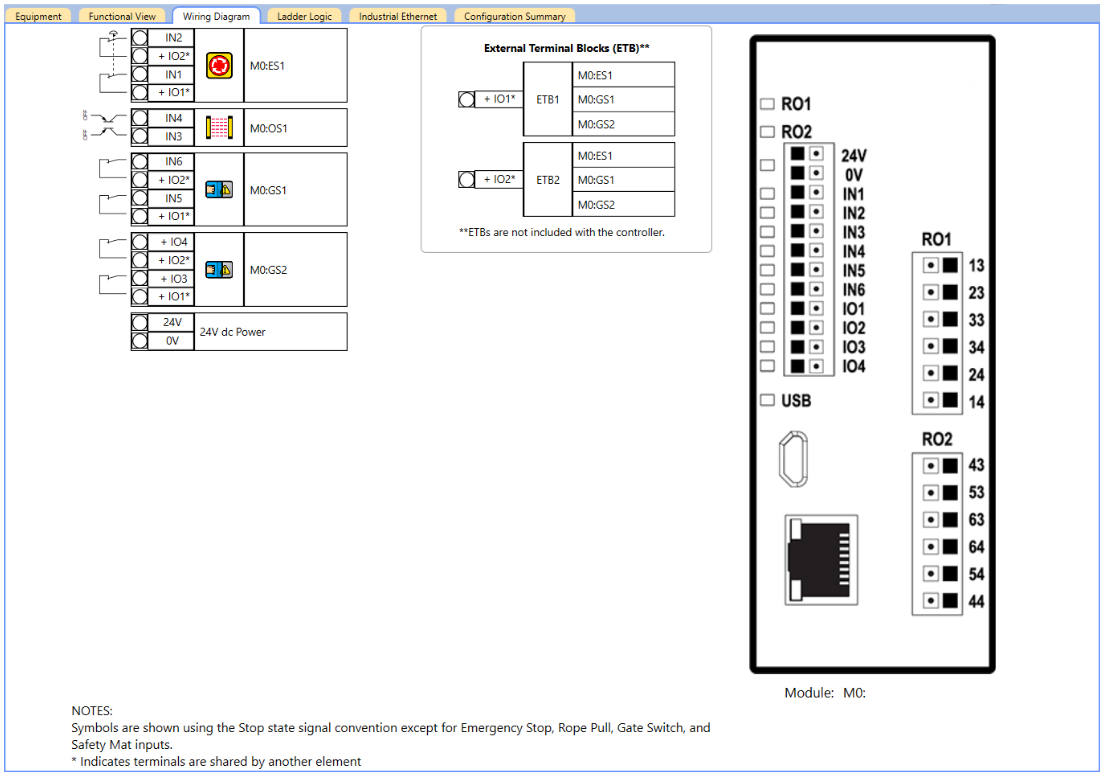
Note: External terminal blocks are user-provided.

Figure 148. Wiring Diagram tab with an E-stop button, optical sensor, gate switch, and ETBs



16. Go to the **Functional View** tab to try to add another Gate Switch.
    Another Gate Switch can now be added because terminal optimization has been done manually.
17. Add a second Gate Switch and click **OK** to accept the default settings.
18. Go to the **Wiring Diagram** tab and notice the second Gate Switch has been added and no additional ETB has been added.

Figure 149. Wiring Diagram tab with an E-stop button, optical sensor, gate switches, and ETBs



14.11 PACSafe 262 Models without an Onboard Interface: Using the IC225ACC001

This procedure is for both expandable and non-expandable models with an onboard interface.

Use an IC225ACC001 to:

- Store a confirmed configuration
- Quickly configure multiple PACSafe 262 Safety Controllers with the same configuration
- Replace one PACSafe 262 Safety Controller with another using the IC225ACC001

Note: The Emerson programming tool (IC225ACC002) and PACSafe Studio Software are required to write a confirmed configuration to an IC225ACC001. This limits access to authorized personnel.

1. Create the desired configuration using the Software.
2. Review and confirm the configuration by loading it onto the PACSafe 262.
   After review and approval, the configuration can be saved and used by the Safety Controller.
3. Write the confirmed configuration to the IC225ACC001 using the programming tool.

   Note: Only a confirmed configuration can be stored on the IC225ACC001. See Write a Confirmed Configuration to an IC225ACC001 using the Programming Tool on p. 87.
4. Use a label to indicate the configuration that is stored on the IC225ACC001.
5. Install and/or connect power to the desired PACSafe 262 (factory default Safety Controller or configured Safety Controller).
   - The USB LED flashes green if the PACSafe 262 is a factory default Safety Controller
   - The USB LED is off if the Safety Controller is a configured controller
6. Insert the IC225ACC001 into the micro USB port on the PACSafe 262.

> **Note:** For additional information regarding the LEDs, see PACSafe 262 LED Status on p. 192.

Factory Default Safety Controller: If the USB LED flashes green for 4 seconds, then stays on, the configuration, network settings, and passwords automatically download to the Safety Controller.

Configured Safety Controller

- If an IC225ACC001 is inserted and the USB LED flashes green for 5 seconds, the configuration and passwords on the Safety Controller and the IC225ACC001 match. Also, if the network settings do not match, the network settings of the Safety Controller transfer to the IC225ACC001, as long as the IC225ACC001 is not locked. If the IC225ACC001 is locked, the USB LED flashes red for 5 seconds and if the IC225ACC001 is not removed during these 5 seconds, the Safety Controller enters a lockout state.
- If an IC225ACC001 is inserted and the USB LED flashes red, the configuration or the passwords on the Safety Controller and the IC225ACC001 do not match. If the IC225ACC001 is not removed within 5 seconds, the power/fault LED flashes red and the Safety Controller enters a lockout state.

7. If the Safety Controller entered a lockout state, remove the IC225ACC001 and cycle the power or perform a system reset.
8. For factory default Safety Controllers: When the USB LED stops fast flashing, cycle the power or perform a system reset.

The Safety Controller is ready for commissioning. See Commissioning Checkout Procedure on p. 184.

14.12 PACSafe 262 Models with an Onboard Interface: Using the IC225ACC001

This procedure is for IC225SXF262 and IC225SSF262 models.

Use an IC225ACC001 to:

- Store a confirmed configuration
- Quickly configure multiple PACSafe 262 Safety Controllers with the same configuration
- Replace one PACSafe 262 Safety Controller with another using the IC225ACC001

> **Note:** The Emerson programming tool (IC225ACC002) and PACSafe Studio Software are required to write a confirmed configuration to an IC225ACC001. This limits access to authorized personnel. A configuration may also be written to an IC225ACC001 using a Safety Controller with an onboard interface.

> **Note:** The LEDs behave the same way with or without an onboard interface (for more details, see PACSafe 262 Models without an Onboard Interface: Using the IC225ACC001 on p. 203), however the following procedure focuses on what happens on the display.

1. Create the desired configuration using the Software.
2. Review and confirm the configuration by loading it onto a PACSafe 262.
   After review and approval, the configuration can be saved and used by the Safety Controller.
3. Write the confirmed configuration to the IC225ACC001 using the programming tool or the onboard interface.

> **Note:** Only a confirmed configuration can be stored on the IC225ACC001.

4. Use a label to indicate the configuration that is stored on the IC225ACC001.
5. Install and/or connect power to the desired PACSafe 262 (factory default Safety Controller or configured Safety Controller).
   - The USB LED flashes green if the PACSafe 262 is a factory default Safety Controller
   - The USB LED is off if the Safety Controller is a configured controller

6. Insert the IC225ACC001 into the micro USB port on the PACSafe 262.

Factory Default Safety Controller

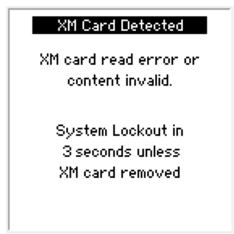
- If an IC225ACC001 is plugged into a factory default Safety Controller, the configuration, network settings, and passwords automatically download to the Safety Controller. The display indicates the autoload:

Figure 150. Autoload Status

After the autoload is done, the display shows: “Config received, please power cycle or system reset”.

