Remote Safe I/O Block Product Manual

Original Instructions
p/n: 245780 Rev. D
22-Jan-26

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Chapter Contents

Chapter 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 instructions. *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 Banner Engineering Corp..

For more information regarding U.S. and international institutions that provide safeguarding application and safeguarding device performance standards, see "Standards and Regulations" on page 128.

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 Use of Warnings and Cautions

The precautions and statements used throughout this document are indicated by alert symbols and must be followed for the safe use of the Banner Remote Safe I/O. Failure to follow all precautions and alerts may result in unsafe use or operation. The following signal words and alert symbols are defined as follows:

Signal Word and Symbol	Definition
WARNING:	**Warnings** refer to potentially hazardous situations which, if not avoided, could result in serious injury or death.
CAUTION:	**Cautions** refer to potentially hazardous situations which, if not avoided, could result in minor or moderate injury.

These statements are intended to inform the machine designer and manufacturer, the end user, and maintenance personnel, how to avoid misapplication and effectively apply the Banner Remote Safe I/O to meet the various safeguarding application requirements. These individuals are responsible to read and abide by these statements.

1.3 EU Declaration of Conformity (DoC)

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

Product	Directive
Remote Safe I/O	EU: Machine Safety Directive 2006/42/EC

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

Chapter Contents

Chapter 2 Product Overview

RSio is a remote safe I/O block that brings Banner's In-Series Diagnostics (ISD) technology into CIP Safety™ systems, providing eight ports of hybrid I/O that are each independently configurable for safety-rated or standard devices. RSio is configured directly in Rockwell Automation's Studio 5000®, without any additional software needed, thanks to an included EDS file that also includes user-selectable port presets that simplify integration of common safety devices. Two configurable outputs provide control signals for final switching devices, safety-rated devices, or non-safety devices. Six inputs support up to 32 ISD-enabled devices per input and deliver device-level diagnostics for faster troubleshooting, expanding PLe/SIL3 safety coverage.

- Eight independently configurable hybrid I/O ports support safety-rated or standard devices, giving more flexibility in how each port is used
- Inputs support dry contacts or solid-state safety devices, In-Series Diagnostics (ISD), and standard control signals; outputs support both safety-rated and standard devices
- Set up directly in Rockwell Automation's Studio 5000® streamlines integration into CIP Safety™ systems with no extra software needed
- User-selectable port presets for common safety devices, such as e-stops, light curtains, and safety switches, are included in Banner's EDS file to simplify setup
- Six inputs each support up to 32 ISD-enabled safety devices, up to 192 devices on a single RSio, enabling device-level diagnostics for faster troubleshooting and minimizing wiring while maintaining up to PLe/SIL3 safety coverage
- Select from models with either M12 L-Code or Mini power connections with M12 A-Code I/O ports for straightforward installation
- Enable or disable test pulses independently on inputs and outputs to match device and application requirements
- Increase installation flexibility with IP67-rated, machine-mountable safe I/O that reduces wiring and cabinet size

RSio

WARNING:
- **T3 Qualified Configuration Tool**
- Using an unqualified configuration tool could result in a configuration that may not reflect user intentions and, as such, may not provide the level of safety that is required.
- The Rockwell Automation's Studio 5000 is a qualified configuration tool which meets the qualification requirements for IEC 61508 T3 tools and is recommended to configure the RSio block. Alternative qualified tools that meet these requirements may be used.

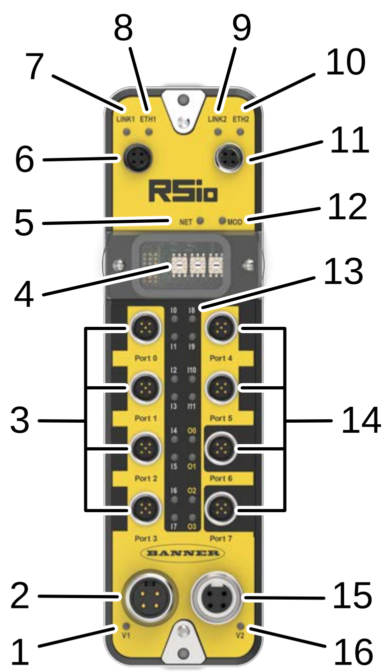
2.1 Models

Model	Safety Communication Standard	Power Connector	Number of Safe and Non-Safe Input Ports	Number of Safe Output Ports
RSIO-MA4-6SI2SO-C	CIP Safety[1]	4-pin Mini	6[2] (ISD compatible[3])	2
RSIO-L5-6SI2SO-C	CIP Safety[1]	5-pin L-Code M12	6[2] (ISD compatible[3])	2

2.2 Features and Indicators

The RSio block models described in this manual feature several functions, depending on the model.

Figure 1. Features



1. V1 = Input Power Status Indicator
2. Power In Connector (Mini is shown. See "Power Connections" on page 45 for details on the L-Code connector.)
3. I/O Connectors
4. Rotary Dials for Setting the IP Address (qty 3)
5. NET = Ethernet Communication Status Indicator
6. Ethernet Port #1
7. LINK1 = Port 1 Ethernet Link Established Indicator
8. ETH1 = Port 1 Ethernet Activity Indicator
9. LINK2 = Port 2 Ethernet Link Established Indicator
10. ETH2 = Port 2 Ethernet Activity Indicator
11. Ethernet Port #2
12. MOD = Module Status Indicator
13. I/O Status Indicators (16 total)
    Ix = Input Indicator
    Ox = Output Indicator
14. I/O Connectors
15. Power Output Connector (Pass-Through) (Mini is shown. See "Power Connections" on page 45 for details on the L-Code connector.)
16. V2 = Output Power Status Indicator

2.2.1 I/O Status Data

The RSio block provides status data for monitoring the I/O circuits and I/O data.

The status data includes the following data, which the controller (PLC) can read. The data structure is 1 = ON/Normal and 0 = OFF/Fault/Alarm.

- Individual point input status
- Combined input status
- Individual point output status
- Combined output status
- Individual test output status

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(1) CIP Safety™ is a trademark of ODVA, Inc.
(2) Pin 1 and pin 5 test outputs independently controlled
(3) Each input supports an ISD chain of up to 32 ISD-enabled devices—192 devices total across one RSio.

- Individual output readback (actual ON/OFF state of the outputs)

Status data indicate whether each safety input, safety output, or test output is normal (normal status: ON; fault status: OFF). For fatal errors, the communication connection can be broken so the status data cannot be read.

2.2.2 Test Outputs

A test output can be used in combination with a safety input for short circuit detection. Configure the test output as a pulse test source (Pulse Test) and associate it to a specific safety input.

A test output can be configured as a standard (non-safety) output. Connect actuators to test outputs that are used for non-safety applications.

A test output can be used as a power supply (Power Supply) to source 24 V DC for an external input circuit (or sensor).

NOTE: Test outputs configured as Pulse Test or Power Supply become active whenever power is applied to the block. These configured functions are independent of the I/O connections to the block.

CAUTION:
If a RSio block with test outputs configurated as Pulse Test or Power Supply is incorrectly installed in an application where actuators are connected to the test output, the actuators are activated when input power is applied.

To prevent this possibility:
- When installing or replacing a block, make sure that the block is correctly configured for the application or is in the factory default configuration before applying input power
- Reset blocks to their factory default condition when removing them from an application
- Make sure that all blocks in replacement stock are in the factory default configuration

- **Pulse Width:** 1 ms
- **Rate:** varies based on the configuration of the block

When the external input contact is closed, the test pulse output from the test output terminal is used to diagnose the field wiring and input circuitry. By using this function, short circuits between input signal lines or power lines can be detected. This function can also detect miswiring of specific test outputs to the wrong input terminal.

2.2.3 Dual-Channel Safety Inputs

NOTE: The dual-channel function is used with two consecutive inputs that are paired together. This pair starts at an even input number, such as inputs 0 and 1, 2 and 3, etc.

Equivalent Dual-Channel Input

In Equivalent mode, both inputs of a pair must be in the same (equivalent) state.

When a transition occurs in one channel of the pair before the transition of the second channel of the pair, a discrepancy occurs. If the second channel transitions to the appropriate state before the discrepancy time elapses, the inputs are considered equivalent (see Dual-Channel Input Discrepancy Time).

If the second transition does not occur before the discrepancy time elapses, the channels fault. In the fault state, the input and status for both channels are set low (OFF). When configured as an equivalent pair, the data bits for both channels are sent to the controller (PLC) as the same (equivalent), either both high or both low.

Complementary Dual-Channel Input

In Complementary mode, the inputs of a pair are in the opposite (complementary) state.

When a transition occurs in one channel of the pair before the transition of the second channel of the pair, a discrepancy occurs. If the second channel transitions to the appropriate state before the discrepancy time elapses, the inputs are considered complementary (see Dual-Channel Input Discrepancy Time).

If the second transition does not occur before the discrepancy time elapses, the channels fault. The fault state of complementary inputs is the even-numbered input OFF and the odd-numbered input ON. If faulted, the status bits of both channels are set low. When configured as a complementary dual-channel pair, the data bits for both channels are sent to the controller (PLC) in opposite (complementary) states.

Dual-Channel Input Discrepancy Time

Evaluate the consistency between signals on two channels to support redundant channel safety devices. The dual-channel selection monitors the time during which there is a discrepancy between the two channels.

If the length of the discrepancy exceeds the configured discrepancy time, the safety input data and the individual safety input status turn OFF for both channels. Configure discrepancy time from 0 ms to 65,530 ms in increments of 10 ms.

Safety Input Fault Recovery

If an error is detected, the safety input data remains in the OFF state.

Use the following procedure to activate the safety input data.

1. Remove the cause of the error.
2. Place the safety input (or safety inputs) into the safe state (OFF).

The safety input status turns ON (fault cleared) after the input-error latch time has elapsed. The I/O indicator (red) turns off. The input data can now be controlled.

Input Delays

Input Delays are set for each individual input.

OFF>ON Delay

An input signal is treated as logic 0 (OFF) during the OFF>ON delay time (10 ms to 1000 ms) after the rising edge of the input contact. The input turns ON only if the input contact remains ON after the OFF>ON delay time has elapsed. This delay helps prevent rapid changes of the input data due to contact bounce.

On>OFF Delay

An input signal is treated as logic 1 (ON) during the ON>OFF delay time (6 ms to 1000 ms) after the falling edge of the input contact. The input turns OFF only if the input contact remains OFF after the ON>OFF delay time has elapsed. This delay helps prevent rapid changes of the input data due to contact bounce.

2.2.4 Safety Outputs

Safety Output with Test Pulse

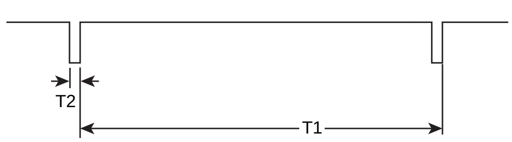
The safety output can be configured for Safety Pulse Test. When configured as such, the output pulses when ON.

By using this function, the following can be detected:
- Short circuits between PNP output signal lines and power lines (positive)
- Short circuits between output signal lines (when used as dual channel with test pulses enabled)

If an error is detected, the safety output data and individual safety output status turn OFF.

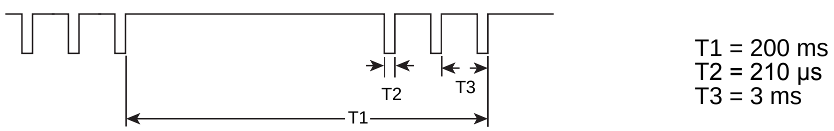
The test pulse for the safety output has the following characteristics depending on the configuration settings of the output:
- **Pulse Width** (depending on the configuration of the outputs):
  - One 210 µs pulse
  - Three 210 µs pulses spaced 3 ms apart
- **Rate:** 200 ms

Figure 2. Pulse Width = 210 µs



T1 = 200 ms
T2 = 210 µs

Figure 3. Pulse Width = Three 210 µs pulses spaced 3 ms apart



> **NOTE:** To prevent the test pulse from causing the connected device to malfunction, pay careful attention to the input response time of the device connected to the output to ensure that it ignores the pulse (does not switch OFF then back ON with the pulse).

> **NOTE:** Selecting a dual-channel safety output without test pulsing results in a lower level of safety because shorts to other voltage sources cannot be detected and because of a reduction in internal testing (CAT 3 PL d can be achieved only when pulsing is turned off).

> **IMPORTANT:** Turning off test pulses on one safety output reduces internal testing, limiting the maximum achievable safety level for the remaining safety outputs to Category 3.

Dual-Channel Safety Output

When the data of both channels is in the ON state, and neither channel has a fault, the outputs turn ON. The status is normal.

If a fault is detected on one channel, the safety output data and individual safety output status turn OFF for both channels.

Single-Channel Safety Output

When the data of the channel is in the ON state, and the channel does not have a fault, the output is turned ON. The status is normal.

If a fault is detected on the channel, the safety output data and individual safety output status turn OFF for the channel.

> **NOTE:** Configuring an output as a single-channel safety output typically results in lower levels of safety than when used as a dual-channel safety output.

Safety Output Faults

If a fault is detected, the safety outputs are switched OFF and remain in the OFF state.

Safety output faults require a block power cycle to clear the fault or a System Reset message is sent to the RSio block (that is, a sourcing safety output channel that is shorted to output power, positive). This condition applies to blocks with sourcing only safety outputs. One of these faults on any safety output channel results in all sourcing only safety outputs being placed in the safe state (OFF).

Use one of the following procedures to reactivate the safety outputs after one of these faults.

Type 1 Reset: Power Cycle Process

1. Remove power from the RSio block.
2. Remove the cause of the error.
3. Restore power to the RSio block.

Type 1 Reset: Manual Process Using the PLC

1. Remove the cause of the error.
2. Make sure the PLC is online.
3. Open the connection to the RSio block in Studio 5000.
4. Click the **Connection** tab.
5. Make sure that the RSio block is at a state in which it can be inhibited. If it can be inhibited, select **Inhibit Module**.
6. Click the **Safety** tab.
7. Click **Reset Ownership**.

This starts the Type 1 reset.

8. Wait for a few seconds.
9. Click the **Connection** tab.
10. Deselect **Inhibit Module**.
    The RSio block connects and is no longer in the faulted state.

Type 1 Reset: Automated Process

1. Remove the cause of the error.
2. Download the AOI file called Banner_RSio_Reset_v1 from www.bannerengineering.com.
3. See "Using the Reset AOI" on page 90 for instructions on using the AOI.

2.2.5 Ethernet Topologies

The Banner Remote Safe I/O block with EtherNet/IP and CIP Safety can be used with a protocol-compliant scanner (PLC) as part of the control system architecture.

The RSio block's built-in two-port Ethernet DLR-capable switch allows the use of different network topologies to meet the needs of the application. These topologies include:

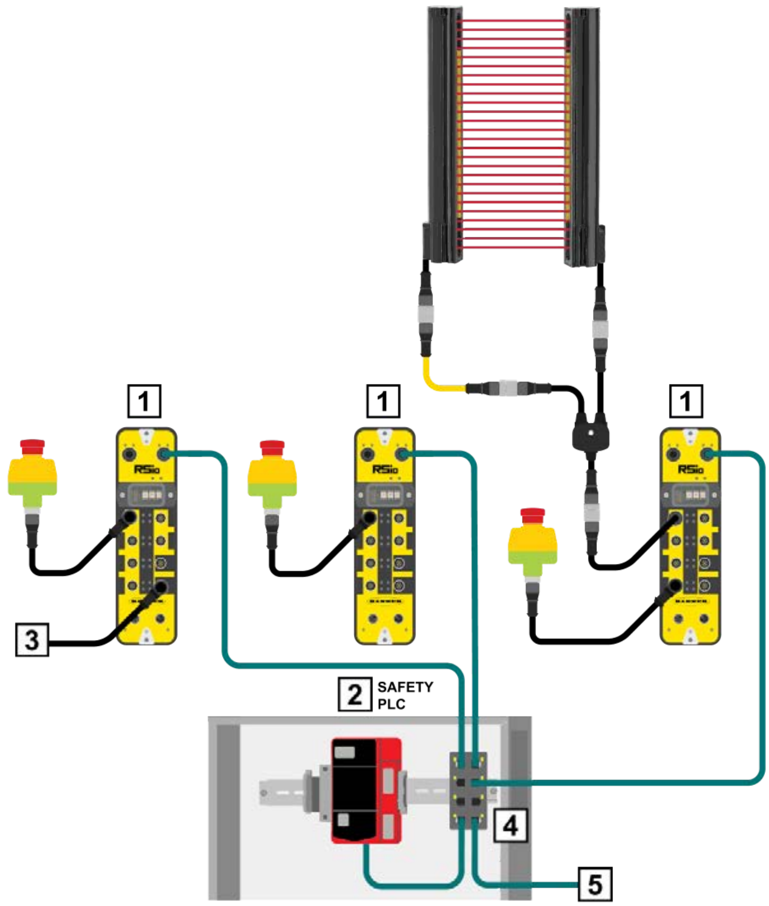
1. Star
2. Daisy-chain
3. Combination of star and daisy-chain
4. DLR (Device Level Ring) for Ethernet media ring redundancy

Star Topology

In a star topology network (spoke and hub), all devices are connected to a central hub or switch, that acts as a central point of communication.

Performing maintenance on one block (for example, by removing its network cable or by cycling power to it) does not affect other blocks on the network.

Figure 4. Example Star Topology



1. RSio Blocks
2. EtherNet/IP CIP Safety PLC
3. Final Switching Devices
4. Ethernet Switch with two DLR Ports
5. HMI Device

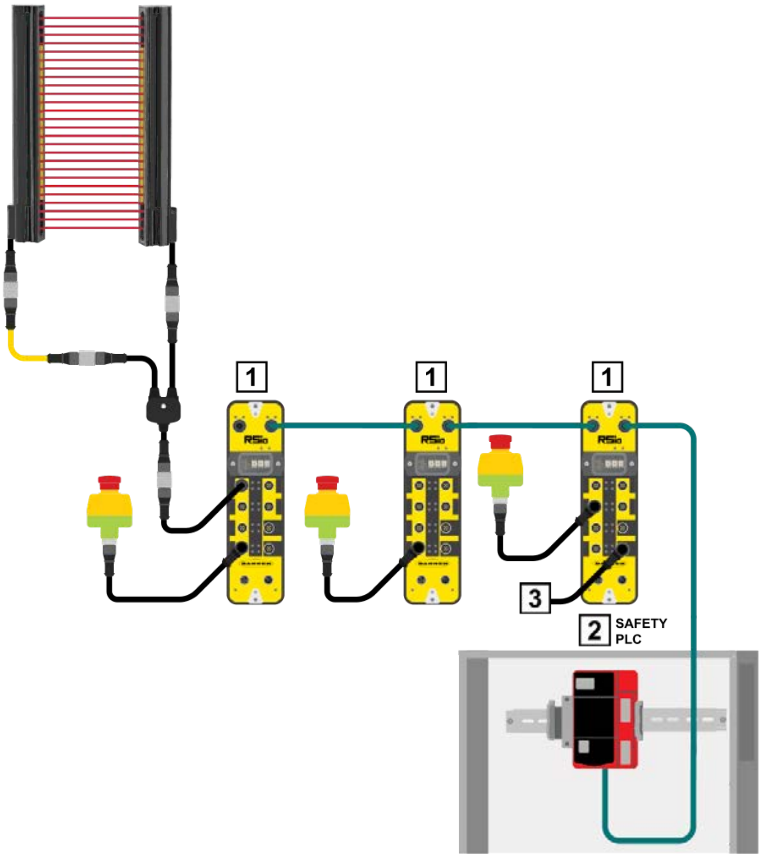
Daisy-Chain Topology

In daisy-chain topology the devices on the network are connected in a linear sequence, where each device connects to the next.

Daisy-chain topology is the easiest way to add more RSio blocks or additional devices to a system. The topology is the simplest topology and is cost-effective because it utilizes the dual-port Ethernet switch integrated in the safety blocks and it reduces the overall Ethernet cable length.

Performing maintenance on any block that is not physically at the end of the daisy-chain (for example, by removing the network cable or by cycling power to the block) affects all blocks located down the chain from the maintained block.

Figure 5. Example Daisy-Chain Topology

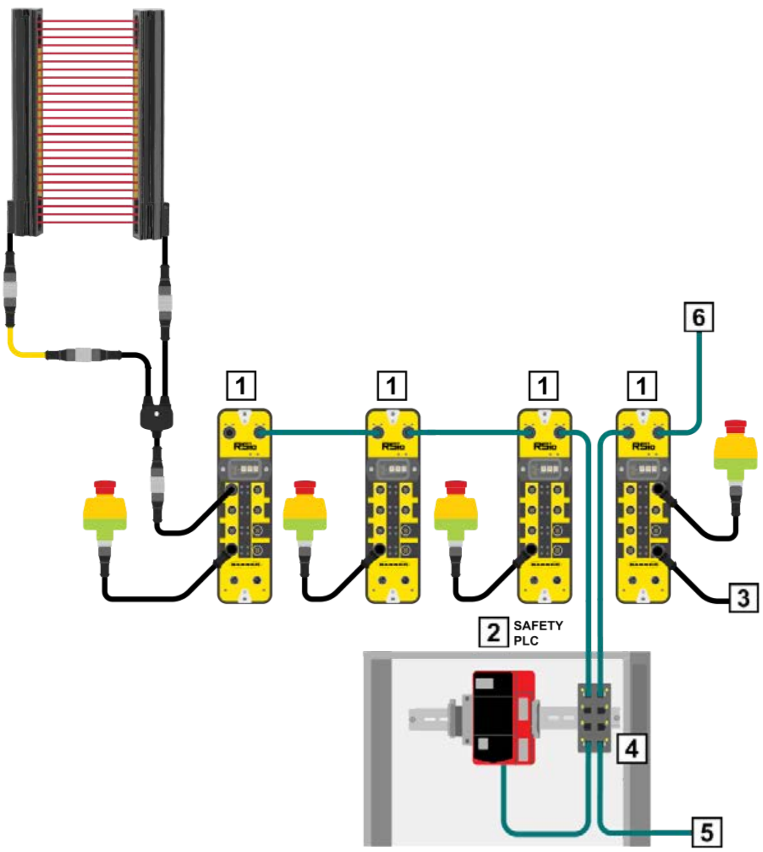


1. RSio Blocks
2. EtherNet/IP CIP Safety PLC
3. Final Switching Devices

Combination of Star and Daisy-Chain Topology

The combination star and daisy-chain network is a star network with some of the spokes including devices that are daisy-chained in series.

Figure 6. Example Combination Network



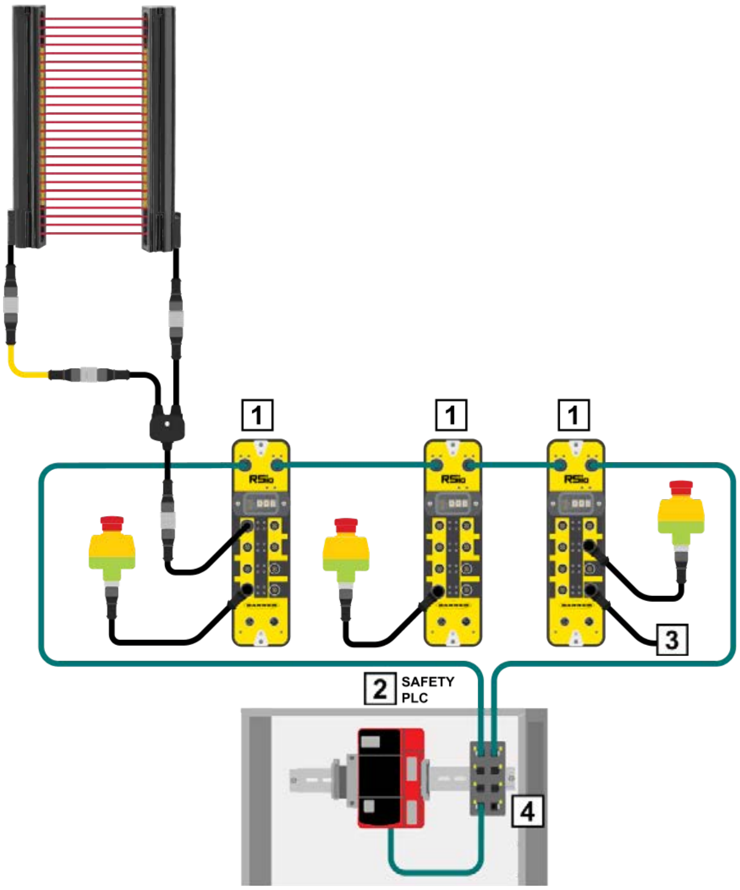
1. RSio Blocks
2. EtherNet/IP CIP Safety PLC
3. Final Switching Devices
4. Ethernet Switch with two DLR Ports
5. HMI Device
6. Drive

DLR Ring Topology

The DLR (Device Level Ring) ring topology is a network configuration where the connected devices create a circular (ring) path for data to travel.

Performing maintenance on one block (for example, by removing a network cable or cycling power to it) does not affect other blocks because the disruption can be detected by the network and the communication can be routed to maintain the network.

Figure 7. Example DLR Ring Topology



1. RSio Blocks
2. EtherNet/IP CIP Safety PLC
3. Final Switching Devices
4. Ethernet Switch with 2 DLR Ports

2.3 Appropriate Applications and Limitations

The Banner Remote Safe I/O block has been engineered and designed exclusively for the proper use described in this manual. The blocks are intended to be used considering all references and information of this manual.

WARNING:
- **Read this Section Carefully Before Installing the System**
- **Failure to follow these instructions could result in serious injury or death.**
- If all mounting, installation, interfacing, and checkout procedures are not followed properly, this Banner Engineering Corp. 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.
- The user has the sole responsibility to ensure that this Banner Engineering Corp. device is installed and interfaced to the guarded machine by Qualified Persons, in accordance with this manual and applicable safety regulations. A Qualified person is 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.

- Use the block only as intended
- Use the block only with the recommended and approved components
- Consider all the data in this manual

- Make sure that only a Qualified Person works with the block
- Make sure during configuration and commissioning that the block will be operated within its specifications
- Make sure that the power supply corresponds to the specifications
- Use the block in a technically adequate condition

The Banner Remote Safe I/O block is a decentralized device. It can be used in harsh industrial environments up to IP67.

Operation of the RSio block in accordance with its designated use and the degree of protection are guaranteed only if open connectors are closed using the caps and the rotary switch cover is in place.

Intended use also includes EMC-compliant electrical installation. The RSio block is intended for use in industrial environments. Radio interference may occur if used in domestic or mixed environments. If the block is used in domestic or mixed environments, pertinent industry standards and practices must be observed.

Do not:
- Alter the design, engineering, or electrical features of the block
- Put emergency stop functions and devices out of operation! Follow the relevant standards (for example, ANSI B11.19, NFPA 79, and IEC/EN 60204-1 require that the emergency stop function remains active at all times)
- Use the block beyond the application fields described in this manual (specifications, operating instructions)
- Climb on the block
- Use the block outdoors or for continuous operation in liquids
- Clean the block using a high-pressure cleaner

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 Banner Engineering Corp. 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.

2.3.1 Responsibility of the User

Use the Banner Remote Safe I/O block in a factory automation environment. Use of this product assumes familiarity with pertinent industry standards and practices.

In addition to the safety instructions in this manual, adhere to relevant accident prevention and environmental protection regulations for the environment in which this product will be used.
- The user must be knowledgeable about the valid industrial safety regulations in order to evaluate additional dangers which arise as a result of the special conditions for the product in the place of operation. This is to be transcribed into working instructions for the operation of the product.
- The working instructions must be kept in the direct environment of the product and accessible at any time for people who work with the product.
- The user must fully adhere to the working instructions.
- The product is to be operated only in a technically flawless and reliable condition.

Every person working with the product must read and understand the operation instructions before carrying out any work. The manual must be available to all personnel involved in:
- Project design
- Installation
- Commissioning
- Operation
- Decommissioning

CAUTION:
- **Safe State**
- Use the Banner Remote Safe I/O block only in applications where the OFF state is the safe state.
- Safe state of the inputs and outputs is defined as the OFF state.
- Safe state of the block and its data is defined as the OFF state.

Chapter Contents

Chapter 3 Specifications and Requirements

3.1 Specifications

Power

Voltage: 24 V DC ±20%
The power supply must meet the requirements for extra low voltages with protective separation (SELV, PELV)

Block Current Consumption: 200 mA (no load, no inputs connected)

Maximum Block Input Current[4][5]:

8 A maximum for V1 (inputs and block)
8 A maximum for V2 (output circuits)

Power: 4-pin Mini or 5-pin L-Code M12

Network Interface

Ethernet 10/100 Base-T/TX

Protocol: CIP Safety™[6] over EtherNet/IP™[7]

Test Pulse

Test Outputs:

- **Pulse Width:** 1 ms
- **Rate:** varies based on the configuration of the block

Safety Outputs:

- **Pulse Width** (depending on the configuration of the outputs):
  - One 210 µs pulse
  - Three 210 µs pulses spaced 3 ms apart
- **Rate:** 200 ms

Output Protection

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

Safety Inputs

Input ON Current: 5 mA typical at 24 V DC, 40 mA peak contact cleaning current at 24 V DC

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 lead resistance: 300 Ohms max (150 Ohms per lead)

Pin 1 (Odd TP) Current[4] **:** 2 A maximum

Pin 5 (Even TP) Current[4] **:** 300 mA maximum, as a non-safe input, it draws 5 mA at 24 V DC

Solid-State Safety Outputs

Current Limit[4] **:** 1 A maximum at 24 V DC (1.0 V DC maximum drop), 2.8 A, 8 ms inrush 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 maximum, 1 H maximum, 10 Ohms maximum per lead

[4] Value for 25 °C (77 °F). See "Figure: Temperature Derating" on page 19 for higher temperatures.
[5] This includes pass-through current.
[6] CIP Safety™ is a trademark of ODVA, Inc.
[7] EtherNet/IP™ is a trademark of ODVA, Inc.

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 3 (IEC 61508)

Safety Ratings

Dual-Channel Inputs with Test Pulses:

- Dual-Channel Output with Test Pulses PFH [1/h]: 1.71×10^{-9}
- Dual-Channel Output without Test Pulses PFH [1/h]: $1.93e \times 10^{-9}$
- Single-Channel (Split) Outputs with Test Pulses PFH [1/h]: $1.93e \times 10^{-9}$
- Single-Channel (Split) Outputs without Test Pulses PFH [1/h]: $1.93e \times 10^{-9}$

Proof Test Interval: 20 years

Product Performance Standards

See "Standards and Regulations" on page 128 for a list of industry applicable U.S. and international standards

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

Reaction Time

Maximum Input time: 6 ms + debounce time (default 6 ms)

Maximum Output time: 5 ms

Construction

Enclosure: Glass filled polyamide

Rotary Switch Cover: Polycarbonate

Encapsulation: Epoxy

Connectors: Nickle plated copper and polyamide

Connections

Power: 4-pin Mini or 5-pin L-Code M12

Safety Inputs: 5-pin A-Code M12

Safety Outputs: 5-pin A-Code M12

Network Interface: 4-pin D-code M12

Operating Conditions

Temperature: –25 °C to +70 °C (–13 °F to +158 °F)

Storage Temperature: –30 °C to +70 °C (–22 °F to +158 °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

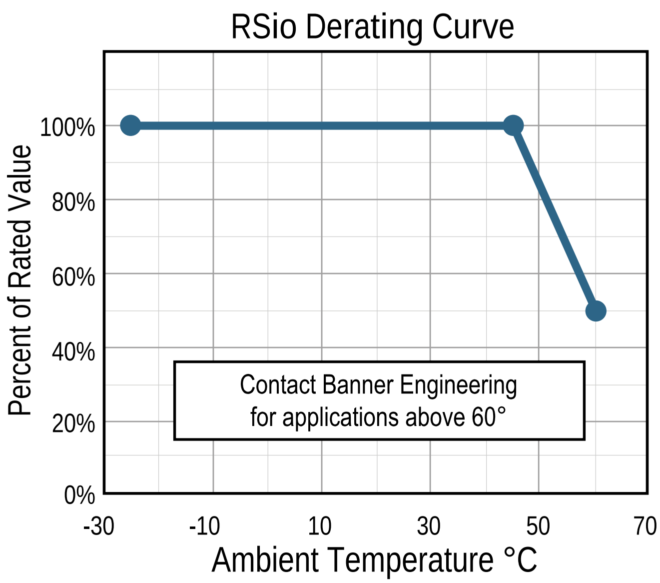
For indoor use only

IP65, IP67, NEMA 1, UL Type 1

Design Standards
EN ISO 13849-1
IEC 61508

Certifications
Certifications pending

Figure 8. Temperature Derating



3.2 Safety System Response Time Calculations

The response time is an important factor in determining the safety distance (minimum distance) for the placement of a safety device (light curtain, gate, etc.).

To calculate the response time of a safety function, the worst-case response times of all the components involved must be added to the delays on the communication paths. Use the following example processes, which include the Remote Safe I/O block reaction times, to assist in the calculation of the system response times.

The response time of a safety output to a safety input must be calculated based on the entire system. The entire system includes:

- Maximum safety input response time
- Maximum PLC processing time
- Communication delay times to the PLC and from the PLC. The communication delay is the safety data transport time, which depends on the setting of the expected packet interval (EPI).
- Maximum response time of the safety output

3.2.1 Maximum Response Time of a Safety Input (Single- or Dual-Channel Mode)

Calculate the maximum response time of a safety input in an error-free state.

Calculate the response time from the instant the physical event happens to the connected input device to the moment a transmission message is ready to be sent to the CIP Safety PLC over the Ethernet/IP network.

Delay Time Calculation:

Response time of connected input device	_____ ms
Input delay time configured(8)	+ _____ ms
Internal maximum reaction time of the RSio block	+ __6__ ms
Maximum response time of the safety input	= _____ ms

(8) Input delay time configured in system (default is 6 ms ON to Off, 10 ms OFF to ON).

3.2.2 Maximum Response Time of a Safety Output (Single- and Dual-Channel Mode)

Calculate the maximum response time of a safety output in an error-free state.

Calculate the response time from the moment a transmission of a corresponding message is received by the Remote Safe I/O block and the actuator physically processes the switch off event.

Delay Time Calculation:

Internal maximum output reaction time of the RSio block	__5__ ms
Any other delay time for the RSio block (list pulse test Configured)	+ _____ ms
Switch-off time of connected actuator/relay	+ _____ ms
Additional switch-off delay (physical signal time)	+ _____ ms
Maximum response time of the safety input	= _____ ms

3.3 Dimensions

All measurements are listed in millimeters [inches], unless noted otherwise. The measurements provided are subject to change.