- If a blank IC225ACC001 is plugged into a factory default Safety Controller, the display indicates the issue and begins the count down to a system lockout:

Figure 151. IC225ACC001 Error



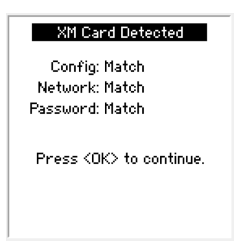
If the IC225ACC001 is not disconnected from the Safety Controller within 3 seconds, the Safety Controller enters a lockout state:

Figure 152. System Lockout

Configured Safety Controller

- If an IC225ACC001 is plugged into a configured Safety Controller and the configuration and password match, the following displays:

Figure 153. Display indicates match



Also, if the network settings do not match, the network settings of the Safety Controller transfer to the IC225ACC001. When this is complete, the display shows the following:

Figure 154. Network Update

Click **OK**. If the update fails (for example, the IC225ACC001 is locked), the display indicates why it failed and begins the countdown to a system lockout:

Figure 155. Network Update Failed

If the IC225ACC001 is not disconnected from the Safety Controller within 3 seconds, the Safety Controller enters a lockout state:

Figure 156. System Lockout

- If an IC225ACC001 is plugged in a configured Safety Controller, but the configuration and/or the password do not match, the display indicates the issue and begins the count down to a system lockout:

Figure 157. Mismatch

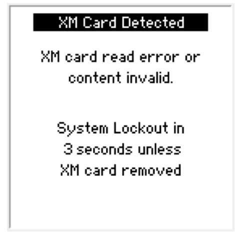
If the IC225ACC001 is not disconnected from the Safety Controller within 3 seconds, the Safety Controller enters a lockout state:

Figure 158. System Lockout

For instructions on importing data from the IC225ACC001, see PACSafe 262 Configuration Mode on p. 158.

- If a blank IC225ACC001 is plugged into a configured Safety Controller, the display indicates the issue and begins the count down to a system lockout:

Figure 159. IC225ACC001 Error



If the IC225ACC001 is not disconnected from the Safety Controller within 3 seconds, the Safety Controller enters a lockout state:

Figure 160. System Lockout

7. If the Safety Controller entered a lockout state, remove the IC225ACC001 and cycle the power or perform a system reset.
8. For factory default Safety Controllers: When the USB LED stops fast flashing, cycle the power or perform a system reset.

The Safety Controller is ready for commissioning. See Commissioning Checkout Procedure on p. 184.

14.13 PACSafe 102: Using the IC225ACC001

Use an IC225ACC001 to:

- Quickly configure multiple PACSafe 102 Safety Controllers with the same configuration
- Replace one PACSafe 102 Safety Controller with another using the IC225ACC001 from the old Safety Controller

Note: The Emerson programming tool (IC225ACC002) and Software are required to write a confirmed configuration to an IC225ACC001. This limits access to authorized personnel.

1. Create the desired configuration using the Software.
2. Review and confirm the configuration by loading it onto an PACSafe 102.
   After review and approval, the configuration can be saved and used by the Safety Controller.
3. Write the confirmed configuration to the IC225ACC001 using the programming tool.

   Note: Only a confirmed configuration can be stored on the IC225ACC001. See Write a Confirmed Configuration to an IC225ACC001 using the Programming Tool on p. 87.

4. Use a label to indicate the configuration that is stored on the IC225ACC001.
5. Install and/or connect power to the desired PACSafe 102 (factory default Safety Controller or configured Safety Controller).

- If the PACSafe 102 is a factory default Safety Controller, the power/fault LED is on green and the USB LED flashes green to indicate that the Safety Controller is waiting for a configuration.
- If the PACSafe 102 is a configured Safety Controller, the power/fault LED is on green and the USB LED is on red.

6. Insert the IC225ACC001 into the micro USB port on the PACSafe 102.

   Factory Default Safety Controller
   - The USB LED fast flashes for 3 seconds, then stays on, and the configuration, network settings, and passwords automatically download to the Safety Controller. Then, the power/fault LED flashes green to indicate that the Safety Controller is waiting for a power cycle.

   Configured Safety Controller
   - If the configuration and passwords on the Safety Controller and the IC225ACC001 match, the USB LED flashes green for 3 seconds and then stays on. Also, if the network settings do not match, the network settings of the Safety Controller transfer to the IC225ACC001 after 3 seconds, as long as the IC225ACC001 is not locked. If the IC225ACC001 is locked, the controller enters a lockout state.
   - If the configuration or the passwords on the Safety Controller and the IC225ACC001 do not match, the USB LED flashes red. If the IC225ACC001 is not disconnected from the Safety Controller within 3 seconds, the power/fault and USB LEDs flash red and the Safety Controller enters a lockout state due to the mismatch.
7. Cycle the power.
   The power/fault LED is green, the USB LED is green (if the IC225ACC001 is still plugged in) or red (no IC225ACC001 or USB cable connected), and the Input and Ouput LEDs show actual input status.

The Safety Controller is ready for commissioning. See Commissioning Checkout Procedure on p. 184.

14.14 Reset the Safety Controller to Factory Defaults

Use the following procedure to reset the Safety Controller to the factory default settings.

The Safety Controller must be powered up and connected to the PC via the IC225CBL001 cable.

1. Click .
2. Click **Reset to Factory Default**.
   A caution displays reminding you that all settings will change to factory defaults.
3. Click **Continue**.
   The **Enter Password** screen opens.
4. Enter the User1 password and click **OK**.
   The Safety Controller is updated to the factory default settings and a confirmation window displays.
5. Click **OK**.
6. Cycle the power.
   The reset to factory default process is complete.

14.15 Factory Defaults

The following table lists some of the factory default settings for both the Safety Controller and the Software.

Setting	Factory Default	Applicable Product
AVM Function	50 ms	PACSafe 262, PACSafe 102

Setting	Factory Default	Applicable Product
Closed-to-Open Debounce Time	6 ms	PACSafe 262, PACSafe 102
EDM	No monitoring	PACSafe 262, PACSafe 102
Function Block: Bypass Block—Default Nodes	IN, BP	PACSafe 262, PACSafe 102
Function Block: Bypass—Time Limit	1 s	PACSafe 262, PACSafe 102
Function Block: Delay Block—Default Nodes	IN	PACSafe 262, PACSafe 102
Function Block: Delay Block—Output Delay	100 ms	PACSafe 262, PACSafe 102
Function Block: Enabling Device Block—Default Nodes	ED, IN, RST	PACSafe 262, PACSafe 102
Function Block: Enabling Device Block—Time Limit	1 s	PACSafe 262, PACSafe 102
Function Block: Latch Reset Block—Default Nodes	IN, LR	PACSafe 262, PACSafe 102
Function Block: Muting Block—Default Nodes	IN, MP1	PACSafe 262, PACSafe 102
Function Block: Muting Block—Time Limit	30 s	PACSafe 262, PACSafe 102
Function Block: Two-Hand Control Block—Default Nodes	TC	PACSafe 262, PACSafe 102
Function Block: One Shot Block—Default Nodes	IN	PACSafe 262
Function Block: One Shot Block—Time Limit	100 ms	PACSafe 262
Network Settings: Gateway Address	0.0.0.0	PACSafe 262, PACSafe 102
Network Settings: IP Address	192.168.0.128	PACSafe 262, PACSafe 102
Network Settings: Link Speed and Duplex Mode	Auto Negotiate	PACSafe 262, PACSafe 102
Network Settings: Subnet Mask	255.255.255.0	PACSafe 262, PACSafe 102
Network Settings: TCP Port	502	PACSafe 262, PACSafe 102
Open-to-Closed Debounce Time	50 ms	PACSafe 262, PACSafe 102
Password User1	1901	PACSafe 262, PACSafe 102
Password User2	1902	PACSafe 262, PACSafe 102
Password User3	1903	PACSafe 262, PACSafe 102
Power up mode	Normal	PACSafe 102

Setting	Factory Default	Applicable Product
Safety Outputs	Automatic reset (trip mode)	PACSafe 262, PACSafe 102
Safety Outputs: Power-up Mode	Normal	PACSafe 262
Safety Outputs: Split (Safety Outputs)	Function in pairs	PACSafe 262
Simulation Mode: Simulation Speed	1	PACSafe 262, PACSafe 102
Automatic Terminal Optimization	Enabled	PACSafe 102
Status Output Signal Conventions	Active = PNP On	PACSafe 262, PACSafe 102
Status Output Flashing Rate	None	PACSafe 262

15 Troubleshooting

The Safety Controller is designed and tested to be highly resistant to a wide variety of electrical noise sources that are found in industrial settings. However, intense electrical noise sources that produce electro-magnetic interference (EMI) or radio frequency interference (RFI) beyond these limits may cause a random trip or lockout condition.