Figure 9. Mini Power (-MA4) Models

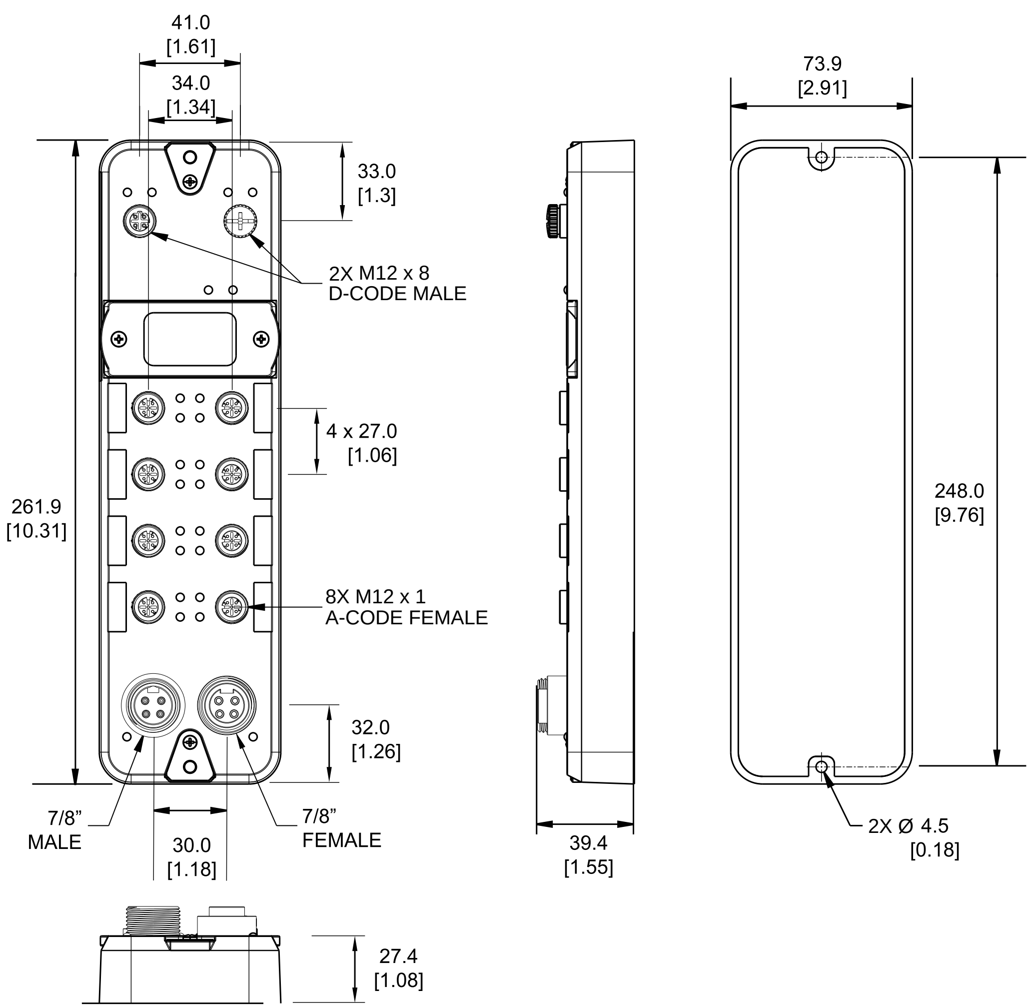
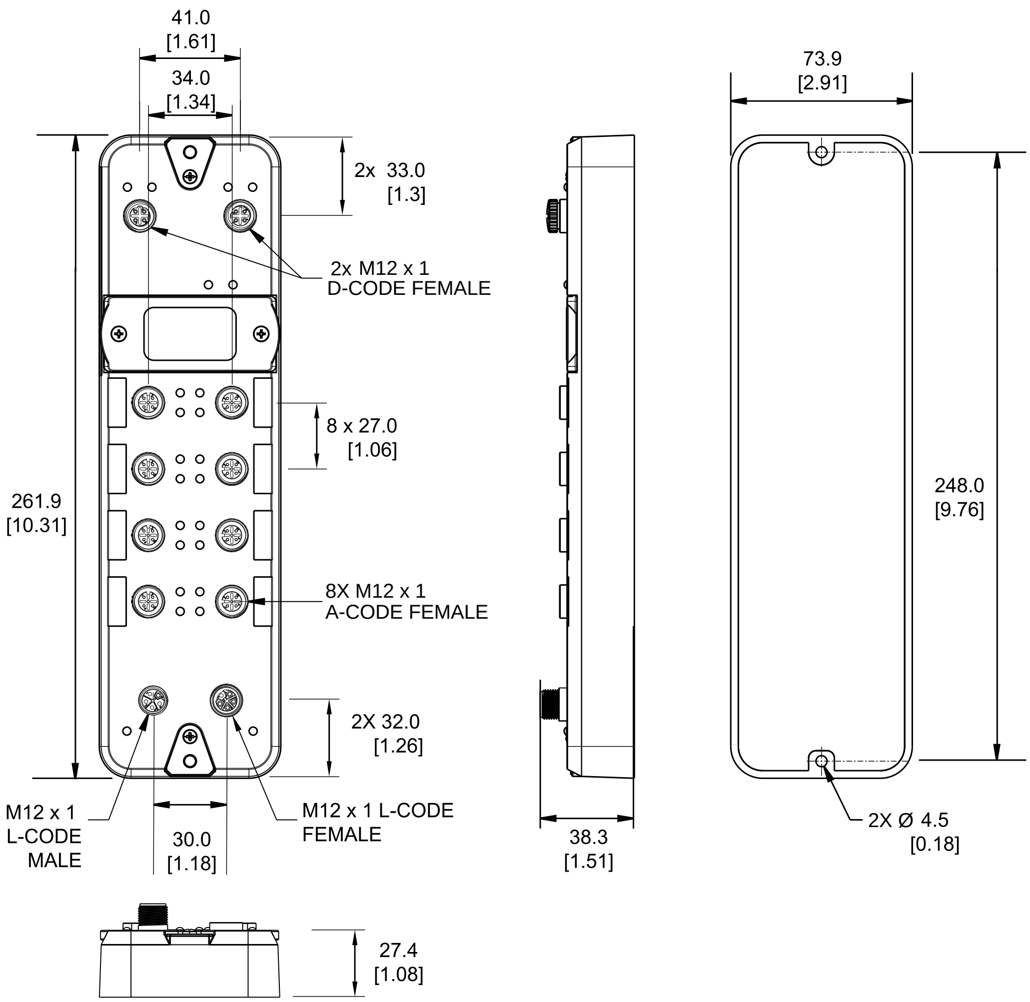


Figure 10. L-Code Power (-L5) Models



Chapter Contents

Chapter 4 Connection Considerations

4.1 Safety Input Devices

The Remote Safe I/O block monitors the state of the safety and non-safety input devices that are connected to it. The RSio block passes the input state information to the safety PLC via the safety bus network.

The RSio can detect input faults with certain input circuits that would otherwise result in a loss of the control of the safety function. The RSio block passes this fault information to the safety PLC via the safety bus network.

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
- Properly installing multi-conductor cabling with proper strain relief
- 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 RSio block, contact Banner Engineering Corp. for assistance.

WARNING:
- **Input Device and Safety Integrity**
- Failure to follow these instructions could result in serious injury or death.
- The Remote Safe I/O block 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 Remote Safe I/O block.
- The user must also eliminate or minimize possible input signal faults/failures that may result in the loss of the safety functions.

4.1.1 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. These safety-related functions can prevent initiation, or they can stop or remove a hazard. The failure of a safety-related function or its associated safety circuit usually results in an increased risk of harm.

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

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

Safety Circuit Integrity Levels

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 Remote Safe I/O block 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 with only Category 2, Category 3, and Category 4 applications, as described in ISO 13849-1. The input device circuits shown in "Input Device Circuit-Change of State" on page 24 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.

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. Although Banner Engineering Corp. always recommends the highest level of safety in any application, the user is responsible 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.

4.1.2 Safety Input Device Properties

The Remote Safe I/O block is configured via the PLC software to accommodate many types of safety input devices.

Reset Logic: Manual or Automatic Reset

A manual reset may be required for safety input devices by using a Latch Reset function 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).

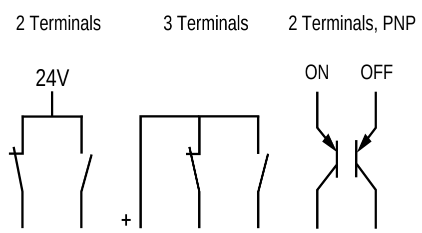
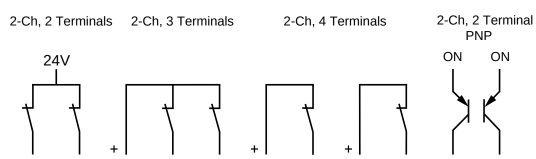
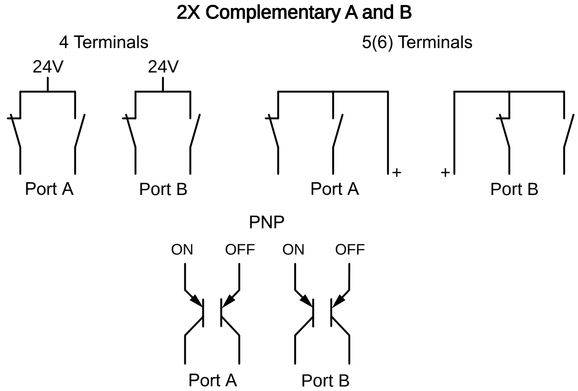
Connecting the Input Devices

The Remote Safe I/O block 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 manually during the configuration process using the PLC software.

Signal Change-of-State Type

The RSio block can be used to monitor that the dual-channel safety input device signals change within the defined discrepancy time.

Table 1. Input Device Circuit-Change of State

Input Circuit	Input Signal Change-of-State (COS) Timing Rules	
	Stop State—Safety Output turns OFF when(9):	**Run State—Safety Output turns ON when(10):**
Dual-Channel A and B Complementary 	At least 1 channel (A or B) input is in the Stop state.	**Simultaneous:** A and B are both in the Stop state and then both switch to the Run state within the defined discrepancy time before outputs turn ON.
Dual-Channel A and B 		
2X Complementary A and B 	At least 1 channel (A or B) within a pair of contacts is in the Stop state.	**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 the defined discrepancy time (0.5 seconds for two-hand control).

(9) Safety Outputs turn OFF when one of the controlling inputs is in the Stop state.
(10) 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).

4.2 Safety Input Device Options

The following table shows the circuit types typically used for each input type. It also lists the highest safety category that can be obtained with the noted circuit type for the input.

Figure 11. Input Device Circuit-Safety Category Guide

General Circuit Symbols		Circuits shown in Run State						Circuits shown in Stop State	
		ES	GS	OS	RP	PS	ISD	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	Cat 4	Type IIIa Cat 1	Cat 4
4 Terminal Dual Channel (see note 4)		Cat 4	Cat 4	Cat 4	Cat 4	Cat 4		Type IIIa Cat 1 Type IIIb Cat 3	Cat 4
2, 3 & 4 Terminal Dual Channel Complementary	4 Terminals 2 Terminals 3 Terminals 24V	Cat 4	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	4 Terminals 5(6) Terminals 24V 24V Port A Port B Port A Port B		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

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.
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. 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.

4.2.1 Safety Circuit Integrity Levels

Requirements vary widely for the level of control reliability or safety category in safety applications per ISO 13849-1. Although Banner Engineering Corp. always recommends the highest level of safety in any application, 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 page 22 for guidance.

4.2.2 Emergency Stop Push Buttons

The Remote Safe I/O 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:
- **Configuration Conforms to Applicable Standards**
- Failure to verify the application may result in serious injury or death.
- The user is responsible for verifying the application of the Banner Remote Safe I/O block and Safety PLC meet the risk assessment requirements and that they conform to all applicable standards.

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 NFPA 79).

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.

4.2.3 Rope (Cable) Pull

The Remote Safe I/O safety inputs may be used to monitor rope (cable) pulls.

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 page 26 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.

4.2.4 Interlocked Guard or Gate

The Remote Safe I/O 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, EN ISO 14120 or the appropriate standard). The guard must be strong enough to contain hazards within the guarded area, which may be ejected, dropped, or emitted by the machine.

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

4.2.5 Optical Sensor

The Remote Safe I/O 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 IEC 61496-1/-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 System outputs to each safety input must be calculated, see "Safety System Response Time Calculations" on page 19.

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 page 33).

> **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.

4.2.6 Two-Hand Control

The Remote Safe I/O 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)).

The Remote Safe I/O block safety inputs used to monitor the actuation of hand controls for two-hand control, pass their state to the Safety PLC. The Safety PLC's logic must 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 Banner Engineering Corp. 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)

Install all hand controls far enough away from the nearest hazard point that the operator cannot reach the hazard with a hand or other body part before the hazardous motion ceases. This is the separation distance (safety distance) and may be calculated as follows.

⚠ 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.

Safety Distance U.S. Formula and Definitions

The Safety Distance formula, as provided in ANSI B11.19-2019:

$$D = (K \times T) + d_{ds} + Z$$

D

The Safety Distance of a device in inches or mm.

K

The maximum speed that an individual can approach the hazard.

63 in/sec or 1600 mm/sec as recommended by OSHA 29CFR1910.217 and ANSI B11.19. Various studies indicate speeds of 1600 mm/sec (63 in/sec) to more than 2500 mm/sec (100 in/sec), however, the studies are not conclusive determinations. Consider all factors, including the physical ability of operators, when determining the value of K to be used.

T

The total time to achieve a safe condition (seconds).

The total time is the total of the following five components:

T_d = the reaction time of each device
T_i = the reaction time of the device interface(s)
T_c = the reaction time of control system
T_s = the reaction time of the machine
T_{scm} = the time associated with stopping-performance monitoring (safe-condition monitoring system)

d_{ds}

The reaching distance associated with devices (inches or mm).

Z

Supplemental distance factors (inches or mm). For example, measurement errors, reflection-based measurement errors, lack of ground clearance of moving equipment, or decreasing braking torque of moving equipment.

Minimum Distance European Formula and Definitions

The Minimum Distance formula, as provided in EN ISO 13855:2024:

$$S = (K \times T) + D_{DS} + Z$$

S

The separation distance in mm (not less than 100 mm)

K

The approach speed in mm/s (approach speeds of body or part of the body as stated in ISO 13855)
- 2000 mm/s for the speed of upper limbs
- 1600 mm/s for walking

T

The overall system response time in seconds

D_{DS}

Supplements the reaching distance associated with a protective device (mm)

Z

The application-dependent supplemental distance factor (mm), such as for measurement uncertainty, brake wear, reflection, etc.

4.2.7 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
- Protective stops

U.S. 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. Banner Engineering Corp. low profile 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 page 18), 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.

4.2.8 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
- Protective stop

Requirements of Bypassing Safeguards

Requirements to bypass a safeguarding device include[11]:

- 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

[11] This summary was compiled from sources including NFPA 79, ANSI/RIA R15.06, ISO 13849-1, IEC 60204-1, and ANSI B11.19. The user is responsible to verify safeguards required by these specifications and all other relevant laws and regulations.

- 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.

4.2.9 ISD Inputs

ISD inputs are available on the RSio block models.

The following inputs are available:
- Port 0 (IN0/IN1) Ethernet ISD Chain 1
- Port 1 (IN2/IN3) Ethernet ISD Chain 2
- Port 2 (IN4/IN5) Ethernet ISD Chain 3
- Port 3 (IN6/IN7) Ethernet ISD Chain 4
- Port 4 (IN8/IN9) Ethernet ISD Chain 5
- Port 5 (IN10/IN11) Ethernet ISD Chain 6

These inputs may be used to monitor chains of devices with embedded In-Series Diagnostics (ISD) data, such as the Banner SI-RFD Safety Switches, the Banner Lighted Emergency Stop Buttons with ISD, or the Banner ISD Connect.

ISD-enabled devices have a maximum cable run of 30 meters between devices and from the last device to the RSio block.

NOTE: The RSio block's response to the Safety PLC is based on the state of the output signal switching device (OSSDs) of the ISD inputs, not the ISD information carried on the OSSDs. The ISD information is non-safety chain/device status information.

ISD devices, such as SI-RFD Safety Switches, must be placed at an appropriate safety distance (minimum distance), according to the application standards. Refer to the applicable standards and to the documentation specific to the device for the appropriate calculations.

The times of all the devices, safety block, and safety PLC must be added to the device response time to get the overall response time. This time must be added to the response time of the ISD chain of devices. See the individual ISD device manuals to determine the response time of the ISD chain.

The active ISD devices' solid-state outputs have (and must have) the ability to detect external shorts to power, to ground, or to each other. The devices will lock out if such a short is detected.

If the application includes a pass-through hazard, supplemental guarding may be required, and manual reset should be selected. See "Manual Reset Input" on page 33.

⚠ **WARNING:**
- Configuration Conforms to Applicable Standards
- Failure to verify the application may result in serious injury or death.
- The Banner Remote Safe I/O block and the Safety PLC software primarily check the logic configuration for connection errors. The user is responsible for verifying the application meets the risk assessment requirements and that it conforms to all applicable standards.
- Changes in ISD chain length and/or order are only reported via Ethernet (input still seen as ON). The user is responsible for verifying that the number and order of devices is correct for the applications.

IMPORTANT: The machine builder (user) is responsible to ensure the wiring/cabling is not easily manipulated by an operator to defeat the safety function(s). For example, the operator cannot remove a device from the system.

> **NOTE:** In a long chain or chains with a lot of ISD devices, the voltage at the last unit (closest to the terminating plug) must stay above 19.5 volts for the chain to operate properly.

For the Individual Device-Specific ISD data, see "ISD Individual Device-Specific Data" on page 105.

4.3 Non-Safety Input Devices

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

Manual Reset Devices

Used to create a reset signal for a function block configured for a manual reset, requiring an operator action for the output of that block to turn ON.

> 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.

Mute Enable Switch

Signals the Remote Safe I/O block 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.

4.3.1 Manual Reset Input

The Manual Reset input may be configured to perform any combination of the following:

Reset of Safety Inputs

Sets the output of the Latch Reset function(s) to a Run state from a Latched state when the input 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.

Manual Reset on Power-Up

Allows various Latch Reset functions to be controlled by a single reset input after the power up.

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 is 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.

Automatic and Manual Reset Inputs Mapped to the Same Safety Output

By default, Safety Outputs are configured for automatic reset (trip mode).

Safety Input Devices operate as automatic reset unless a Latch Reset function is added.

4.4 Safety Outputs

The RSio block has two pairs of solid-state safety outputs (terminals O0 and O1, and O2 and O3). The outputs provide 1 A maximum per output pin (pins 2 and 4). Each redundant Solid-State Safety Output can be configured to function individually or in pairs.

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.

4.4.1 Solid-State Safety Outputs

The solid-state Safety Outputs 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 with test pulses is sufficient for Category 3 applications due to an internal series connection of two switching devices, but an external short must be prevented.

Output test pulses are used to detect short circuits from safety outputs to +24 V (V2) and short circuits between safety outputs.

WARNING:
- Dual-channel outputs without test pulses are not recommended for use in Safety Critical Applications
- Failure to incorporate proper fault exclusion methods when using dual-channel outputs without test pulses in safety critical applications may cause a loss of safety control and result in serious injury or death.
- If a dual-channel output without test pulses is used in a safety critical application the fault exclusion principles must be incorporated to ensure Category 3 safety operation. Routing and managing output wires so shorts to other outputs or other voltage sources are not possible is an example of a proper fault exclusion method

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 2 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) is highly recommended to monitor devices under control (FSDs and MPCEs) for unsafe failures. See "External Device Monitoring (EDM)" on page 37 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 device (FSDs) typically accomplish this when the safety outputs go to the OFF state. Refer to the "Specifications and Requirements" on page 18 before making connections and interfacing the Remote Safe I/O 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).

NOTE: The following table lists the highest safety category that can be obtained with the noted output type.

	Banner Remote Safe I/O Block			
	Single-Channel (Split) Outputs		Dual-Channel Output	
	without Test Pulses(12)	With Test Pulses	Without Test Pulses(12)	With Test Pulses
Safety Integrity level (IEC 61508)	SIL 2	SIL 3	SIL 3	SIL 3
Category (ISO 13849-1)	Cat 2	Cat 3	Cat 3	Cat 4
Performance level (ISO 13849-1)	PL d	PL d	PL e	PL e

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.

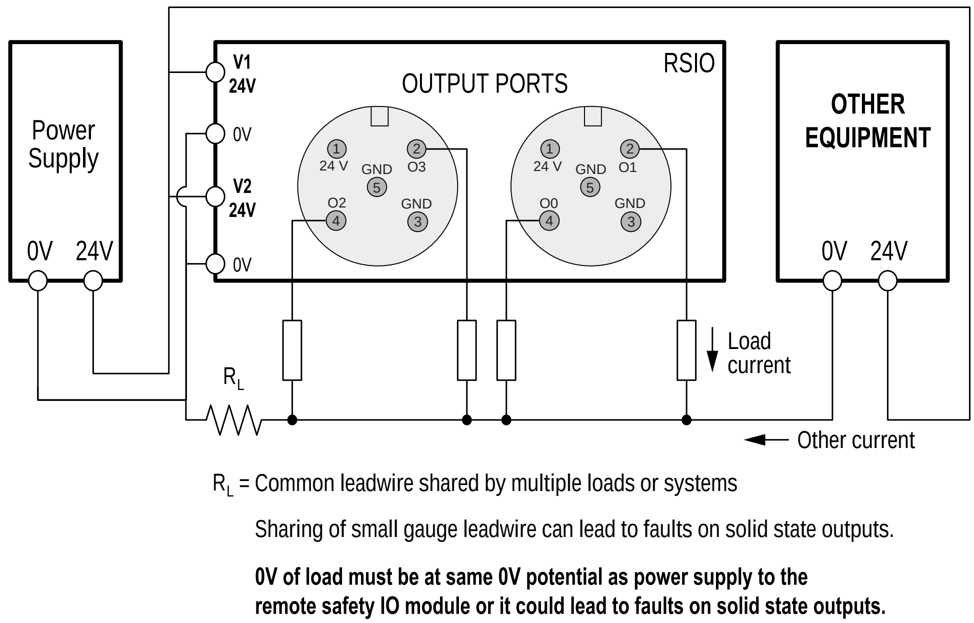
Common Wire Installation

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 (R_L).

Methods to prevent nuisance lockouts include:
- Using larger gauge or shorter wires to reduce the resistance (R_L) of the 0 V common wire
- Separating the 0 V common wire from the loads connected to the RSio block and the 0 V common wire from other equipment powered by the common 24 V supply
- Wiring the return from each safety output back to the appropriate ground pin of the output port

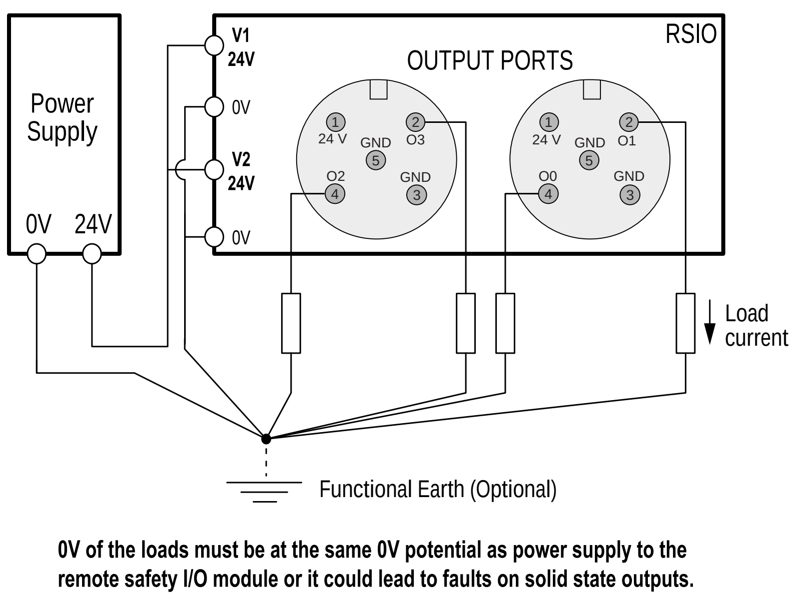
(12) Outputs must be cycled at least 1/month to meet the requirements of ISO 13849-1 Table E.1 Note 4.

Figure 12. Common Wire Installation—Single Common Wire



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 the block. If the voltage is higher than 1.7 V, the Safety Output 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 13. Wiring Diagram—– Multiple Common Wires



4.4.2 EDM and FSD Wiring

External Device Monitoring (EDM)

The safety outputs of the RSio block 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 RSio block 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.

The external device monitoring (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 linked to one or multiple Safety Outputs. This is accomplished by adding a single-channel contact input to the RSio block, then, in the PLC program link the EDM input to the desired Safety Output(s).

One-channel EDM inputs are used when the output signal switching device (OSSD) outputs directly control the de-energizing of the MPCEs or external devices.

One-channel monitoring is a series connection of closed monitor contacts that are forced-guided (mechanically linked) from each device controlled by the RSio block. The monitor contacts must be closed before the Outputs can be reset (either manual or automatic). After a reset is executed and the safety outputs turn ON, the monitor contacts may change state and their status (open or closed) will continually be passed to the PLC. However, the monitor contacts must be closed within X time of the safety outputs changing from ON to OFF, where X is a time specified in the PLC program.

See "Figure: Generic RSio Hookup: Solid-State Safety Output with EDM—External Connections " on page 40 for wiring.

⚠

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.

FSD Interfacing Connections

A final switching device (FSDs) interrupts 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 Remote Safe I/O. 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 Remote Safe I/O. 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 Remote Safe I/O.

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 the physical distance between the FSD safety stop circuits and the MPCEs increases
- 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 Banner Engineering Corp. 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 Remote Safe I/O solid-state safety outputs and the machine inputs is not exceeded.
  The solid-state safety output maximum OFF state voltage of the Remote Safe I/O does not result in an ON condition.
  The solid-state safety output maximum leakage current of the Remote Safe I/O, 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[13] 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.

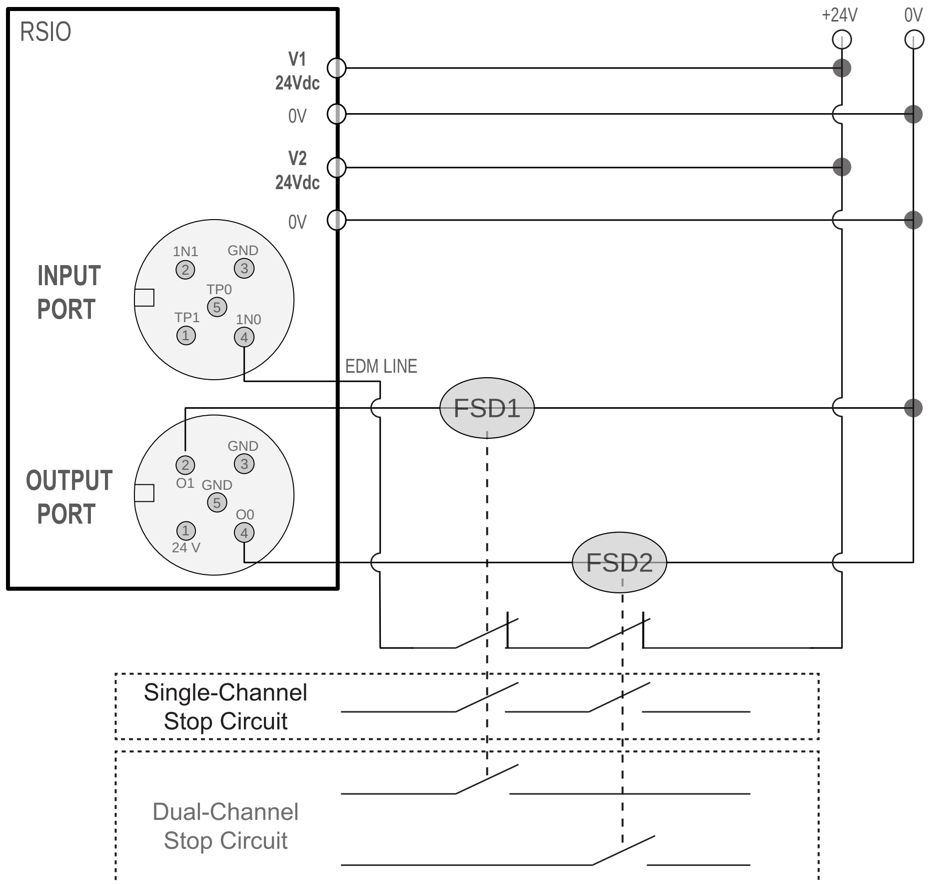
WARNING:

- **Properly Wire the Device**
- Failure to properly wire the Remote Safe I/O 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 Remote Safe I/O. The generalized wiring configurations are provided only to illustrate the importance of proper installation.

[13] 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 RSio Hookup: Safety Output with EDM

Figure 14. Generic RSio Hookup: Solid-State Safety Output with EDM—External Connections



DC common (0 V DC) must be common between the RSio block's 0 V DC terminal and the common of the load (for example, FSD).

Figure 15. Generic RSio Hookup: Solid-State Safety Output with EDM—Internal Connections

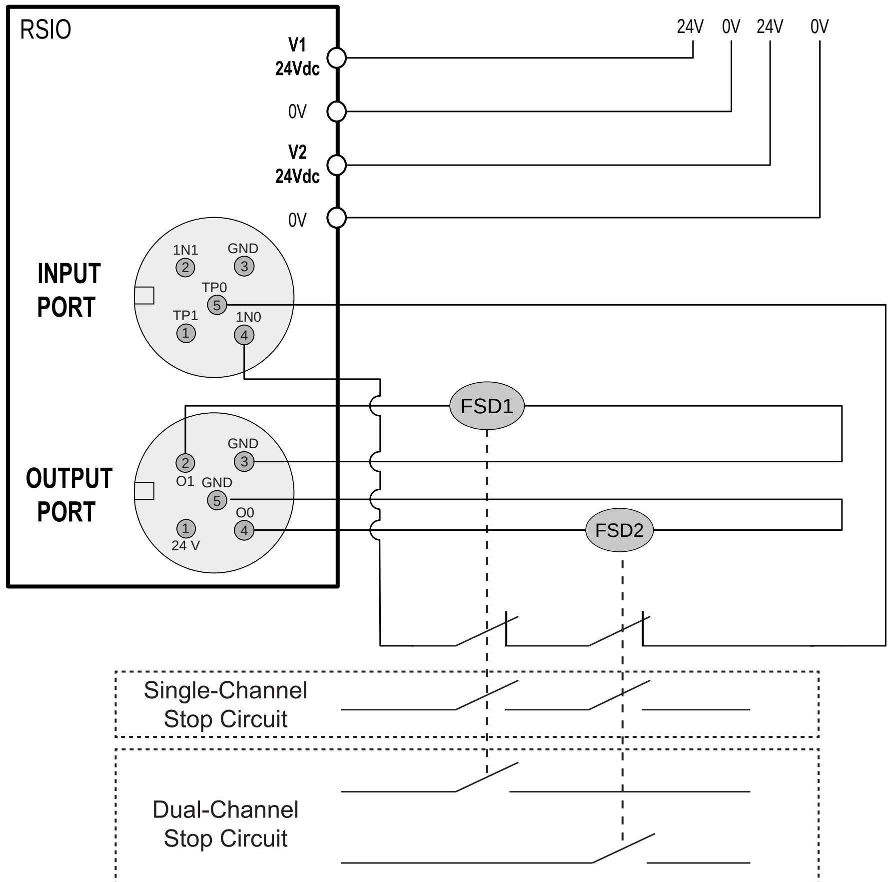


Figure 16. Generic RSio Hookup: Solid-State Safety Output to Motor Drive

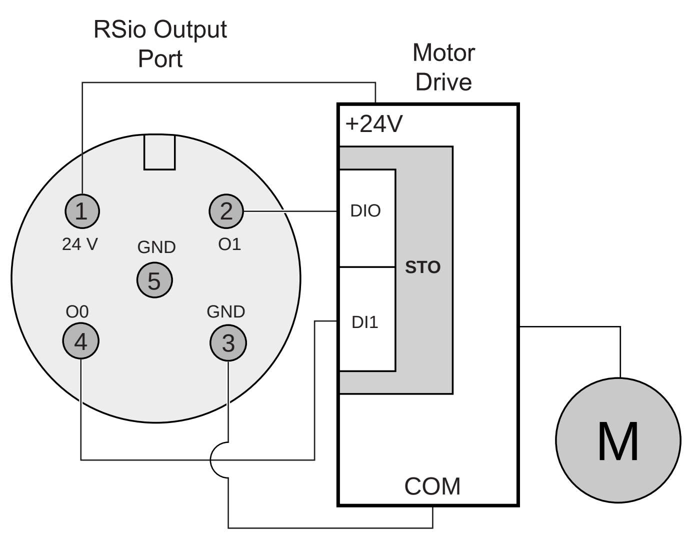
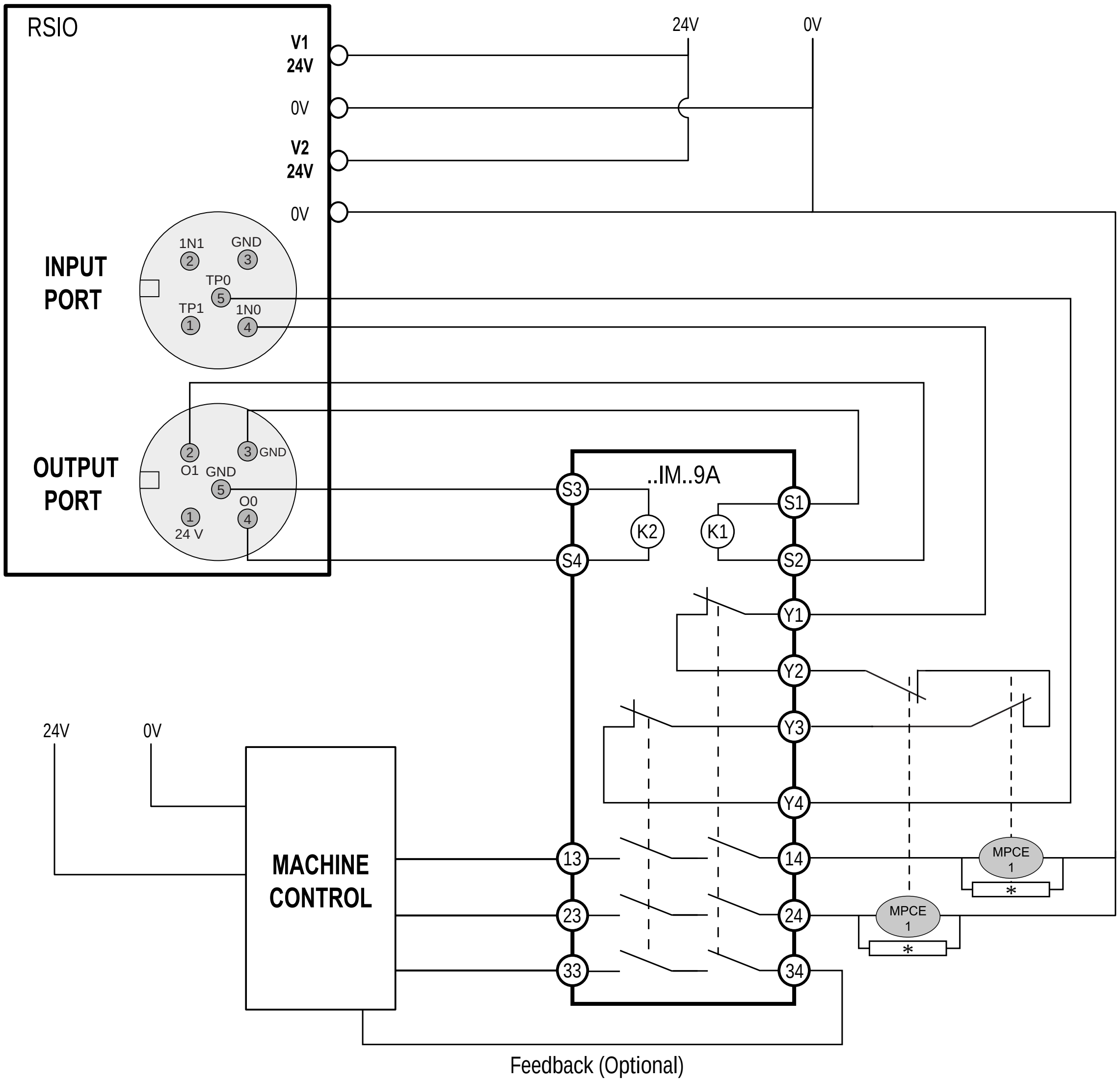


Figure 17. Generic RSio Hookup: Solid-State Safety Output to IM-T-9A



***Installation of transient (arc) suppressors across the coils of MPCE 1 and MPCE 2 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.

4.5 Status Outputs

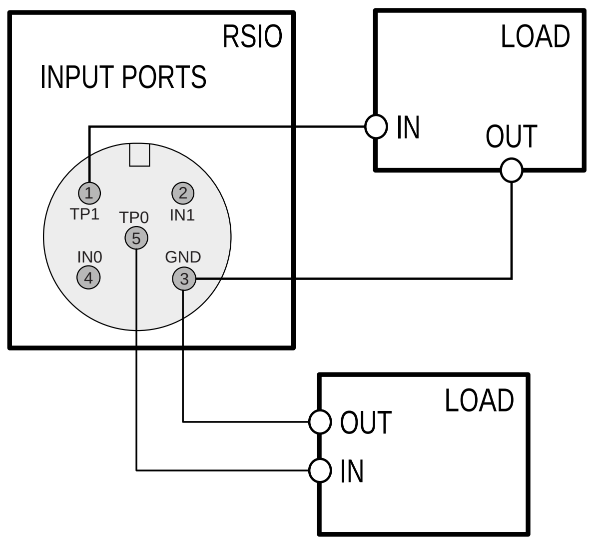
A status output can be used to send a non-safety signal to devices such as lights to signify the state of an input, safety output, or PLC function. For example, an Input status output is used to signify the state (ON or OFF) of the selected input (to the light).

4.5.1 Status Output Addition

The Status output is controlled by the Safety PLC.