If random trips or lockouts occur, check that:

- The supply voltage is within 24 V DC ± 20%
- The Safety Controller's plug-on terminal blocks are fully inserted
- Wire connections to each individual terminal are secure
- No high-voltage or high-frequency noise sources or any high-voltage power lines are routed near the Safety Controller or alongside wires that are connected to the Safety Controller
- Proper transient suppression is applied across the output loads
- The temperature surrounding the Safety Controller is within the rated ambient temperature (see Specifications and Requirements on p. 19)

15.1 Software: Troubleshooting

Live Mode button is unavailable (grayed out)

1. Make sure the IC225CBL001 cable is plugged into both the computer and the Safety Controller.

> **Note:** Use of the Emerson IC225CBL001 cable is preferred. If other USB cables are used, make sure that the cable includes a communication line. Many cell phone charging cables do not have a communication line.

2. Verify that the Safety Controller is installed properly—see Verifying Driver Installation on p. 214.
3. Exit the Software.
4. Unplug the Safety Controller and plug it back in.
5. Start the Software.

Unable to read from the Safety Controller or send the configuration to the Safety Controller (buttons grayed out)

1. Make sure **Live Mode** is disabled.
2. Make sure the IC225CBL001 cable is plugged into both the computer and the Safety Controller.

> **Note:** Use of the Emerson IC225CBL001 cable is preferred. If other USB cables are used, make sure that the cable includes a communication line. Many cell phone charging cables do not have a communication line.

3. Verify that the Safety Controller is installed properly—see Verifying Driver Installation on p. 214.
4. Exit the Software.
5. Unplug the Safety Controller and plug it back in.
6. Start the Software.

Unable to move a block to a different location

Not all blocks can be moved. Some blocks can be moved only within certain areas.

- **Safety Outputs** are placed statically and cannot be moved. **Referenced Safety Outputs** can be moved anywhere within the left and middle areas.
- **Safety** and **Non-Safety Inputs** can be moved anywhere within the left and middle areas.
- **Function** and **Logic blocks** can be moved anywhere within the middle area.

IC225ACC001 button is unavailable (grayed out)

1. Make sure all connections are secure—IC225ACC002 to the USB port of the computer and to the IC225ACC001 drive.
2. Verify that the IC225ACC002 Programming Tool is installed properly—see Verifying Driver Installation on p. 214.
3. Exit the Software.
4. Disconnect and re-connect all connections—IC225ACC002 to the USB port of the computer and to the IC225ACC001 drive.
5. Start the Software.

Note: Contact Emerson if you require further assistance.

15.2 Software: Error Codes

The following table lists error codes that are encountered when attempting to make an invalid connection between blocks on the **Functional View** tab.

Software Code	Error
A.1	This connection creates a loop.
A.2	A connection from this block already exists.
A.3	Connecting a block to itself is not allowed.
B.2	This Bypass Block is connected to the **TC** node of a Two-Hand Control Block. You can connect only a Two-Hand Control input to the **IN** node of this Bypass Block.
B.3	This Bypass Block is already connected to another block.
B.4	This Bypass Block is connected to the **TC** node of a Two-Hand Control Block and cannot be connected to any other blocks.
B.5	Cannot connect Two-Hand Control Input to the **IN** node of this Bypass Block because it has the "Output turns OFF when both inputs (**IN** and **BP**) are ON" option disabled.
B.6	The **IN** node of a Bypass Block cannot be connected to Emergency Stop and Rope Pull inputs.
B.7	The **IN** node of a Bypass Block cannot be connected to Emergency Stop and Rope Pull inputs via other blocks.
C.1	Only a Cancel OFF-Delay input can be connected to the **CD** node.
C.2	A Cancel OFF-Delay input can be connected only to the **CD** node of a Safety Output, One Shot Function Block, or Delay Function Block.
D.1	This External Device Monitoring input is configured for a Dual-Channel 2 Terminal circuit and can be connected only to the **EDM** node of a Safety Output.
E.1	The Enabling Device Block output nodes (**P** or **S**) can be connected only to the **IN** node of a Safety Output.
E.2	The **IN** node of an Enabling Device Block cannot be connected to Emergency Stop and Rope Pull inputs.
E.3	The **ED** node of an Enabling Device Block can be connected only to an Enabling Device input.
E.4	The **ED** node of an Enabling Device Block cannot be connected to Emergency Stop and Rope Pull inputs via other blocks.
E.5	An Enabling Device Block that has a Two-Hand Control input connected to the **IN** node cannot be connected to a Safety Output that has *Safety Output Delay* set to "Off Delay".
F.1	Emergency Stop and Rope Pull inputs cannot be muted, and thus cannot be connected to the **IN** node of a Mute Function Block or the **M Safety** input of the Press Control Inputs Function Block.
F.2	Emergency Stop and Rope Pull inputs cannot be connected to a Latch Reset Block that is connected to a Muting Block.

Software Code	Error
F.3	A Latch Reset Block that is connected to an Emergency Stop or a Rope Pull input cannot be connected to a Muting Block.
G.1	**PACSafe 102:** Only a Manual Reset output can be connected to the **FR** node of a Safety Output. **PACSafe 262:** Only a Manual Reset input or an output node of a Reset-Designated OR Block can be connected to the **FR** node of a Safety Output.
G.2	**PACSafe 102:** Only a Manual Reset input can be connected to the **LR** node of a Latch Reset Block or Safety Output. **PACSafe 262:** Only a Manual Reset input or the output node of a Reset-Designated OR Block can be connected to the **LR** node of a Latch Reset Block or Safety Output.
G.3	**PACSafe 102:** Only a Manual Reset output can be connected to the **RST** node of an Enabling Device Block. **PACSafe 262:** Only a Manual Reset input or an output node of a Reset-Designated OR Block can be connected to the **RST** node of an Enabling Device Block.
G.4	**PACSafe 102:** A Manual Reset input can be connected only to **LR** and **FR** nodes of a Safety Output, an **LR** node of a Latch Reset Block, an **RST** node of an Enabling Device Block, and **SET** and **RST** nodes of the Flip-Flop Blocks. **PACSafe 262:** A Manual Reset input can be connected only to **LR** and **FR** nodes of a Safety Output, an **LR** node of a Latch Reset Block, an **RST** node of an Enabling Device Block, **SET** and **RST** nodes of the Flip-Flop Blocks, **RST** node of a Press Control Block, and an input node of a Reset-Designated OR Block.
G.5	The input node of a Reset-Designated OR Block can be connected only to a Manual Reset, Virtual Manual Reset input, and the output node of a Reset-Designated OR Block.
G.6	The output node of a Reset-Designated OR Block can be connected only to **LR** and **FR** nodes of a Safety Output, an **LR** node of a Latch Reset Block, an **RST** node of an Enabling Device Block, **SET** and **RST** nodes of the Flip-Flop Blocks, and an input node of a Reset-Designated OR Block.
H.1	A latch reset block already connected to a function block cannot connect to a Mute block.
H.2	A latch reset block already connected to a Mute block cannot connect to another function block.
I.1	Only Muting Sensor Pair, Optical Sensor, Gate Switch, Safety Mat, or Protective Stop inputs can be connected to the **MP1** and **MP2** nodes of a Muting Block or to the **MP1** node of a Two-Hand Control Block.
I.2	The **MP1** and **MP2** nodes of a Muting Block and the **MP1** node of a Two-Hand Control Block can be connected to inputs that are using only Dual-Channel circuits.
I.3	A Muting Sensor Pair input can be connected only to **MP1** and **MP2** nodes of a Muting Block or the **MP1** node of a Two-Hand Control Block.
J.1	A Two-Hand Control Block can be connected only to a Logic Block (excluding Flip-Flop Blocks), the **IN** node of an Enabling Device Block, or the **IN** node of a Safety Output.
J.3	Only Two-Hand Control inputs or Bypass Blocks with Two-Hand Control inputs connected to them can be connected to the **TC** node of a Two-Hand Control Block. A Bypass Block with a Two-Hand Control input connected to its **IN** node can only be connected to the **TC** node of a Two-Hand Control Block.
K.1	A Two-Hand Control input can be connected only to a Two-Hand Control Block (**TC** node), Bypass Block (**IN** node), Logic Block (excluding Flip-Flop Blocks), Press Control Block (**GO** node), or an output without an OFF-delay.
K.2	A Safety Output that has *Safety Output Delay* set to "OFF-Delay" cannot be directly connected to a Two-Hand Control Block.
K.3	A Safety Output that has *Safety Output Delay* set to "OFF-Delay" cannot be connected to a Two-Hand Control Block via an Enabling Device Block.
L.1	This Safety Output is disabled because a Status Output is using its terminals.
L.2	The **IN** node of a Safety Output cannot be connected to External Device Monitoring, Adjustable Valve Monitor, Mute Sensor Pair, Bypass Switch, Manual Reset, Mute Enable, or Cancel OFF-Delay inputs.
L.3	A Safety Output block that has *LR (Latch Reset)* function enabled cannot be connected to Two-Hand Control Blocks or Enabling Device Blocks.

Software Code	Error
L.4	A Safety Output block that has *Power up Mode* set to 'Manual Reset' cannot be connected to Two-Hand Control Inputs, Two-Hand Control Blocks, or Enabling Device Blocks.
P.1	Only physical or virtual ON/OFF inputs can be connected to the **RUN**, **INCH UP**, and **INCH DOWN** nodes of the Press Control Mode Function Block.
P.2	Only a physical ON/OFF Input can be connected to the **TOS** and **BOS** nodes of the Press Control Function Block, and the **PIP** node of the Press Control Inputs Function Block.
P.3	Only an **SQS** Input can be connected to the **SQS** Input node of the Press Control Input function block.
P.4	The only input that can be connected to the **M Sensor** input of the Press Control Input function block is a Press Control Mute Sensor input device.
P.5	When the Press Control block is configured for Single Actuator Control, the **GO** input node can only be connected to a Cycle Initiation Input, a Foot Pedal Input, or a Two-Hand Control Input. When the Press Control Block is configured for Manual Upstroke Setting, the **GO** input node can only be connected to a Foot Pedal Input or Two-Hand Control Input.
P.6	If Single Actuator Control is selected in the Press Control Function Block, then Sequential Stop (**SQS**) and Manual Upstroke are not allowed.
P.7	Only a physical ON/OFF input or a Foot Pedal input can be connected to the **Ft Pedal** input of the Press Control Inputs Function Block.
P.8	The Press Control Function Block output nodes (**U**, **D**, **H**, and **L**) can be connected only to the **IN** node of a Safety Output.
P.9	When the Press Control Mute Sensor input is not selected, only a dual-channel SQS input can be connected to the **SQS** input node of the Press Control Input function block.

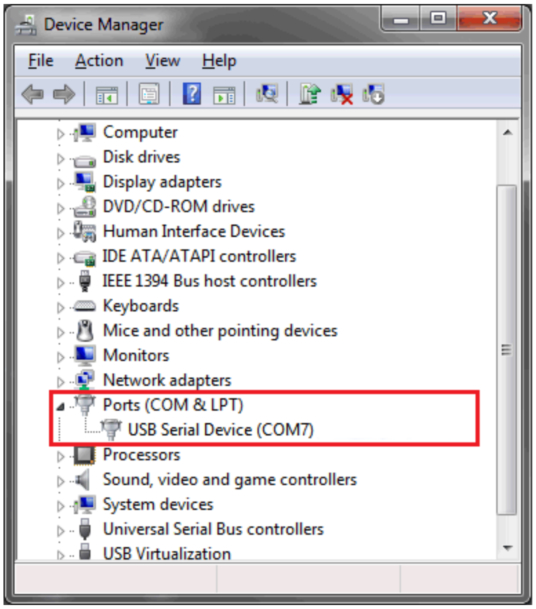
15.3 Verifying Driver Installation

This section applies to both the PACSafe 262 and the PACSafe 102.

Safety Controller Drivers—Windows 10

1. Open **Device Manager**.
2. Expand the **Ports (COM & LPT)** dropdown menu.
3. Find **USB Serial Device** followed by a COM port number (for example, COM3). It must not have an exclamation mark, a red ×, or a down arrow on the entry. If you do not have any of these indicators, your device is properly installed. If any of the indicators appear, use the instructions below to resolve these issues.

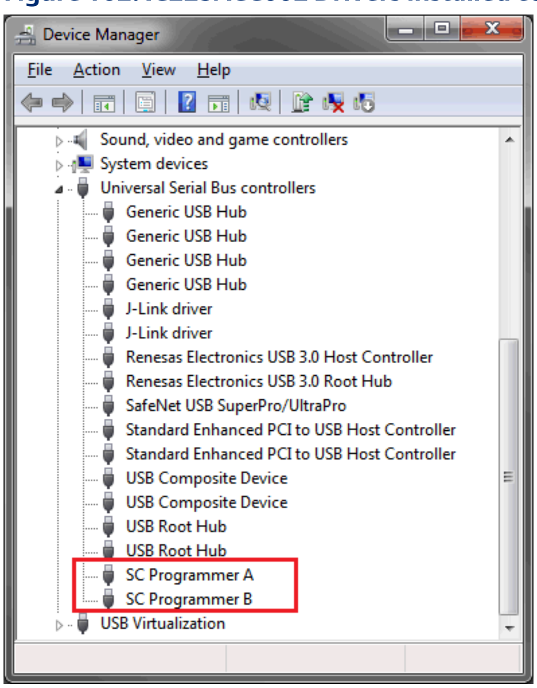
Figure 161. PACSafe 262 Safety Controller Drivers installed correctly



IC225ACC002 Drivers—Windows 10

1. Open **Device Manager**.
2. Expand the **Universal Serial Bus controllers** dropdown menu.
3. Find **SC Programmer A** and **SC Programmer B**. Either one of the entries must not have an exclamation mark, a red ×, or a down arrow on the entry. If you do not have any of these indicators, your device is properly installed. If any of the indicators appear, use the instructions below to resolve these issues.

Figure 162. IC225ACC002 Drivers installed correctly



Resolve an Exclamation Mark, a Red ×, or a Down Arrow Indicator

1. Make sure your device is enabled:
    a. Right-click on the entry that has the indicator.
    b. If you see **Disable**, the device is enabled; if you see **Enable**, the device is disabled.
        - If the device is enabled, continue with troubleshooting steps.
        - If the device is disabled, click **Enable**. If this does not remove the indicator, continue to the next step.
2. Unplug the USB cable either from the Safety Controller or from the computer, wait a few seconds and plug it back in. If this does not remove the indicator, continue to the next step.
3. Try plugging in the Safety Controller or IC225ACC002 to a different USB port. If this does not remove the indicator, continue to the next step.
4. Reboot your computer. If this does not remove the indicator, continue to the next step.
5. Uninstall and re-install the Software from **Add/Remove Programs** or **Programs and Features** located in the **Control Panel**. If this does not remove the indicator, continue to the next step.
6. Contact Emerson. See the contact information at the end of this manual.