An input port can be set up so that the test points (TP) are controlled by the PLC to turn ON or OFFf. Input preset #9 (see "Figure: Input Point Presets" on page 68) can be used to set Pin 1 and Pin 5 of an input port to be controlled by the PLC. This preset sets the TPs as standard so the PLC must tell it to turn ON and then again to turn OFF.

Figure 18. Hookup: Test Points Controlled by the PLC



4.5.2 Status Output Functionality

Up to twelve input test points may be used as status outputs.

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

Track Input

Indicates the state of a particular safety input.

Track Output

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

Waiting for Manual Reset

Indicates a particular configured reset is needed.

Chapter Contents

Chapter 5 System Installation

5.1 Mounting Considerations

The Banner Remote Safe I/O block is intended for use in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

The RSio block is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments.

This block is supplied as enclosed equipment. It should not require additional enclosures when used in locations consistent with the enclosure ratings stated in "Specifications and Requirements" on page 18.

Operation of the RSio block in accordance with its designated use and the degree of protection are guaranteed only if open connectors are closed using caps and the rotary switch cover is in place.

The RSio block must be fastened to a flat surface, so that there is no strain on the housing when the block is tightened down. The mounting distances depend on which plug-in connectors are used and on the bend radius of the cables.

The RSio block can be mounted in a horizontal or a vertical direction.

5.2 Mount the Block

Use the following instructions to mount the Banner Remote Safe I/O block.

The RSio block is supplied with two optional grounding tabs for the two internal ground planes. If grounding is needed, install the metal grounding tabs before mounting. The metal tab at the power connector end grounds the internal power plane. The metal tab at the Ethernet port end grounds the Ethernet circuit. If the RSio block is being mounted to a non-grounded surface, ground straps to a ground should be installed.

1. If needed, install the provided grounding tabs using the included mounting screws.
2. Mark the drill holes.

> **NOTE:** The RSio block can be used to mark the holes.

3. Pre-drill the marked holes.
4. Insert two M4 (#8) fixing screws of an appropriate length, with washers, to mount the product.

> **NOTE:** Locking washers are recommended in vibration environments.

5. Tighten the screws to 0.68 Nm (6 lb-in) of torque (recommended).

5.3 Block Wiring Connections

The following sections describe the wiring connections on the RSio block.

See Features and Indicators for the location of the ports and connectors.

> **NOTE:** Use proper wiring practices when connecting to the inputs or outputs of the RSio block. Ensure proper insulation on conductors to avoid shorts between conductors.

5.3.1 Power Connections

This section describes the power connections on the RSio block. There are two.

Table 2. Mini Power Connections

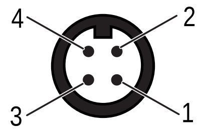
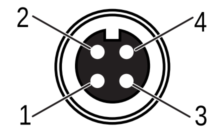
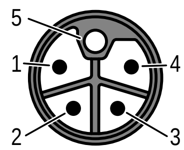
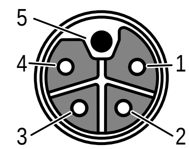
Pin	Description	Pinout	
1	Output +24 V DC power	*Figure 19. Male* 	*Figure 20. Female* 
2	Input +24 V DC power		
3	Input power, common		
4	Output power, common		

Table 3. L-Code M12 Connections

Pin	Description	Pinout	
1	Input +24 V DC power	*Figure 21. Male* 	*Figure 22. Female* 
2	Output power, common		
3	Input power, common		
4	Output +24 V DC power		
5	Functional ground		

The RSio block requires two 24 V DC power supplies. These power supplies are called the "input +24 V DC power" and the "output +24 V DC power".

The input +24 V DC power provides power for the:
- Block control
- Ethernet portions of the block
- Safety inputs/test outputs circuits
- Test output loads

The output +24 V DC power provides power for the:
- Safety output circuits
- Safety output loads

Internally, the input +24 V DC power and output +24 V DC power are isolated from each other.

> **NOTE:** The power supplies for input power and output power must be isolated from each other; the zero-volt reference must be the same.

Power Pass-Through: The power that the RSio block requires is supplied via the male connector. The female connector is provided so that power can be passed from block to block (daisy chained).

> **IMPORTANT:** The maximum current that any pin on the power connector can carry is 10 A.

The input current to a block is roughly equal to the current required to operate the block (with no test output load current), plus the load currents on the various test outputs, plus the total input side current being supplied out of the female power connector (input power current to the input side of blocks that are daisy chained from the given block).

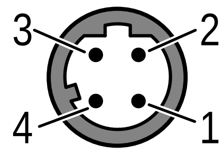
The output current to a block is roughly equal to the current required to operate the output side of the block (with no safety output load current), total current loads on the safety outputs, total sensor load current (loads on pin 1s of the safety outputs powering an active device), and total output side current being supplied out of the female power connector (input power current to the output side of blocks that are daisy chained from the given block).

> **NOTE:** This equipment and all connected I/O must be powered from a power supply compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV) requirements.

5.3.2 Network Connections

This section describes the network connections on the RSio block. There are two.

Table 4. Network: D-Code M12 Connection

Pin	Description	Pinout
1	Tx+	*Figure 23. Male* 
2	Rx+	
3	Tx-	
4	Rx-	

5.3.3 Input and Output Port Connections

This section describes the I/O connectors on the RSio block. There are eight.

Table 5. Input: A-Code M12 Connection

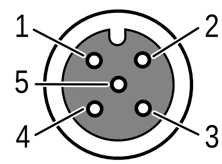
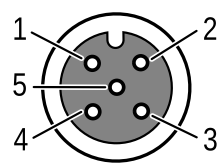
Pin	Contact Input Port	Active PNP Input Port	Pinout
1	Test Out n + 1	+24 V DC	*Figure 24. Female* 
2	Input n + 1	Input n + 1	
3	Input Common	Input Common	
4	Input n	Input n	
5	Test out n	Not used/Status Input	

Table 6. Output: A-Code M12 Connection

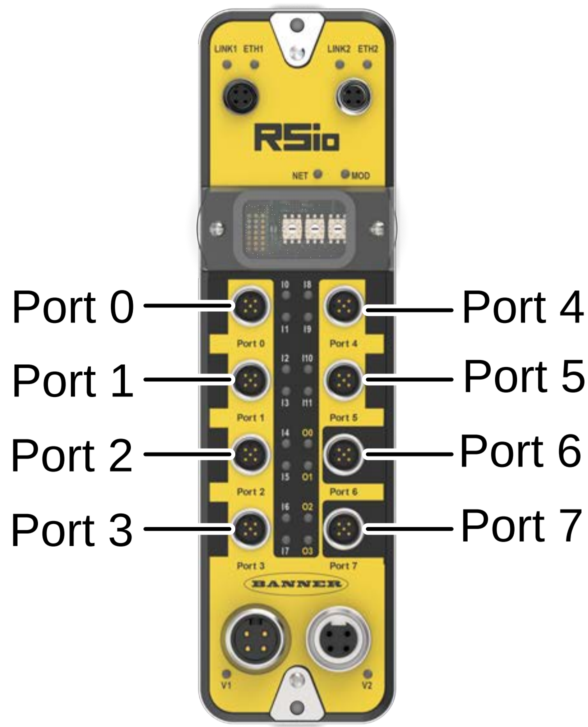
Pin	Output Port	Pinout
1	Output +24 V DC Power	*Figure 25. Female* 
2	OSSD n+1	
3	Output Power Common	
4	OSSD n	
5	Output Power Common	

"n" is an even number such as 0, 2, 4, etc.

NOTE: Pin 3 Input Common (also pin 5 on the output ports) should be used only as a return path for power supplied by the RSio block. If it becomes a second return path to the power supply, the return current could exceed the 2A limit of the M12 pins.

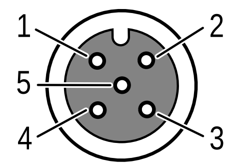
Table 7. RSio Block Terminal Position

Terminal	RSIO-MA4-6S12SO-C / RSIO-L5-6S12SO-C	
Port 0-1	Test out 1	
Port 0-2	Safety input 1	
Port 0-3	Input common	
Port 0-4	Safety input 0	
Port 0-5	Test out 0	
Port 1-1	Test out 3	
Port 1-2	Safety input 3	
Port 1-3	Input common	
Port 1-4	Safety input 2	
Port 1-5	Test out 2	
Port 2-1	Test out 5	
Port 2-2	Safety input 5	
Port 2-3	Input common	
Port 2-4	Safety Input 4	
Port 2-5	Test out 4	
Port 3-1	Test out 7	
Port 3-2	Safety input 7	
Port 3-3	Input common	
Port 3-4	Safety input 6	
Port 3-5	Test out 6	
Port 4-1	Test out 9	
Port 4-2	Safety input 9	
Port 4-3	Input common	
Port 4-4	Safety input 8	
Port 4-5	Test out 8	
Port 5-1	Test out 11	
Port 5-2	Safety input 11	
Port 5-3	Input common	
Port 5-4	Safety input 10	
Port 5-5	Test out 10	
Port 6-1	Output +24 V DC Power	
Port 6-2	Safety output 1 (OSSD)	
Port 6-3	Output power common	
Port 6-4	Safety output 0 (OSSD)	
Port 6-5	Output power common	
Port 7-1	Output +24 V DC Power	
Port 7-2	Safety output 3 (OSSD)	
Port 7-3	Output power common	
Port 7-4	Safety output 2 (OSSD)	
Port 7-5	Output power common	



5.4 Wiring Examples

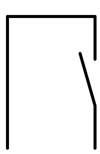
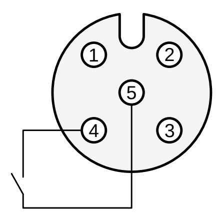
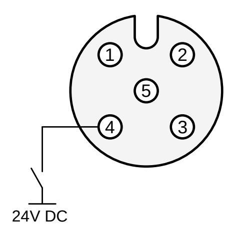
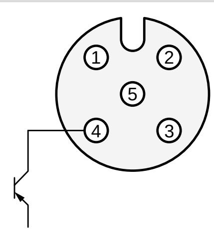
The schematic diagrams in this section use the following 5-pin assignments.

Pin	Description	Pinout (Female)
1	Test Output 1 (TP1) or +24 V DC	
2	Input 1 (IN1)	
3	Input Common	
4	Input 0 (IN0)	
5	Test Output 0 (TP0)	

5.4.1 Single-Channel Input: 1- and 2-Terminal

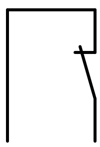
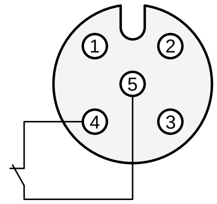
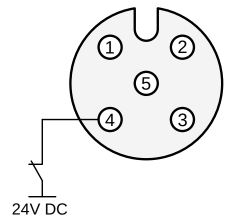
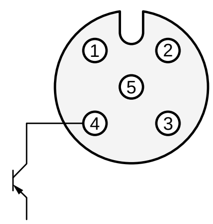
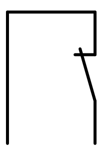
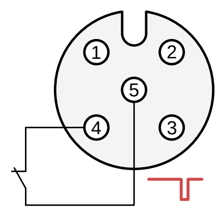
NOTE: The Port Preset column refers to configuration selections options explained in Input Port Presets.

Table 8. Single-Channel Non-Safety Input: 1- and 2-Terminal

Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	No	Connect contact between TP0 (TP1) to IN0 (IN1), TP0 (TP1) configured for 24 V power only		2	C	1[14]
	No	Connect contact between 24 V and IN0 (IN1)		2	C	1[14]
	No	Connect PNP output to IN0 (IN1)		2	C	1[14]

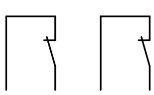
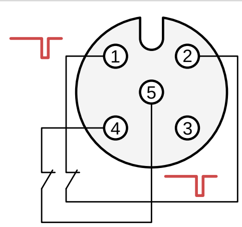
[14] Preset 1 allows the addition of two single-channel inputs per port.

Table 9. Single-Channel Safety Input: 1- and 2-Terminal

Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	No	Connect contact between TP0 (TP1) to IN0 (IN1), TP0 (TP1) configured for 24 V power only		2	C	1[15]
24V 	No	Connect contact between 24 V and IN0 (IN1)		2	C	1[15]
	No	Connect PNP output to IN0 (IN1)		2	C	1[15]
	Yes	Connect contact between TP0 (TP1) to IN0 (IN1)		2	C	2[15]

5.4.2 Dual-Channel Input: 2-, 3-, and 4-Terminal

Table 10. Dual-Channel Input: 2-, 3-, and 4-Terminal

Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	Yes	Connect contacts between TP0 and IN0, and TP1 and IN1		4	E	3

Continued on page 50

[15] Presets 1 and 2 allow the addition of two single-channel inputs per port.

Continued from page 49

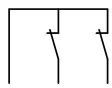
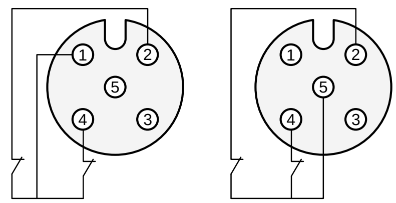
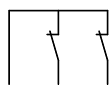
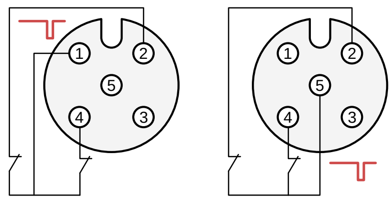
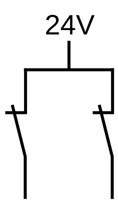
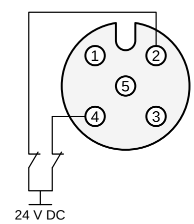
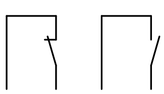
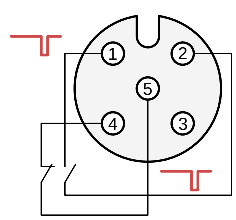
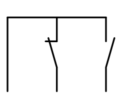
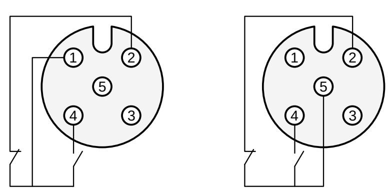
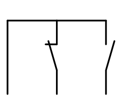
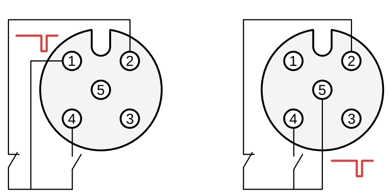
Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	No	Connect contacts between TP0 (or TP1) and IN0 and IN1, TP0 (or TP1) is configured for 24 V power supply		3	D	15
	Yes	Connect contacts between TP0 (or TP1) and IN0 and IN1		3	D	15
	No	Connect contacts between 24V and IN0 and IN1		3	D	15

Table 11. Complementary Contact Inputs: 2-, 3-, 4-, and 5-Terminal

Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	Yes	Connect contacts between TP0 and IN0, and TP1 and IN1		4	E	4
	No	Connect contacts between TP0 (or TP1) and IN0 and IN1, TP0 (or TP1) is configured for 24 V power supply		4	E	15
	Yes	Connect contacts between TP0 (or TP1) and IN0 and IN1		4	E	15

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Continued from page 50

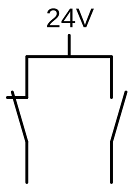
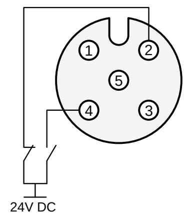
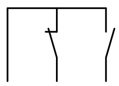
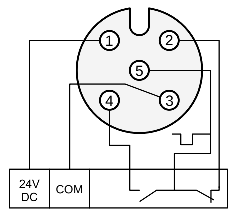
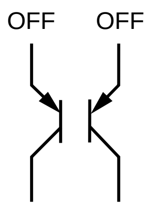
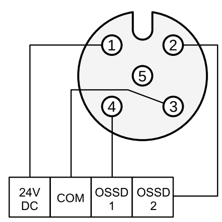
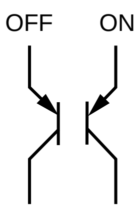
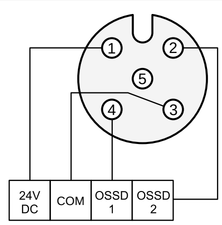
Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	No	Connect contacts between 24 V and IN0 and IN1		3	D	15
	Yes	Connect contacts between TP0 and IN0 (NO) and IN1 (NC) with TP0 set to Test Pulse. TP1 is configured for 24 V power supply.		4	E	10

Table 12. Solid State Inputs

Input Circuit	Test Pulsed	Connection	Schematic Diagram	Safety Category	Maximum Performance Level	Port Preset
	No	Connect OSSD1 to IN0, OSSD2 to IN1, TP1 is configured for 24 V power supply		4	E	5
	No	Connect OSSD1 to IN0, OSSD2 to IN1, TP1 is configured for 24 V power supply		4	E	6

> **NOTE:** It is the responsibility of the solid-state outputs (OSSDs) of the input device to have the ability to detect external shorts to power, to ground, or to each other. The input device must lockout if such a short is detected. The RSio block will not detect such shorts for OSSD input configurations. (This is also true for single channel devices wired into an input port configured for OSSD inputs.)

5.4.3 Wiring Examples for Specific Applications

The following sections provide examples of typical wiring scenarios.

Dual-Channel Emergency Stop Switch with Manual Reset

Pin	Description: E-stop Switch (port 0)	Description: Reset Switch (port 1)
1	Test Output 1	Test Output 3
2	Input 1	Input 3

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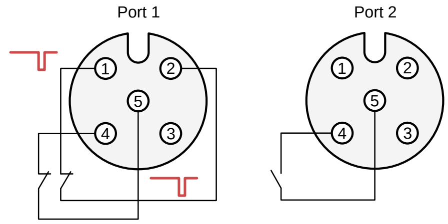
Pin	Description: E-stop Switch (port 0)	Description: Reset Switch (port 1)
3	Input Common	Input Common
4	Input 0	Input 2
5	Test Output 0	Test Output 2

Figure 26. Dual-Channel Emergency Stop Switch with Manual Reset



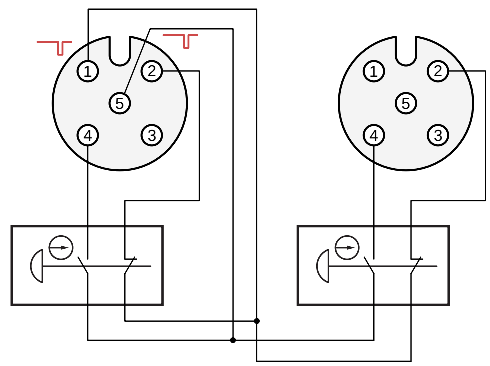
This example shows wiring and block configuration when using the RSio block. If used in combination with an appropriate program in a safety PLC, the wiring is Safety Category 4, PL e in accordance with ISO 13849-1 wiring requirements.

RSio Configuration	Parameter Name	Configuration Setting
Safety Input 0	Safety Input 0 Channel Mode	Test Pulse from Test Output
	Safety Input 0 Test Source	Test Output 0
	Dual-channel Safety Input 0/1 Mode	Dual-channel Equivalent
	Dual-channel Safety Input 0/1 Discrepancy Time	3000 ms (application dependent)
Safety Input 1	Safety Input 1 Channel Mode	Test Pulse from Test Output
	Safety Input 1 Test Source	Test Output 1
Safety Input 2	Safety Input 2 Channel Mode	Used as standard input
	Safety Input 2 Test Source	Not used
	Dual-channel Safety Input 2/3 Mode	Single Channel
Test Output 0	Test Output 0 Mode	Pulse Test Output
Test Output 1	Test Output 1 Mode	Pulse Test Output
Test Output 2	Test Output 2 Mode	Power Supply Output

Two-Hand Control Monitoring

Pin	Description: Switch 1 (port 0)	Description: Switch 2 (port 1)
1	Test Output 1	Test Output 3
2	Input 1	Input 3
3	Input Common	Input Common
4	Input 0	Input 2
5	Test Output 0	Test Output 2

Figure 27. Two-Hand Control Monitoring



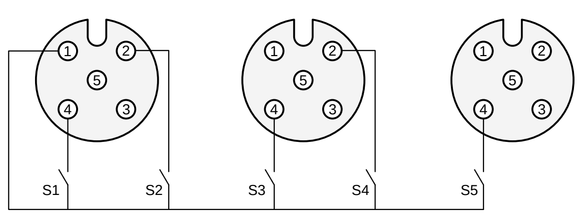
This example shows wiring and block configuration when using the RSio block. If used in combination with an appropriate program in a safety PLC, the wiring is Safety Category 4, PL e in accordance with ISO 13849-1 wiring requirements.

RSio Configuration	Parameter Name	Configuration Setting
Safety Input 0	Safety Input 0 Channel Mode	Test Pulse from Test Output
	Safety Input 0 Test Source	Test Output 0
	Dual Channel Safety Input 0/1 Mode	Dual-Channel Complementary
	Dual Channel Safety Input 0/1 Discrepancy Time	100 ms (application dependent)
Safety Input 1	Safety Input 1 Channel Mode	Test Pulse from Test Output
	Safety Input 1 Test Source	Test Output 1
Safety Input 2	Safety Input 2 Channel Mode	Test Pulse from Test Output
	Safety Input 2 Test Source	Test Output 0
	Dual Channel Safety Input 2/3 Mode	Dual-Channel Complementary
	Dual Channel Safety Input 2/3 Discrepancy Time	100 ms (application dependent)
Safety Input 3	Safety Input 3 Channel Mode	Test Pulse from Test Output
	Safety Input 3 Test Source	Test Output 1
Test Output 0	Test Output 0 Mode	Pulse Test Output
Test Output 1	Test Output 1 Mode	Pulse Test Output

Mode Select Switch

Pin	Description: Port 0	Description: Port 1	Description: Port 2
1	Test Output 1	Test Output 3	Test Output 5
2	Input 1	Input 3	Input 5
3	Input Common	Input Common	Input Common
4	Input 0	Input 2	Input 4
5	Test Output 0	Test Output 2	Test Output 4

Figure 28. Mode Select Switch

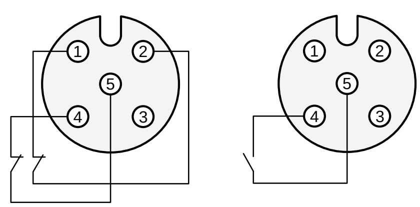


RSio Configuration	Parameter Name	Configuration Setting
Safety Input 0	Safety Input 0 Channel Mode	Safety Input
	Safety Input 0 Test Source	None
	Dual-channel Safety Input 0/1 Mode	Single Channel
Safety Input 1	Safety Input 1 Channel Mode	Safety Input
	Safety Input 1 Test Source	None
Safety Input 2	Safety Input 2 Channel Mode	Safety Input
	Safety Input 2 Test Source	None
	Dual-channel Safety Input 2/3 Mode	Single Channel
Safety Input 3	Safety Input 3 Channel Mode	Safety Input
	Safety Input 3 Test Source	None
Safety Input 4	Safety Input 4 Channel Mode	Safety Input
	Safety Input 4 Test Source	None
	Dual-Channel Safety Input 4/5 Mode	Single Channel
Test Output 0	Test Output 0 Mode	Power Supply

Dual-Channel Safety Limit Switch with a Manual Reset

Pin	Description: Switch 1	Description: Switch 2
1	Test Output 1	Test Output 3
2	Input 1	Input 3
3	Input Common	Input Common
4	Input 0	Input 2
5	Test Output 0	Test Output 2

Figure 29. Dual-Channel Safety Limit Switch with a Manual Reset



This example shows wiring and block configuration when using the RSio block. If used in combination with an appropriate program in a safety PLC, the wiring is Safety Category 4, PL e in accordance with ISO 13849-1 wiring requirements.

RSio Configuration	Parameter Name	Configuration Setting
Safety Input 0	Safety Input 0 Channel Mode	Test Pulse from Test Output
	Safety Input 0 Test Source	Test Output 0
	Dual-channel Safety Input 0/1 Mode	Dual-channel Equivalent
	Dual-channel Safety Input 0/1 Discrepancy Time	3000 ms (application dependent)
Safety Input 1	Safety Input 1 Channel Mode	Test Pulse from Test Output
	Safety Input 1 Test Source	Test Output 1
Safety Input 2	Safety Input 2 Channel Mode	Used as Standard Input
	Safety Input 2 Test Source	Not Used

Continued on page 55

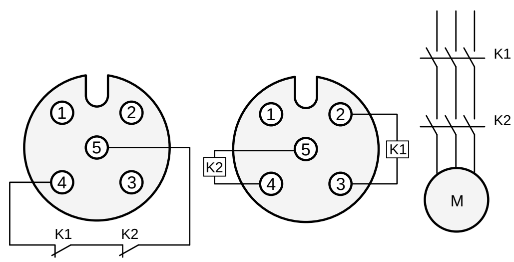
Continued from page 54

RSio Configuration	Parameter Name	Configuration Setting
	Dual-channel Safety Input 2/3 Mode	Single Channel
Test Output 0	Test Output 0 Mode	Pulse Test Output
Test Output 1	Test Output 1 Mode	Pulse Test Output
Test Output 2	Test Output 2 Mode	Power Supply Output

OSSD Outputs with an EDM Circuit

Pin	Description: Input Port	Description: Output Port
1	Test Output 1	Out 24 V DC
2	Input 1	Out 1
3	Input Common	Out Common
4	Input 0	Out 0
5	Test Output 0	Out Common

Figure 30. OSSD Outputs with an EDM Circuit



When used in combination with an appropriate program in a safety PLC, the wiring can result in a Safety Category 4, PL e circuit in accordance with ISO 13849-1 wiring requirements.

RSio Configuration	Parameter Name	Configuration Setting
Safety Input 0	Safety Input 0 Channel Mode	Test Pulse from Test Output
	Safety Input 0 Test Source	Test Output 0
	Dual-channel Safety Input 0/1 Mode	Single Channel
Test Output 0	Test Output 0 Mode	Pulse Test Output
Safety Output 0/1	Safety Output 0/1 Operation Type	Dual
Safety Output 0	Safety Output 0 Channel Mode	Safety Pulse Test
Safety Output 1	Safey Output 1 Channel Mode	Safety Pulse Test

Chapter Contents

Chapter 6 AB Studio 5000 Configuration

This section explains how to configure the Banner Banner Remote Safe I/O with an Allen Bradley PLC using Rockwell Automation's Studio 5000®(16). The images shown use version 36 of the software for illustration purposes.

WARNING:
- **T3 Qualified Configuration Tool**
- Using an unqualified configuration tool could result in a configuration that may not reflect user intentions and, as such, may not provide the level of safety that is required.
- The Rockwell Automation’s Studio 5000 is a qualified configuration tool which meets the qualification requirements for IEC 61508 T3 tools and is recommended to configure the RSio block. Alternative qualified tools that meet these requirements may be used.

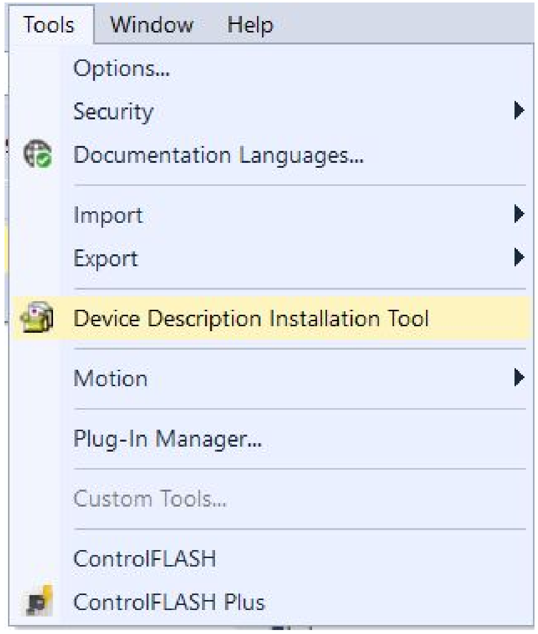
6.1 RSio EDS File Installation in Studio 5000

Use the **Device Description Installation Tool** to install the Electronic Data Sheet (EDS) file.

1. Download the EDS file for the RSio block from www.bannerengineering.com.
2. In Studio 5000®, on the **Tools** menu, click **Device Description Installation Tool**.

(16) Studio 5000® is a registered trademark of Rockwell Automation, Inc.

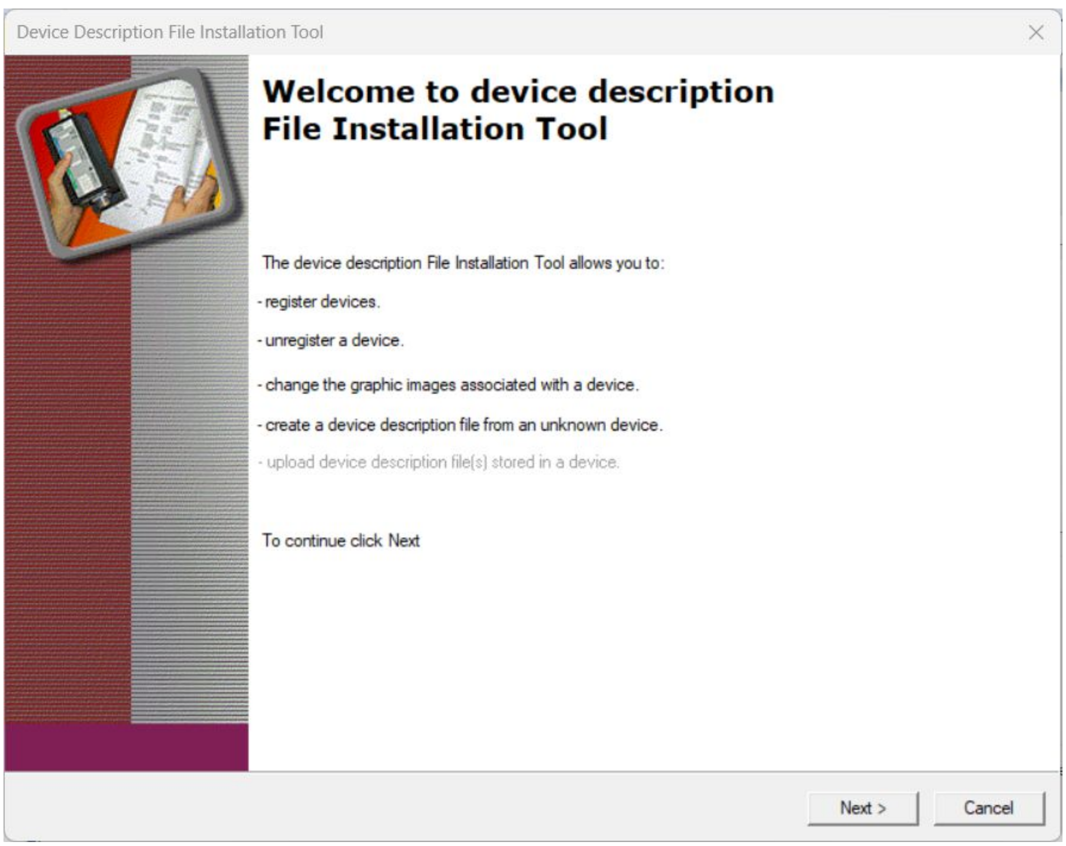
Figure 31. Select Device Description Installation Tool



NOTE: Older versions of Studio 5000 used the **EDS Hardware Installation Tool** instead.

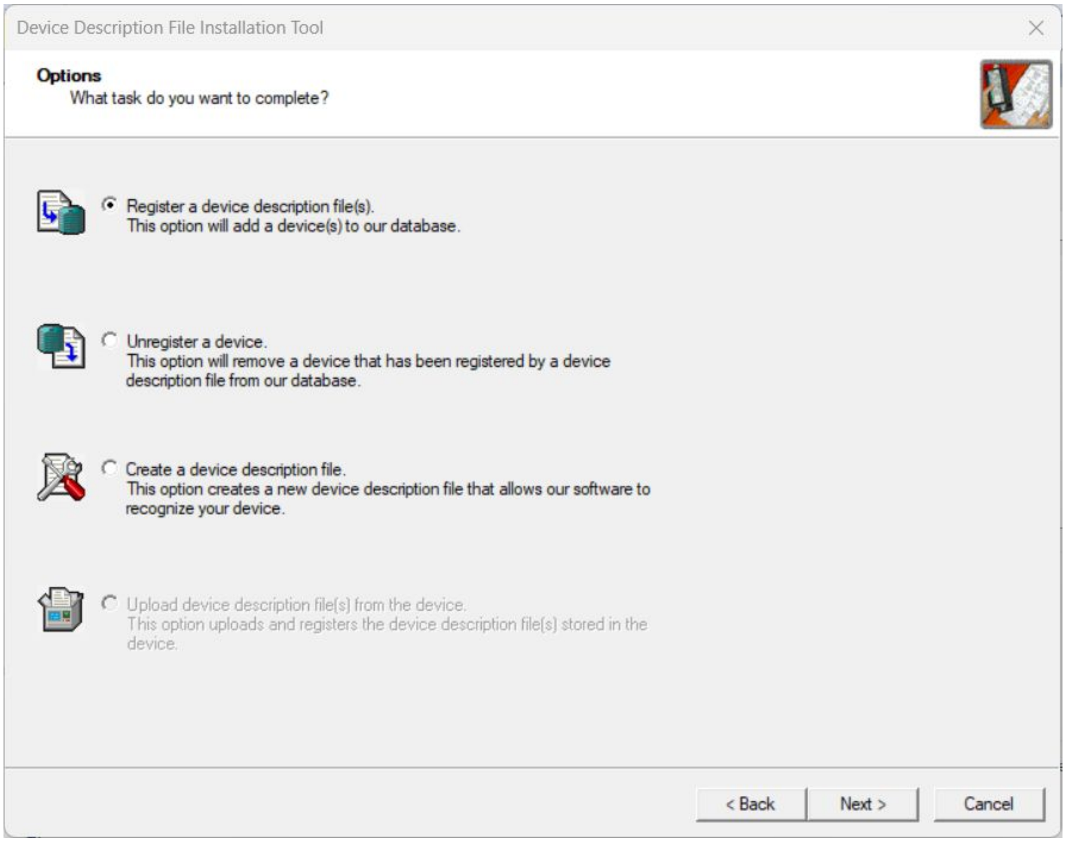
The **Device Description File Installation Tool** window opens.

Figure 32. Tools—Device Description Installation Tool



3. Click **Next**.
4. Select the **Register a device description file(s)** option.

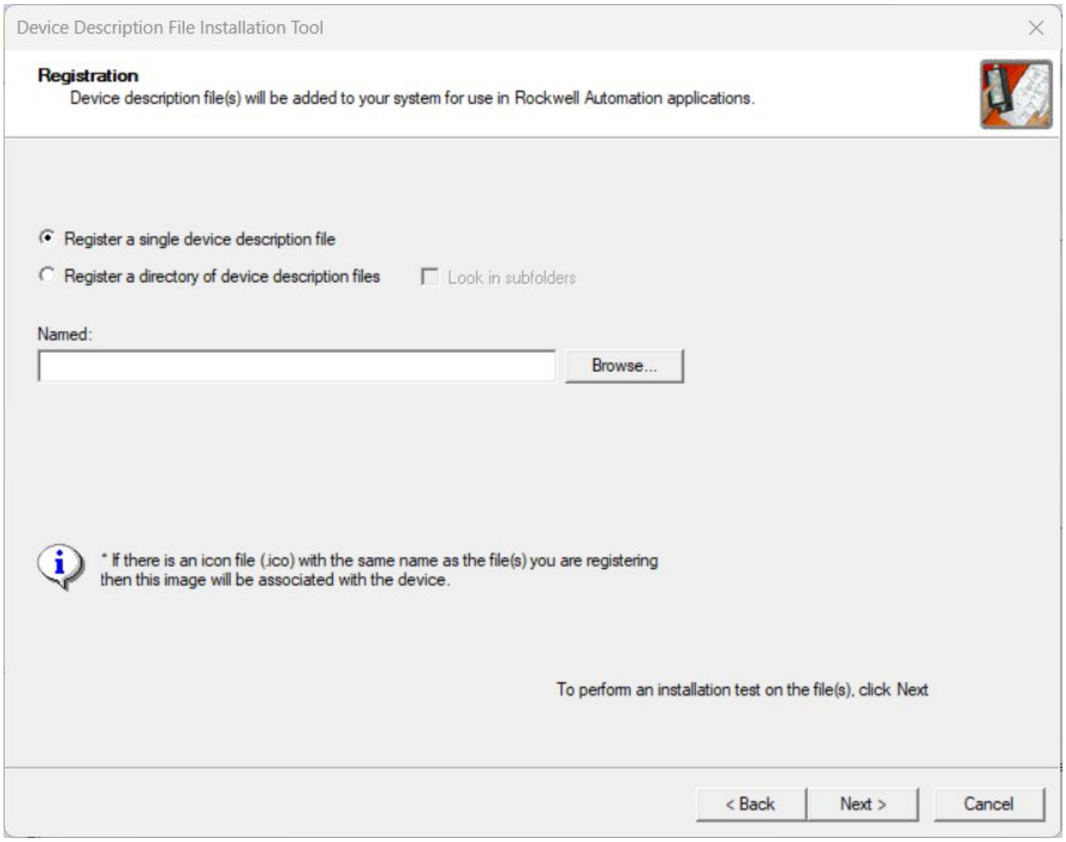
Figure 33. Device Description File Installation Tool—Options



5. Click **Next**.

   The **Registration** window opens.