Resolve the Safety Controller listed in Device Manager as 'Generic USB Device'

1. Right click on the Generic USB Device port that is the PACSafe Safety Controller.
2. Click **Update Driver**.
3. Select **Browse my Computer for Driver Software**.
4. Click the **Browse** box to the right of the **Search this Location** box. A new window opens.
5. Select **Local Disk (C:)** > **Program Files (x86)** > **Emerson** > **PACSafe Studio Software** > **Driver**.
6. Click **OK**; the window closes.
7. In the update driver box, click **Next**. The driver should now be updated.

You might have to close the PACSafe Studio Software and open it again. The USB ports should now link PACSafe Safety Controllers to the Software.

15.4 Finding and Fixing Faults

Depending on the configuration, the Safety Controller is able to detect a number of input, output, and system faults, including:

- A stuck contact
- An open contact
- A short between channels
- A short to ground
- A short to a voltage source
- A short to another input
- A loose or open connection
- An exceeded operational time limit
- A power drop
- An overtemperature condition

When a fault is detected, a message describing the fault displays in the **Fault Diagnostics** menu (models with display). For models not equipped with a display, use the **Live Mode** tab in the Software on a PC connected to Safety Controller with the IC225CBL001 cable. Fault diagnostics are also available over the network. An additional message may also be displayed to help remedy the fault.

Note: The fault log is cleared when power to the Safety Controller is cycled.

15.4.1 PACSafe 262 Fault Code Table

The following table lists the Safety Controller Fault Code, the message that displays, any additional messages, as well as the steps to resolve the fault.

The Error Code and the Advanced Error Code, taken together, form the Safety Controller Fault Code. The format for the Fault Code is `Error Code 'dot' Advanced Error Code`. For example, a Safety Controller Fault Code of 2.1 is represented by an Error Code of `2` and an Advanced Error Code of `1`. The Error Message Index value is the Error Code and the Advanced Error Code together, and includes a leading zero with the Advanced Error Code, if necessary. For example, a Safety Controller Fault Code of 2.1 is represented by an Error Message Index of `201`. The Error Message Index value is a convenient way to get the complete Fault Code while only reading a single 16-bit register.

Fault Code	Displayed Message	Additional Message	Steps to resolve
1.1	Output Fault	**Base Module or Solid-State Module** Check for shorts **Relay Module** n/a	**Base Module or Solid-State Module** A Safety Output appears ON when it should be OFF: • Check for a short to the external voltage source • Check the DC common wire size connected to the Safety Output loads. The wire must be a heavy-gauge wire or be as short as possible to minimize resistance and voltage drop. If necessary, use a separate DC common wire for each pair of outputs and/or avoid sharing this DC common return path with other devices (see Common Wire Installation on p. 66) **Relay Module** • Replace Relay module
1.2	Output Fault	**Base Module or Solid-State Module** Check for shorts **Relay Module** n/a	**Base Module or Solid-State Module** A Safety Output is sensing a fault to another voltage source while the output is ON: • Check for a short between Safety Outputs • Check for a short to the external voltage source • Check load device compatibility • Check the DC common wire size connected to the Safety Output loads. The wire must be a heavy-gauge wire or be as short as possible to minimize resistance and voltage drop. If necessary, use a separate DC common wire for each pair of outputs and/or avoid sharing this DC common return path with other devices (see Common Wire Installation on p. 66) **Relay Module** • Replace Relay module
1.3 – 1.8	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)
1.9	Output Fault	Internal Relay Failure	• Replace Relay module
1.10	Output Fault	Check Input Timing	Sequence timing error: • Perform a System Reset to clear the fault
2.1	Concurrency Fault	Cycle Input	On a dual-channel input, or a complementary input, with both inputs in the Run state, one input went to the Stop state then back to Run. On a dual-complementary input, with both pairs of inputs in the Run state, one pair of inputs went to the Stop state then back to Run. • Check the wiring • Check the input signals • Consider adjusting the debounce times

Fault Code	Displayed Message	Additional Message	Steps to resolve
2.2	Simultaneity Fault	Cycle Input	On a dual-channel input, or a complementary input, one input went into the Run state but the other input did not follow the change within 3 seconds. On a dual-complementary input, one pair of inputs went into the Run state but the other pair of inputs did not follow the change within 3 seconds. • Check the wiring • Check the input signal timing
2.3 or 2.5	Concurrency Fault	Cycle Input	On a dual-complementary input, with both inputs of one complementary pair in the Run state, one input of this complementary pair changed to Stop then back to Run: • Check the wiring • Check the input signals • Check the power supply providing input signals • Consider adjusting the debounce times
2.4 or 2.6	Simultaneity Fault	Cycle Input	On a dual-complementary input, one input of a complementary pair went into the Run state, but the other input of the same complementary pair did not follow the change within the time limit: • Check the wiring • Check the input signal timing
2.7	Internal Fault		Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)
2.8 – 2.9	Input Fault	Check Terminal xx	Input stuck high: • Check for shorts to other inputs or other voltage sources • Check the input device compatibility
2.10	Input Fault	Check Terminal xx	• Check for a short between inputs
2.11 – 2.12	Input Fault	Check Terminal xx	• Check for a short to ground
2.13	Input Fault	Check Terminal xx	Input stuck low • Check for a short to ground
2.14	Input Fault	Check Terminal xx	Missing test pulses: • Check for a short to other inputs or other voltage sources
2.15	Open Lead	Check Terminal xx	• Check for an open lead
2.16 – 2.18	Input Fault	Check Terminal xx	Missing test pulses: • Check for a short to other inputs or other voltage sources
2.19	Open Lead	Check Terminal xx	• Check for an open lead
2.20	Input Fault	Check Terminal xx	Missing test pulses: • Check for a short to ground
2.21	Open Lead	Check Terminal xx	• Check for an open lead
2.22 – 2.23	Input Fault	Check Terminal xx	• Check for an unstable signal on the input
2.24	Input Activated While Bypassed	Perform System Reset	A Two-Hand Control input was activated (turned ON) while it was bypassed.

Fault Code	Displayed Message	Additional Message	Steps to resolve
2.25	Input Fault	Monitoring Timer Expired Before AVM Closed	After the associated Safety Output turned OFF, the AVM input did not close before its AVM monitoring time expired: • The AVM may be disconnected; check the wiring to the AVM • Either the AVM is disconnected, or its response to the Safety Output turning OFF is too slow • Check the wiring to the AVM • Check the timing setting; increase the setting if necessary • Contact Emerson; see contact information at the end of this manual
2.26	Input Fault	AVM Not Closed When Output Turned On	The AVM input was open, but should have been closed, when the associated Safety Output was commanded ON: • The AVM may be disconnected; check the wiring to the AVM
3.1	EDMxx Fault	Check Terminal xx	EDM contact opened prior to turning ON the Safety Outputs: • Check for a stuck ON contactor or relay • Check for an open wire
3.2	EDMxx Fault	Check Terminal xx	EDM contact(s) failed to close within 250 ms after the Safety Outputs turned OFF: • Check for a slow or stuck ON contactor or relay • Check for an open wire
3.4	EDMxx Fault	Check Terminal xx	EDM contact pair mismatched for longer than 250 ms: • Check for a slow or stuck ON contactor or relay • Check for an open wire
3.5	EDMxx Fault	Check Terminal xx	• Check for an unstable signal on the input
3.6	EDMxx Fault	Check Terminal xx	• Check for a short to ground
3.7	EDMxx Fault	Check Terminal xx	• Check for a short between inputs
3.8	AVMxx Fault	Perform System Reset	After this Safety Output turned OFF, an AVM input associated with this output did not close before its AVM monitoring time expired: • The AVM may be disconnected or its response to the Safety Output turning OFF may be too slow • Check the AVM input and then perform a System Reset to clear the fault
3.9	Input Fault	AVM Not Closed When Output Turned On	The AVM input was open, but should have been closed, when the associated Safety Output was commanded On: • The AVM may be disconnected; check the wiring to the AVM
3.10	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)
4.x	-	-	See the following table.
5.1 – 5.3	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)
6.xx	Internal Fault	-	Invalid configuration data. Possible internal failure: • Try writing a new configuration to the Safety Controller

Fault Code	Displayed Message	Additional Message	Steps to resolve
7.1	Press Control Fault	Check TOS and BOS	TOS and BOS inputs on at the same time • Check for shorts on the TOS and BOS inputs • Check for functional issues with the TOS and BOS devices
7.2	Press Control Fault	Check TOS and SQS	TOS and SQS inputs on at the same time • Check for shorts on the TOS and SQS inputs • Check for functional issues with the TOS and SQS devices
7.3	Press Control Fault	Check TOS and PCMS	TOS and PCMS inputs on at the same time • Check for shorts on the TOS and PCMS inputs • Check for functional issues with the TOS and PCMS devices
7.4	Press Control Fault	Check SQS and BOS	SQS to BOS sequencing error (BOS came on before SQS) • Check wiring of SQS and BOS sensors • Check for placement and functional issues of SQS and BOS sensors
7.5	Press Control Fault	Check TOS	TOS Timeout error (On automatic upstroke, the internal 30 second time limit was exceeded) • Check the wiring of the TOS system • Check for placement and functional issues of the TOS sensor
7.6	Press Control Fault	Check BOS	BOS Timeout error (On automatic downstroke, the internal 30 second time limit was exceeded) • Check the wiring of the BOS system • Check for placement and functional issues of the BOS sensor
7.7	Press Control Fault	Check Mode Selection Inputs	Mode Selection Error (more than one mode selection input on at the same time • Check the wiring from the mode state inputs • Check the Mode selection switch for faults
7.8	Press Control Fault	-	Index Error (Internal Configuration Error) Contact Emerson (see Repairs and Warranty Service on p. 228)
7.9	Press Control Fault	Check Foot Pedal Input	Foot pedal Error (when configured with a SQS, the Ft Pedal input node came on instead of the GO input node) • Sequencing error • If it persists check wiring of THC and Foot Pedal inputs
7.10	Press Control Fault	Check Down Cylinder	Down AVM Error (Down AVM is in wrong state when compared to expected state) • Check Down AVM wiring • Check Down AVM sensor and Down Stroke system
7.11	Press Control Fault	Check Up Cylinder	Up AVM Error (Up AVM is in wrong state when compared to expected state) • Check Up AVM wiring • Check Up AVM sensor and Up Stroke system
7.12	Press Control Fault	Check High Cylinder	High AVM Error (High AVM is in wrong state when compared to expected state) • Check High AVM wiring • Check High AVM sensor and High Stroke system

Fault Code	Displayed Message	Additional Message	Steps to resolve
7.13	Press Control Fault	Check Low Cylinder	Low AVM Error (Low AVM is in wrong state when compared to expected state) • Check Low AVM wiring • Check Low AVM sensor and Low Stroke system
7.14	Press Control Fault	SQS to PCMS Simultaneity	SQS to PCMS simultaneity error (3 second time limit between inputs exceeded) • Check wiring of SQS and PCMS • Check placement of SQS and PCMS with considerations to ram speed
7.15	Press Control Fault	Check SQS State	SQS State error (SQS state level not as expected during the press cycle) • Check wiring of the SQS input • Check the placement of the SQS sensor and its functionality
7.16	Press Control Fault	Check PCMS State	PCMS State error (PCMS state level not as expected during the press cycle) • Check wiring of the PCMS input • Check the placement of the PCMS sensor and its functionality
7.17	Press Control Fault	Check TOS State	TOS State error (TOS state level not as expected during the press cycle) • Check wiring of the TOS input • Check the placement of the TOS sensor and its functionality
7.18	Press Control Fault	Check BOS State	BOS State error (BOS state level not as expected during the press cycle) • Check wiring of the BOS input • Check the placement of the BOS sensor and its functionality
10.xx	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)

For fault codes 4.x, check the fault log for additional faults to determine the specific module in which the original fault occurred.

Fault Code	Displayed Message	Additional Message	Steps to resolve
4.1	Supply Voltage Low	Check the power supply	The supply voltage dropped below the rated voltage for longer than 6 ms: • Check the power supply voltage and current rating • Check for an overload on the outputs that might cause the power supply to limit the current
4.2	Internal Fault		A configuration parameter has become corrupt. To fix the configuration: • Replace the configuration by using a backup copy of the configuration • Recreate the configuration using the Software and write it to the Safety Controller
4.3 – 4.11	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).

Fault Code	Displayed Message	Additional Message	Steps to resolve
4.12	Configuration Timeout	Check Configuration	The Safety Controller was left in Configuration mode for more than one hour without pressing any keys. • Cycle the power • Perform a System Reset
4.13	Configuration Timeout	Check Configuration	The Safety Controller was left in Configuration mode for more than one hour without receiving any commands from the Software. • Cycle the power • Perform a System Reset
4.14	Configuration Unconfirmed	Confirm Configuration	The configuration was not confirmed after being edited: • Confirm configuration using the Software
4.15 – 4.19	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.20	Unassigned Terminal in Use	Check Terminal xx	This terminal is not mapped to any device in the present configuration and should not be active: • Check the wiring
4.21 – 4.34	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.35	Overtemperature	-	An internal overtemperature condition has occurred. Verify that the ambient and output loading conditions meet the specifications of the Safety Controller.
4.36 – 4.39	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.40 – 4.41	Module Communication Failure	Check module power	An output expansion module lost contact with the Base Controller.
4.42	Module Mismatch	-	The module or modules detected do not match the Safety Controller configuration.
4.43	Module Communication Failure	Check module power	An expansion module lost contact with the Base Controller.
4.44 – 4.45	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.46 – 4.47	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.48	Unused output	Check output wiring	A voltage was detected on an unconfirmed terminal.
4.49 – 4.55	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.56	Display Comm Failure	-	Display (Onboard Interface) Communication Failure: • Cycle power to the Safety Controller. If fault code persists, contact Emerson (see Repairs and Warranty Service on p. 228
4.57 – 4.59	Internal Fault	-	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.60	Output Fault	Check for shorts	An output terminal detected a short. Check output fault for details.

15.4.2 PACSafe 102 Fault Code Table

The following table lists the Safety Controller Fault Code, the message that displays, any additional messages, as well as the steps to resolve the fault.

The Error Code and the Advanced Error Code, taken together, form the Safety Controller Fault Code. The format for the Fault Code is `Error Code 'dot' Advanced Error Code`. For example, a Safety Controller Fault Code of 2.1 is represented by an Error Code of `2` and an Advanced Error Code of `1`. The Error Message Index value is the Error Code and the Advanced Error Code together, and includes a leading zero with the Advanced Error Code, if necessary. For example, a Safety Controller Fault Code of 2.1 is represented by an Error Message Index of `201`. The Error Message Index value is a convenient way to get the complete Fault Code while only reading a single 16-bit register.