Figure 34. Device Description File Installation Tool—Registration



6. Click **Browse** and navigate to the location where the EDS file is saved.
7. Select the file and click **Open**.
8. Click **Next** to register the tested file.
9. Click **Next** on the additional windows that open until the **Finish** button is available.
10. Click **Finish** to close the **Device Description File Installation Tool**.

6.2 Set the IP Address of the RSio Block

This section describes how to configure the IP address for the Banner Remote Safe I/O block.

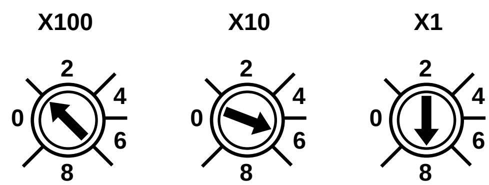
6.2.1 Set the IP Address Using the Rotary Switches

If the network uses 192.168.1.xxx as the first three octets, the rotary switches can be used to set the last (fourth) octet of the IP address. Valid octet numbers range from 001 to 254.

Use the following procedure to set the last octet using the switches.

1. Make sure power has been removed from the RSio block.
2. Remove the screws that secure the rotary switch cover, then remove the cover.
3. Use the rotary switches to set the last octet value from 001 to 254.

Figure 35. Example IP Address



This example shows the switches set to 168 (IP Address 192.168.1.168).

4. Re-install the rotary switch cover and torque the screws to 0.3 ± 0.03 Nm (2.5 ± 0.3 lb-in).
5. Apply power to the RSio block.

   The block reads the rotary switches to determine if they are set to a valid number for the last octet of the IP address (between 001 and 254).
   Valid settings result in the following:

   IP Address: 192.168.1.xxx (where xxx represents the switch settings)
   Subnet Mask: 255.255.255.0
   Gateway Address: 192.168.1.1
   Assigned host name: none
   Domain Name System: not used

> **NOTE:** The gateway address automatically changes to 0.0.0.0 if the address switches are set to 192.168.1.1.

6.2.2 Set the IP Address Using a DHCP Server

If the network does not use 192.168.1.xxx, use the following process to set the IP address.

1. Make sure power has been removed from the RSio block.
2. Remove the screws that secure the rotary switch cover, then remove the cover.
3. Set the rotary switches to 999.
4. Apply power to the RSio block.
5. Use a DHCP Server to set the IP address.

   For example:

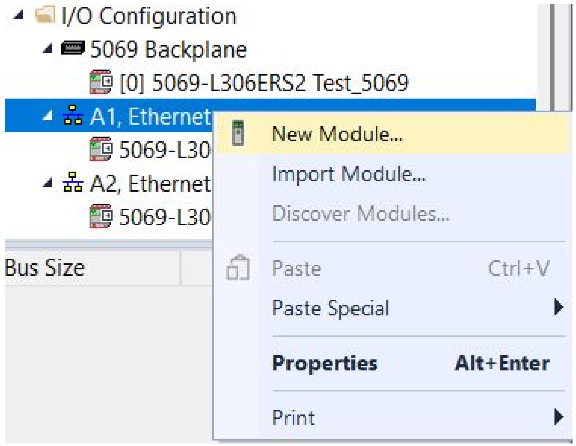
   Bootstrap Protocol/Dynamic Host Configuration Protocol (BOOTP/DHCP) server
   RS Linx Classic Software
   Studio 5000 Logix Designer application
   Other PLC software packages
6. Re-install the rotary switch cover and torque the screws to 0.3 ± 0.03 Nm (2.5 ± 0.3 lb-in).
7. Apply labels to the RSio block to identify the IP address, if desired.

6.3 Create a Connection to the RSio

1. Go to **Controller Organizer** in a Studio 5000 project and find the Ethernet connections for the PLC being used.

   This example uses a Guardlogix 5069-L306ERS2.
2. Right-click on the Ethernet port being used for the safety connection and select **New Module...**.

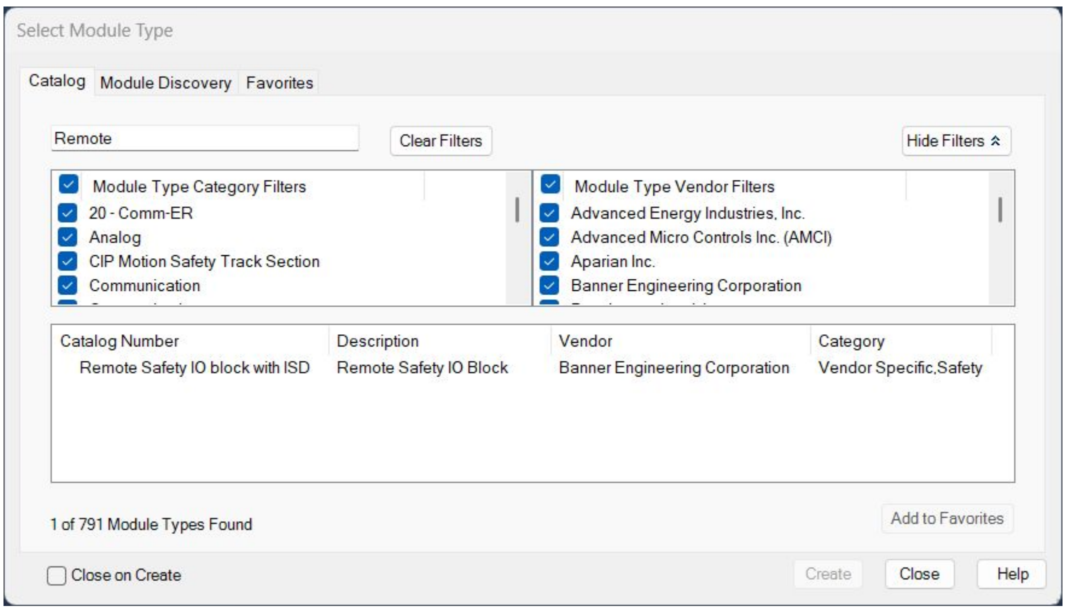
Figure 36. Select New Module



The **Select Module Type** window opens.

3. Type `Remote` or `Banner` to find the "Remote Safe I/O block with ISD".
4. Select the "Remote Safe I/O block with ISD" and click **Create**.

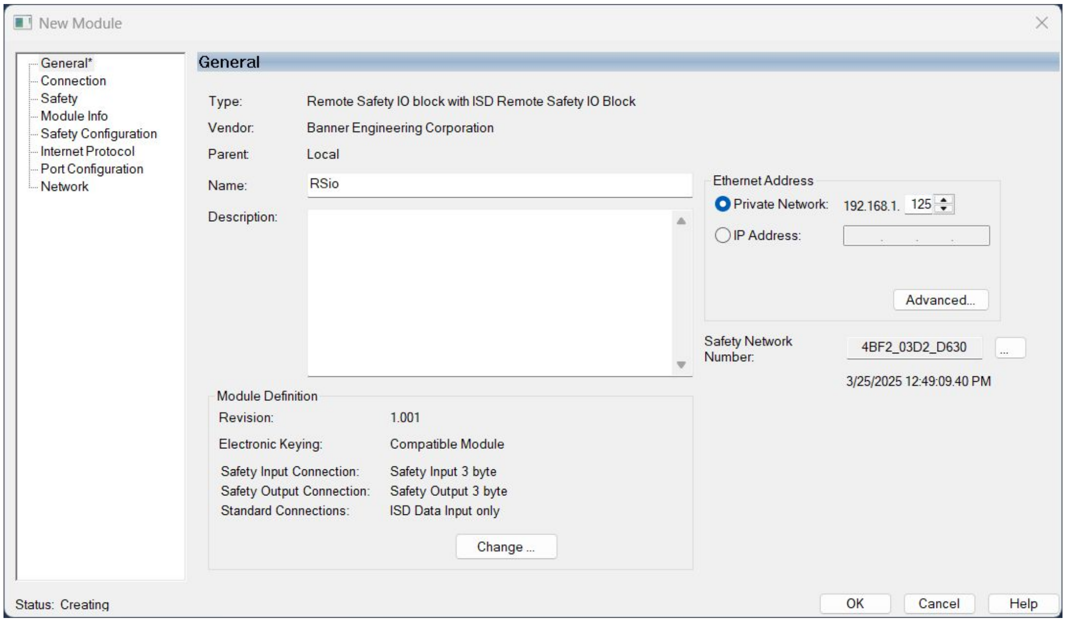
*Figure 37. **Select Module Type** Window*



The **New Module** window opens with the **General** settings as the default.

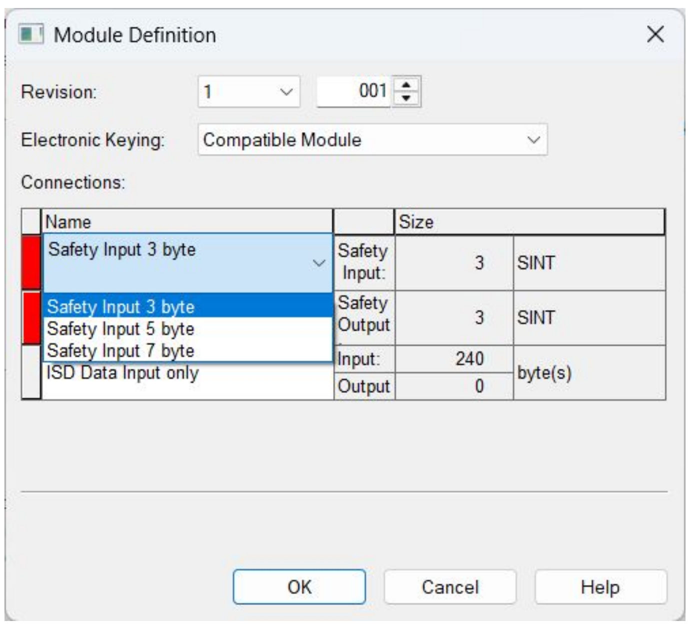
5. Enter a name, description (optional), and IP address for the device.
   This example uses `RSio` for the name and `192.168.1.125` for the IP address.

*Figure 38. **New Module** Window*



6. Click **Change** to set up the necessary data connections.
7. Select the necessary options for the system.
   a. Select one of three **Safety Input** options.

Figure 39. Module Definition—Safety Input



- **3 byte**

Table 13. Safety Input 3 Byte

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Input 7	Input 6	Input 5	Input 4	Input 3	Input 2	Input 1	Input 0
1	Input 3 Status	Input 2 Status	Input 1 Status	Input 0 Status	Input 11	Input 10	Input 9	Input 8
2	Input 11 Status	Input 10 Status	Input 9 Status	Input 8 Status	Input 7 Status	Input 6 Status	Input 5 Status	Input 4 Status

- **5 byte**

Table 14. Safety Input 5 Byte

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Input 7	Input 6	Input 5	Input 4	Input 3	Input 2	Input 1	Input 0
1	Input 3 Status	Input 2 Status	Input 1 Status	Input 0 Status	Input 11	Input 10	Input 9	Input 8
2	Input 11 Status	Input 10 Status	Input 9 Status	Input 8 Status	Input 7 Status	Input 6 Status	Input 5 Status	Input 4 Status
3	Output 3 State (readback)	Output 2 State (readback)	Output 1 State (readback)	Output 0 State (readback)	Output 3 Status	Output 2 Status	Output 1 Status	Output 0 Status
4	V1 (Input Power) Overcurrent	V2 (Output Power) Overcurrent	V1 (Input Power) Over/ Undervoltage	V2 (Output Power) Over/ Undervoltage	Overtemperature	*reserved*	*reserved*	System Fault

- **7 byte**

Table 15. Safety Input 7 Byte

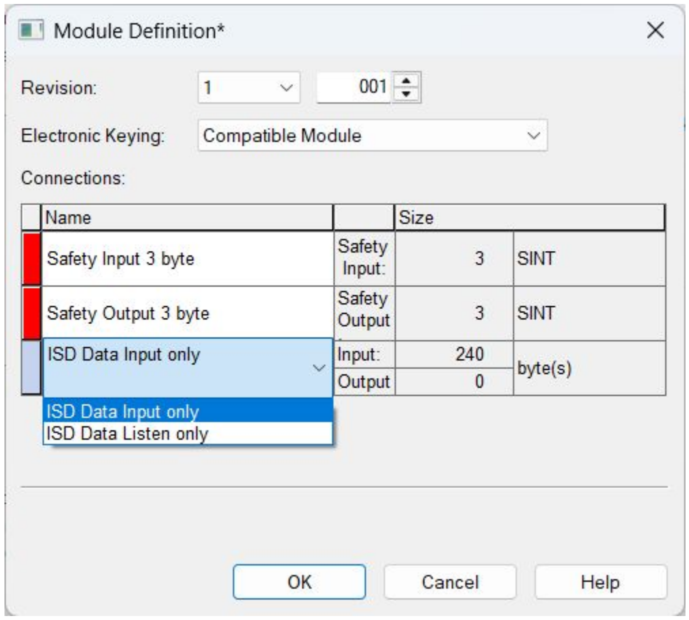
Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Input 7	Input 6	Input 5	Input 4	Input 3	Input 2	Input 1	Input 0
1	Input 3 Status	Input 2 Status	Input 1 Status	Input 0 Status	Input 11	Input 10	Input 9	Input 8
2	Input 11 Status	Input 10 Status	Input 9 Status	Input 8 Status	Input 7 Status	Input 6 Status	Input 5 Status	Input 4 Status
3	Output 3 State (readback)	Output 2 State (readback)	Output 1 State (readback)	Output 0 State (readback)	Output 3 Status	Output 2 Status	Output 1 Status	Output 0 Status
4	*reserved*	TP6 Status	*reserved*	TP4 Status	*reserved*	TP2 Status	*reserved*	TP0 Status
5	*reserved*	*reserved*	*reserved*	*reserved*	*reserved*	TP10 Status	*reserved*	TP8 Status
6	V1 (Input Power) Overcurrent	V2 (Output Power) Overcurrent	V1 (Input Power) Over/ Undervoltage	V2 (Output Power) Over/ Undervoltage	Overtemperature	*reserved*	*reserved*	System Fault

b. Select the **Safety Output** option (**3 bytes**).

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	TP3	TP2	TP1	TP0	Output 3	Output 2	Output 1	Output 0
1	TP11	TP10	TP9	TP8	TP7	TP6	TP5	TP4
2	*reserved*	*reserved*	*reserved*	*reserved*	*reserved*	*reserved*	*reserved*	*reserved*

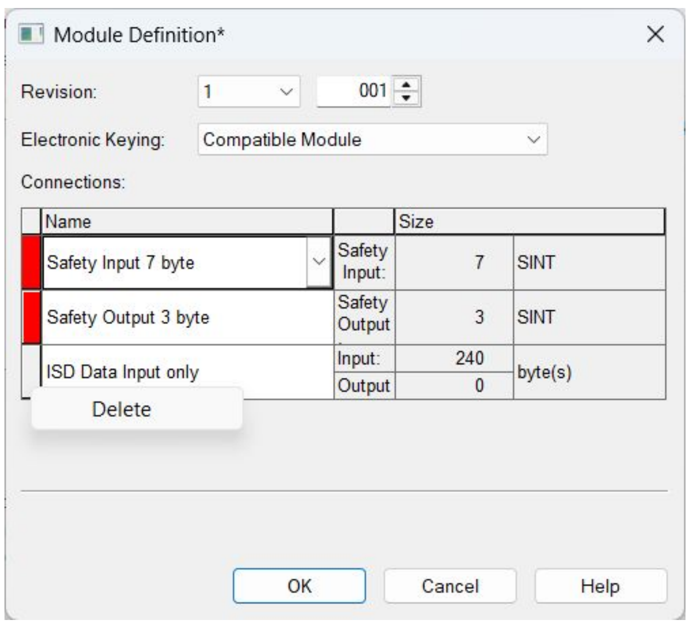
c. Select one of two **Standard Input** options.
- **ISD Data Input Only**—for the main PLC
- **ISD Data Listen Only**—for any additional PLCs

Figure 40. Module Definition—Standard Input



d. If the system is not using ISD devices, it is best practice to delete the connection.

Figure 41. Module Definition—Delete ISD Connection



8. Click **OK** to finalize any changes for the system
9. Locate the Safety Network Number (SNN).

   Safety Network Number (SNN) is a unique number used by the CIP Safety network. This ensures that the safety data is only being sent and received by the necessary devices.

   The SNN must match between the PLC and the safety device.

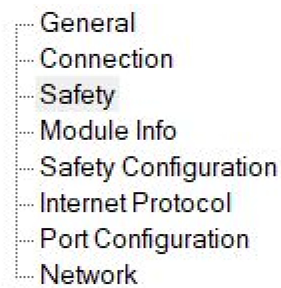
   > ⚠ **WARNING:** An “automatic” SNN setting feature should only use that feature when the safety system is not being relied upon.

10. Change the SNN to what is needed for the system by selecting the **...** to the right of the SNN value.

NOTE: Assign unique SNN numbers for each safety network or safety sub-net. They must be unique system-wide.

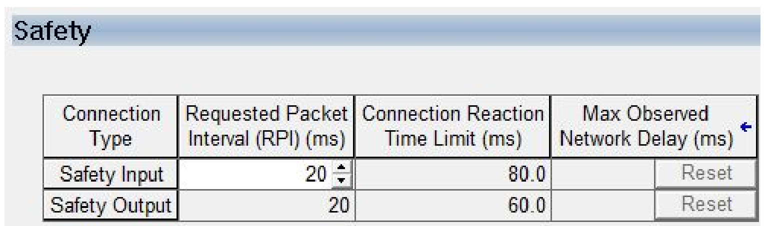
11. Click **Safety** on the **Module Definition** window.