Fault Code	Fault Code Description	Steps to resolve
1.1 – 1.2	Output Fault	Replace the Safety Controller
1.3 – 1.8	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)
1.9	Output Fault	Replace the Safety Controller
1.10	Output Fault	Sequence timing error: • Perform a System Reset to clear the fault
2.1	Concurrency Fault	On a dual-channel input, or a complementary input, with both inputs in the Run state, one input went to the Stop state then back to Run. On a dual-complementary input, with both pairs of inputs in the Run state, one pair of inputs went to the Stop state then back to Run. • Check the wiring • Check the input signals • Consider adjusting the debounce times • Cycle input
2.2	Simultaneity Fault	On a dual-channel input, or a complementary input, one input went into the Run state but the other input did not follow the change within 3 seconds. On a dual-complementary input, one pair of inputs went into the Run state but the other pair of inputs did not follow the change within 3 seconds. • Check the wiring • Check the input signal timing • Cycle input
2.3 or 2.5	Concurrency Fault	On a dual-complementary input, with both inputs of one complementary pair in the Run state, one input of this complementary pair changed to Stop then back to Run.: • Check the wiring • Check the input signals • Check the power supply providing input signals • Consider adjusting the debounce times • Cycle input
2.4 or 2.6	Simultaneity Fault	On a dual-complementary input, one input of a complementary pair went into the Run state, but the other input of the same complementary pair did not follow the change within the time limit: • Check the wiring • Check the input signal timing • Cycle input
2.7	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228)

Fault Code	Fault Code Description	Steps to resolve
2.8 – 2.9	Input Fault	Input stuck high: • Check for shorts to other inputs or other voltage sources • Check the input device compatibility
2.10	Input Fault	• Check for a short between inputs
2.11 – 2.12	Input Fault	• Check for a short to ground
2.13	Input Fault	Input stuck low • Check for a short to ground
2.14	Input Fault	Missing test pulses: • Check for a short to other inputs or other voltage sources
2.15	Open Lead	• Check for an open lead
2.16 – 2.18	Input Fault	Missing test pulses: • Check for a short to other inputs or other voltage sources
2.19	Open Lead	• Check for an open lead
2.20	Input Fault	Missing test pulses: • Check for a short to ground
2.21	Open Lead	• Check for an open lead
2.22 – 2.23	Input Fault	• Check for an unstable signal on the input
2.24	Input Activated While Bypassed	A Two-Hand Control input was activated (turned On) while it was bypassed.
2.25	Input Fault	After the associated Safety Output turned Off, the AVM input did not close before its AVM monitoring time expired: • The AVM may be disconnected; check the wiring to the AVM • Either the AVM is disconnected, or its response to the Safety Output turning Off is too slow • Check the wiring to the AVM • Check the timing setting; increase the setting if necessary • Contact Emerson; see contact information at the end of this manual
2.26	Input Fault	The AVM input was open, but should have been closed, when the associated Safety Output was commanded On: • The AVM may be disconnected; check the wiring to the AVM
3.1	EDMxx Fault	EDM contact opened prior to turning On the Safety Outputs: • Check for a stuck On contactor or relay • Check for an open wire
3.2	EDMxx Fault	EDM contact(s) failed to close within 250 ms after the Safety Outputs turned Off: • Check for a slow or stuck On contactor or relay • Check for an open wire
3.4	EDMxx Fault	EDM contact pair mismatched for longer than 250 ms: • Check for a slow or stuck On contactor or relay • Check for an open wire
3.5	EDMxx Fault	• Check for an unstable signal on the input
3.6	EDMxx Fault	• Check for a short to ground
3.7	EDMxx Fault	• Check for a short between inputs

Fault Code	Fault Code Description	Steps to resolve
3.8	AVMxx Fault	After this Safety Output turned Off, an AVM input associated with this output did not close before its AVM monitoring time expired: • The AVM may be disconnected or its response to the Safety Output turning Off may be too slow • Check the AVM input and then perform a System Reset to clear the fault
3.9	Input Fault	The AVM input was open, but should have been closed, when the associated Safety Output was commanded On: • The AVM may be disconnected; check the wiring to the AVM
3.10	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.1	Supply Voltage Low	The supply voltage dropped below the rated voltage for longer than 6 ms: • Check the power supply voltage and current rating • Check for an overload on the outputs that might cause the power supply to limit the current
4.2	Internal Fault	A configuration parameter has become corrupt. To fix the configuration: • Replace the configuration by using a backup copy of the configuration • Recreate the configuration using the Software and write it to the Safety Controller
4.3 – 4.12	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.13	Configuration Timeout	The Safety Controller was left in Configuration mode for more than one hour without receiving any commands from the Software. • Cycle the power • Perform a System Reset
4.14	Configuration Unconfirmed	The configuration was not confirmed after being edited: • Confirm configuration using the Software
4.15 – 4.19	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.20	Unassigned Terminal in Use	This terminal is not mapped to any device in the present configuration and should not be active: • Check the wiring
4.21 – 4.34	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.35	Overtemperature	An internal overtemperature condition has occurred. Verify that the ambient and output loading conditions meet the specifications of the Safety Controller.
4.36 – 4.47	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.48	Unused output	A voltage was detected on an unconfirmed terminal.
4.49 – 4.59	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
4.60	Output Fault	An output terminal detected a short. Check output fault for details.
5.1 – 5.3	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).
6.xx	Internal Fault	Invalid configuration data. Possible internal failure: • Try writing a new configuration to the Safety Controller

Fault Code	Fault Code Description	Steps to resolve
10.xx	Internal Fault	Internal failure—Contact Emerson (see Repairs and Warranty Service on p. 228).

16 Components and Accessories

16.1 Replacement Parts and Accessories

Model	Description	Applicable Product
IC225CBL001	USB cable	PACSafe 262, PACSafe 102
IC225ACC002	Programming tool for IC225ACC001	PACSafe 262, PACSafe 102
IC225ACC001	External memory drive	PACSafe 262, PACSafe 102
IC225STB008	Screw terminal blocks controller	PACSafe 262
IC225STB004	Screw terminal blocks expansion module	PACSafe 262
IC225STS008	Spring cage terminal blocks controller	PACSafe 262
IC225STS004	Spring cage terminal blocks expansion module	PACSafe 262

16.2 Interface Modules

See GFK-3195A and EDM and FSD Wiring on p. 69 for more information.

Model	Input Voltage	Inputs	Safety Outputs	Aux. Outputs	Output Rating	EDM Contacts
IC225SRD130	24 V DC	2 (dual-channel wiring)	3 Normally Open (NO)	–	See GFK-3195A for specifications	2 Normally Closed (NC)
IC225SRD121			2 Normally Open (NO)	1 Normally Closed (NC)		

17 Product Support and Maintenance

17.1 Cleaning

1. **Disconnect power to the Safety Controller.**
2. Wipe down the polycarbonate enclosure and the display (models with display) with a soft cloth that has been dampened with a mild detergent and warm water solution.

17.2 Repairs and Warranty Service

Contact Emerson for troubleshooting of this device. **Do not attempt any repairs to this Emerson device; it contains no field-replaceable parts or components.** If the device, device part, or device component is determined to be defective, Emerson will advise you of the 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.

To assist Emerson with troubleshooting a problem, while the PC is connected to the Safety Controller, go to **Help** in the software and click **Support Information**. Click **Save Controller Diagnostics** to generate a file that contains status information. This information may be helpful to the support team at Emerson. Send the file to Emerson according to the instructions provided on screen.

See the contact information at the end of this manual.

17.3 Intelligent Platforms, LLC, an Emerson Automation Solutions company ("Emerson") End User License Agreement

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1. DEFINITIONS

   1.1 "Application Software" shall mean those portions of the Licensed Software, in object code form only, created by Emerson.

   1.2 "Third Party Software" shall mean software, including but not limited to operating systems, owned or licensed by a third party that is supplied to Customer by Emerson.

   1.3 "Licensed Software" shall mean the Application Software plus any other software (including Third Party Software), in object code form only, supplied by Emerson pursuant to this Agreement. If no operating system software is included in the software provided under this Agreement, Customer must make provision for any required operating system software licenses.
2. LICENSE

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18 Standards and Regulations

The list of standards below is included as a convenience for users of this Emerson device. Inclusion of the standards below does not imply that the device complies specifically with any standard, other than those specified in the Specifications section of this manual.

18.1 Applicable U.S. Standards

ANSI B11.0 Safety of Machinery, General Requirements, and Risk Assessment

ANSI B11.1 Mechanical Power Presses

ANSI B11.2 Hydraulic Power Presses

ANSI B11.3 Power Press Brakes

ANSI B11.4 Shears

ANSI B11.5 Iron Workers

ANSI B11.6 Lathes

ANSI B11.7 Cold Headers and Cold Formers

ANSI B11.8 Drilling, Milling, and Boring

ANSI B11.9 Grinding Machines

ANSI B11.10 Metal Sawing Machines

ANSI B11.11 Gear Cutting Machines

ANSI B11.12 Roll Forming and Roll Bending Machines

ANSI B11.13 Single- and Multiple-Spindle Automatic Bar and Chucking Machines

ANSI B11.14 Coil Slitting Machines

ANSI B11.15 Pipe, Tube, and Shape Bending Machines

ANSI B11.16 Metal Powder Compacting Presses

ANSI B11.17 Horizontal Extrusion Presses

ANSI B11.18 Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate

ANSI B11.19 Performance Criteria for Safeguarding

ANSI B11.20 Manufacturing Systems

ANSI B11.21 Machine Tools Using Lasers

ANSI B11.22 Numerically Controlled Turning Machines

ANSI B11.23 Machining Centers

ANSI B11.24 Transfer Machines

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

NFPA 79 Electrical Standard for Industrial Machinery

ANSI/PMMI B155.1 Package Machinery and Packaging-Related Converting Machinery — Safety Requirements

18.2 Applicable OSHA Regulations

OSHA Documents listed are part of: Code of Federal Regulations Title 29, Parts 1900 to 1910

OSHA 29 CFR 1910.212 General Requirements for (Guarding of) All Machines

OSHA 29 CFR 1910.147 The Control of Hazardous Energy (lockout/tagout)

OSHA 29 CFR 1910.217 (Guarding of) Mechanical Power Presses

18.3 Applicable European and International Standards

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

ISO 13857 Safety of Machinery – Safety Distances to Prevent Hazard Zones Being Reached

ISO 13850 (EN 418) Emergency Stop Devices, Functional Aspects – Principles for Design

ISO 13851 Two-Hand Control Devices – Principles for Design and Selection

IEC 62061 Functional Safety of Safety-Related Electrical, Electronic and Programmable Control Systems

EN ISO 13849-1 Safety-Related Parts of Control Systems

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

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

IEC 61496 Electro-sensitive Protection Equipment

IEC 60529 Degrees of Protection Provided by Enclosures

IEC 60947-1 Low Voltage Switchgear – General Rules

IEC 60947-5-1 Low Voltage Switchgear – Electromechanical Control Circuit Devices

IEC 60947-5-5 Low Voltage Switchgear – Electrical Emergency Stop Device with Mechanical Latching Function

IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

IEC 62046 Safety of Machinery – Applications of Protective Equipment to Detect the Presence of Persons

ISO 16092-1 Machine Toll Safety—Presses, Part 1 Generic Safety Requirements

ISO 16092-3 Machine Tool Safety—Presses, Part 3 Safety Requirements for Hydraulic Presses

ISO 16092-4 Machine Tool Safety—Presses, Part 4 Safety Requirements for Pneumatic Presses

ISO 4413 Hydraulic Fluid Power—General Rules and Safety Requirements for Systems and their Components

ISO 4414 Pneumatic Fluid Power—General Rules and Safety Requirements for Systems and their Components

19 Glossary

A

Automatic Reset

The safety input device control operation setting where the assigned safety output will automatically turn on when all of its associated input devices are in the Run state.

C

Change of State (COS)

The change of an input signal when it switches from Run-to-Stop or Stop-to-Run state.

Closed-Open Debounce Time

Time to bridge a jittery input signal or bouncing of input contacts to prevent nuisance tripping of the Controller. Adjustable from 6 ms to 100 ms. The default value is 6 ms (50 ms for mute sensors).

Complementary Contacts

Two sets of contacts which are always in opposite states.

Concurrent (also Concurrency)

The setting in which both channels must be off at the same time before turning back on. If this is not satisfied, the input will be in a fault condition.

D

Designated Person

A person or persons identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure.

Diverse-Redundancy

The practice of using components, circuitry or operation of different designs, architectures or functions to achieve redundancy and to reduce the possibility of common mode failures.

Dual-Channel

Having redundant signal lines for each safety input or safety output.

F

Fault

A state of a device characterized by the inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources. A fault is often the result of a failure of the device itself, but may exist without prior failure.

Final Switching Device (FSD)

The component of the machine's safety-related control system that interrupts the circuit to the machine primary control element (MPCE) when the output signal switching device (OSSD) goes to the OFF-state.

H

Hard (Fixed) Guard

Screens, bars, or other mechanical barriers affixed to the frame of the machine intended to prevent entry by personnel into the hazardous area(s) of a machine, while allowing the point of operation to be viewed. The maximum size of the openings is determined by the applicable standard, such as Table O-10 of OSHA 29CFR1910.217, also called a "fixed barrier guard."

M

Machine Primary Control Element (MPCE)

An electrically powered element, external to the safety system, which directly controls the machine's normal operating motion in such a way that the element is last (in time) to operate when machine motion is either initiated or arrested.

Machine Response Time

The time between the activation of a machine stopping device and the instant when the dangerous parts of the machine reach a safe state by being brought to rest.

Machine Safeguarding Device

A device that provides protection from a hazard(s) by preventing or detecting exposure to the hazard zone.

Manual reset

The safety input device control operation setting where the assigned safety output will turn ON only after a manual reset is performed and if the other associated input devices are in their Run state.

O

OFF Signal

The safety output signal that results when at least one of its associated input device signals changes to the Stop state. In this manual, the safety output is said to be OFF or in the OFF state when the signal is 0 V DC nominally.

ON Signal

The safety output signal that results when all of its associated input device signals change to the Run state. In this manual, the safety output is said to be ON or in the ON state when the signal is 24 V DC nominally.

Open-Closed Debounce Time

Time to bridge a jittery input signal or bouncing of input contacts to prevent unwanted start of the machine. Adjustable from 10 ms to 500 ms. The default value is 50 ms.

P

Pass-Through Hazard

A pass-through hazard is associated with applications where personnel may pass through a safeguard (which issues a stop command to remove the hazard), and then continues into the guarded area, such as in perimeter guarding. Subsequently, their presence is no longer detected, and the related danger becomes the unexpected start or restart of the machine while personnel are within the guarded area.

PELV

Protected extra-low voltage power supply, for circuits with earth ground. Per IEC 61140: "A PELV system is an electrical system in which the voltage cannot exceed ELV (25 V AC rms or 60 V ripple free DC) under normal conditions, and under single-fault conditions, except earth faults in other circuits."

Q

Qualified Person

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.

R

Run Signal

The input signal monitored by the Controller that, when detected, causes one or more safety outputs to turn On, if their other associated input signals are also in the Run state.

S

SELV

Separated or safety extra-low voltage power supply, for circuits without earth ground. Per IEC 61140: "A SELV system is an electrical system in which the voltage cannot exceed ELV (25 V AC rms or 60 V ripple free DC) under normal conditions, and under single-fault conditions, including earth faults in other circuits."

Simultaneous (also Simultaneity)

The setting in which both channels must be off at the same time AND, when they turn back on, they must turn on within 3 seconds of each other. If both conditions are not satisfied, the input will be in a fault condition.

Single-Channel

Having only one signal line for a safety input or safety output.

Start Up Test

For certain safety devices, like safety light curtains or safety gates, it can be an advantage to test the device on power up at least one time for proper function.

Stop Signal

The input signal monitored by the Controller that, when detected, causes one or more safety outputs to turn OFF. In this manual, either the input device or device signal is said to be in the Stop state.

System Reset

A configurable reset of one or more safety outputs to turn ON after Controller power-up, when set for manual power-up, or lockout (fault detection) situations.

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