Figure 42. Module Definition—Safety



12. Change the Safety Input Requested Packet Interval (RPI) value as needed for the system.
    The minimum value is 10 ms; the recommended value is 20 ms.

Figure 43. Safety Input RPI Value



Safety

Connection Type	Requested Packet Interval (RPI) (ms)	Connection Reaction Time Limit (ms)	Max Observed Network Delay (ms)	
Safety Input	20	80.0		Reset
Safety Output	20	60.0		Reset

Safety Output RPI is set by the Safety Task in the PLC itself.

The Safety Configuration ID (SCID) is located on this page. It is shown as the Configuration Signature. That section of Studio 5000 does not allow any modification. This is due to how the EDS is used for the CIP Safety EIP connection. When changes that require an updated SCID are needed, Studio 5000 changes the SCID as necessary.

SCID is an ID number specific to a configuration for a CIP Safety Device.

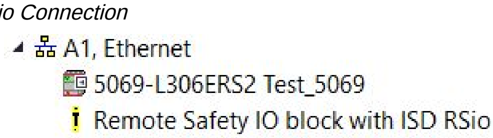
It is used to ensure no changes to the RSio block have been made. If the value in the RSio block and the PLC do not match, the CIP Safety EIP connection is rejected.

NOTE: Consider the signature “verified” (and configuration locked) only after user testing.

NOTE: Configuring an originator with connection data and/or target configuration data must be downloaded to the target so it can be tested and verified. Only then can SCIDs from the target be confirmed.

13. Click **OK** to finish creating the connection to the RSio block.
    There is a connection to the RSio block in **Control Organizer**.

Figure 44. Control Organizer—RSio Connection



6.4 Label the RSio Data

The EDS file does not supply labeling for the data of the Banner Remote Safe I/O block. There are two options to label the data.

Option 1: Manually Labeling

Manually label the data using the following tables:

- "Safety Input 3 Byte" on page 62
- "Safety Input 5 Byte" on page 63
- "Safety Input 7 Byte" on page 63

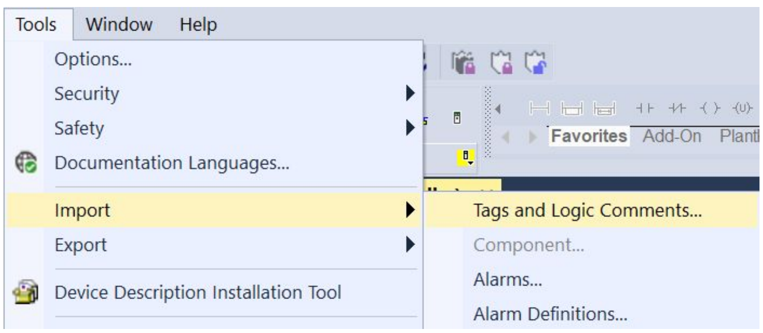
Label the data in the description column in the Controller Tags for the PLC.

Option 2: Tag Import

Use the Tag Import feature in Studio 5000 to import the data labels.

1. Download the RSio PLC support files from www.bannerengineering.com.
2. If a connection to the RSio block has not been established, follow the instructions in "Create a Connection to the RSio" on page 60.
3. Set the name of the RSio block connection to `RSio`. Make note of the original name; this will be a temporary name change.
4. Go to **Tools › Import** and select **Tags and Logic Comments**.

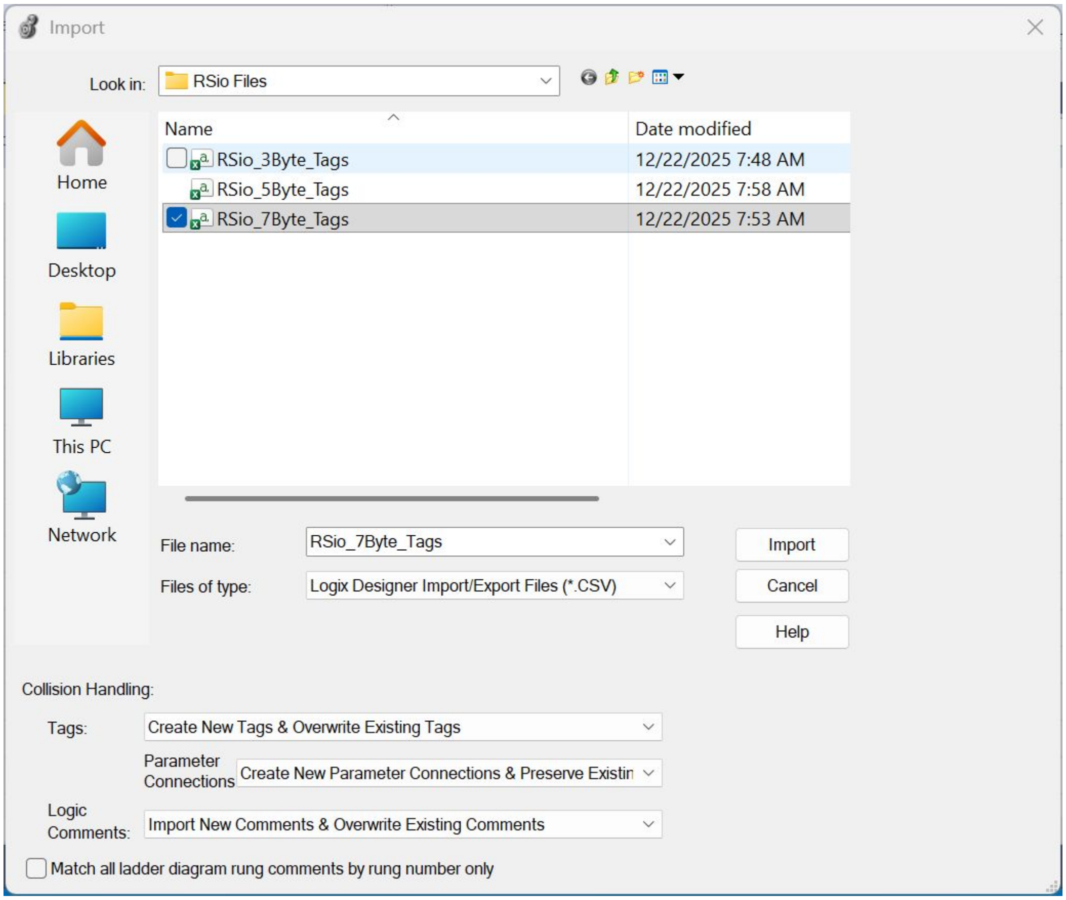
*Figure 45. Select **Tags and Logic Comments** Option*



The **Tags and Logic Comments Import** window opens.

5. Navigate to the location where the RSio PLC support files are saved (from step 1).
6. Select the 3-, 5-, or 7-byte file.
This file corresponds to the Safety Input option selected in "Create a Connection to the RSio" on page 60.

*Figure 46. **Import** Window*



7. Click **Import** to begin the import process.
   Labels are added in the Description column in Controller Tags for the RSio block connection.

*Figure 47. **Controller Tags***

Name	Value	Style	Data Type	Description
RSio:I	{...}		_000C:RemoteSafetyIO...	ISD Data
RSio:SI	{...}		_000C:RemoteSafetyIO...	
RSio:SI.ConnectionFaulted	0	Decimal	BOOL	
RSio:SI.Data	{...}	Decimal	SINT[7]	
RSio:SI.Data[0]	0	Decimal	SINT	
RSio:SI.Data[0].0	0	Decimal	BOOL	Port 0 In0
RSio:SI.Data[0].1	0	Decimal	BOOL	Port 0 In1
RSio:SI.Data[0].2	0	Decimal	BOOL	Port 1 In2
RSio:SI.Data[0].3	0	Decimal	BOOL	Port 1 In3
RSio:SI.Data[0].4	0	Decimal	BOOL	Port 2 In4
RSio:SI.Data[0].5	0	Decimal	BOOL	Port 2 In5
RSio:SI.Data[0].6	0	Decimal	BOOL	Port 3 In6
RSio:SI.Data[0].7	0	Decimal	BOOL	Port 3 In7

8. Set the name of the RSio block connection back to the original name (noted in step 2).
9. Repeat this process for all RSio block connections.

6.5 Configure the RSio Block

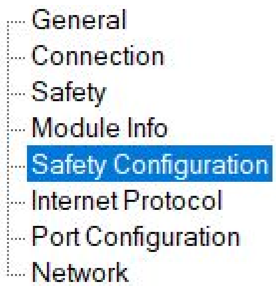
The following instructions use Studio 5000®[17]

1. In Studio 5000, select the **Properties** option for the RSio block.

   The **Module Properties** window opens.
2. Click **Safety Configuration** on the **Module Definition** window.

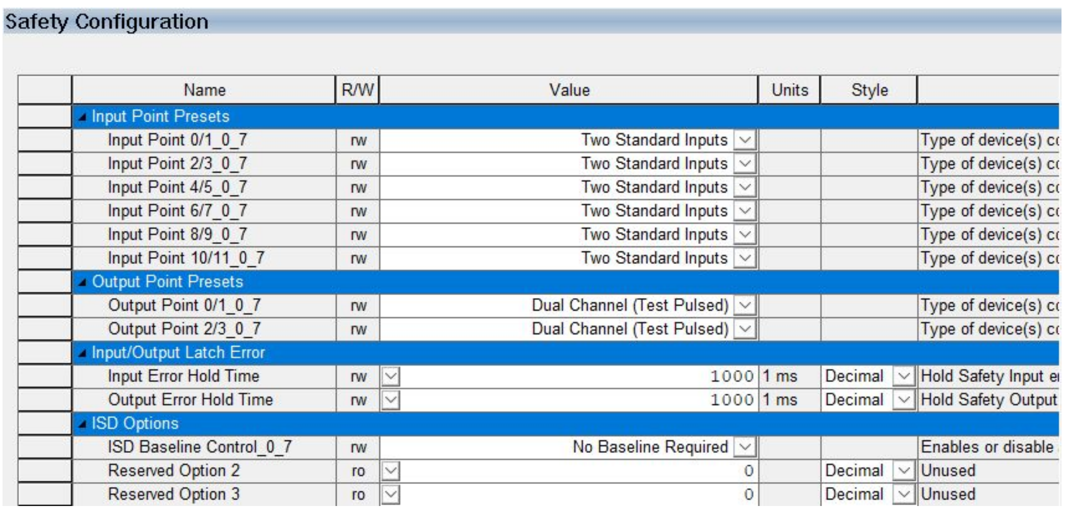
   This location allows for setting up each port on the RSio block.

   Figure 48. Module Definition—Safety Configuration

   The **Safety Configuration** settings open.

   Figure 49. Safety Configuration Presets

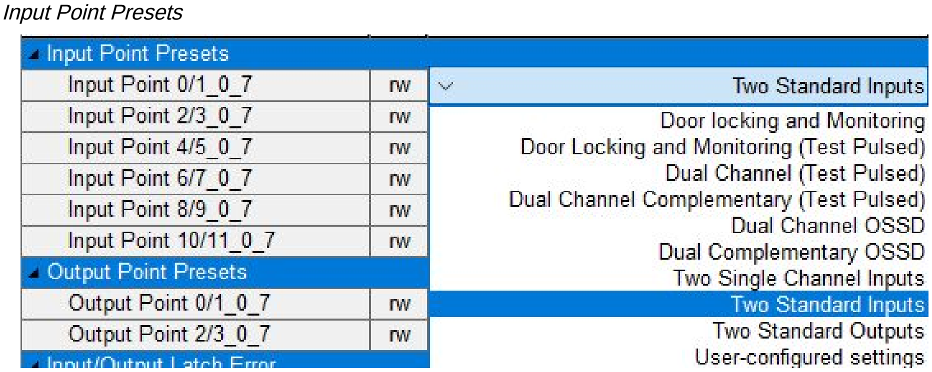
   Safety Configuration

	Name	R/W	Value	Units	Style	
	Input Point Presets					
	Input Point 0/1_0_7	rw	Two Standard Inputs			Type of device(s) cc
	Input Point 2/3_0_7	rw	Two Standard Inputs			Type of device(s) cc
	Input Point 4/5_0_7	rw	Two Standard Inputs			Type of device(s) cc
	Input Point 6/7_0_7	rw	Two Standard Inputs			Type of device(s) cc
	Input Point 8/9_0_7	rw	Two Standard Inputs			Type of device(s) cc
	Input Point 10/11_0_7	rw	Two Standard Inputs			Type of device(s) cc
	Output Point Presets					
	Output Point 0/1_0_7	rw	Dual Channel (Test Pulsed)			Type of device(s) cc
	Output Point 2/3_0_7	rw	Dual Channel (Test Pulsed)			Type of device(s) cc
	Input/Output Latch Error					
	Input Error Hold Time	rw	1000	1 ms	Decimal	Hold Safety Input er
	Output Error Hold Time	rw	1000	1 ms	Decimal	Hold Safety Output
	ISD Options					
	ISD Baseline Control_0_7	rw	No Baseline Required			Enables or disable
	Reserved Option 2	ro	0		Decimal	Unused
	Reserved Option 3	ro	0		Decimal	Unused

3. Set the Input Point Presets.

   For information on the presets, see Input Port Presets.

   Figure 50. Input Point Presets

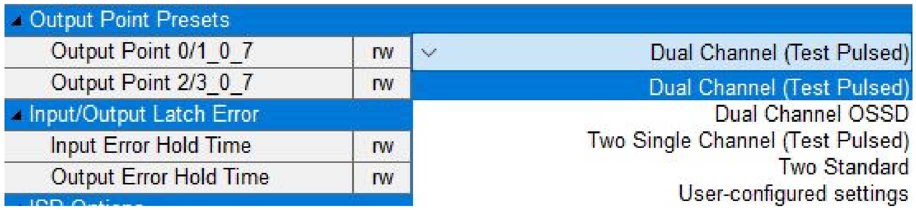
   

4. Set the Output Point Presets.

   For information on the presets, see Output Port Presets.

[17] Studio 5000® is a registered trademark of Rockwell Automation, Inc.

Figure 51. Output Point Presets



5. Set up each port as needed for the system.
6. Click **OK** to save the port setup.

6.6 Use Port Presets to Configure Block Inputs and Outputs

If the Banner EDS file is loaded into the Studio 5000 software, the following presets can be selected to configure each input or output port on the **Module Properties** window **Safety Configuration** tab.

6.6.1 Input Port Presets

The following is a brief description of each input port preset.

The detailed information about each input port preset follows after the table. The option numbers are used only for reference between the table and the descriptions, and also with the wiring examples.

Table 16. Inputs

Option	
1	Two Standard Inputs (default)
2	Two Single-Channel Inputs
3	Dual-Channel (Test Pulsed)
4	Dual-Channel Complementary (Test Pulsed)
5	Dual-Channel OSSD
6	Dual-Channel Complementary OSSD
7	Door Locking and Monitoring
8	Door Locking and Monitoring (Test Pulsed)
9	Two Standard Outputs
10	Dual-Channel Complementary (Single Test Pulsed)
15	User-Configured Settings

NOTE: The PLC software lists the presets in alphabetical order.

Option 1: Two Standard Inputs (default)

Two times single-channel inputs with the test outputs (TPs) set to Power Supply can be used with:

- Any input from "Single-Channel Non-Safety Input: 1- and 2-Terminal" on page 48
- Any of the first three single-channel inputs from "Single-Channel Safety Input: 1- and 2-Terminal" on page 49

Use the links to see wiring and pinout information.

The inputs (INs) look for a 24 V signal for ON or a 0 V signal for OFF. The inputs are not monitoring for test pulses; thus, no short testing/detection is performed. The TPs could be supplying power through a contact to be returned to the input, or the odd TP could be supplying power to an active sensor (with common on pin 3).

This preset can be used to add any non-safety single channel input; for example, reset, mute enable, part in place sensor, or any other switch or sensor input. It can also be used for a single-channel safety input.

Option 2: Two Single-Channel Inputs

Two times single-channel inputs with test outputs (TPs) set to Safety Test Pulse can be used with the fourth single-channel input circuit from "Single-Channel Safety Input: 1- and 2-Terminal" on page 49. Use the link to see wiring and pinout information.

When the input (IN) is receiving a 24 V signal, it monitors for the correct test pulse sequence. Thus, each input is checking for wiring shorts to power or wiring errors to the wrong test output.

Option 2 can be used to monitor one or two single-channel contact safety inputs. It can also be used to power an active sensor with a contact output. In the latter case, the even TP would power the unit, while the odd TP would supply power and pulses to the contact to be monitored by the odd IN.

This preset can be used to add any single-channel safety input; for example, E-stop, mechanical gate switch, etc. It can also be used for a non-safety input device.

Option 3: Dual-Channel (Test Pulsed)

Dual-channel (equivalent contact) inputs with test outputs (TPs) set to Safety Test Pulse can be used with the first dual-channel input circuit from "Dual-Channel Input: 2-, 3-, and 4-Terminal" on page 49. Use the link to see wiring and pinout information.

When the inputs (INs) are receiving a 24 V signal, they monitor for the correct test pulse sequence. Thus, each input is checking for wiring shorts to power or wiring errors to the wrong test point output.

The input port will ensure that the two contacts maintain the same states within the set discrepancy time. Either both open or both closed are acceptable states. When one contact changes state, the port monitors that the other contact changes to match that state within the set discrepancy time. If this does not happen, both inputs will be set to OFF because a fault has occurred.

This preset can be used with any two normally closed contact input devices; for example, emergency stop buttons, mechanical door switches, relay module inputs, etc.

Option 4: Dual-Channel Complementary (Test Pulsed)

Dual-Channel complementary contact inputs with test outputs (TPs) set to Safety Test Pulse can be used with the first dual-channel input circuit from "Complementary Contact Inputs: 2-, 3-, 4-, and 5-Terminal" on page 50. Use the link to see wiring and pinout information.

When the inputs (INs) are receiving a 24 V signal, they monitor for the correct test pulse sequence. Thus, each input is checking for wiring shorts to power or wiring errors to the wrong test output.

The input port will ensure that the two contacts maintain their complementary states within the set discrepancy time. One input must be open while the other input must be closed for an acceptable state. When one contact changes state, the port monitors that the other contact changes state within the set discrepancy time. If this does not happen, both inputs will be set to OFF because a fault has occurred.

This preset can be used with any one normally closed/one normally open contact input device; for example, emergency stop buttons, mechanical door switches, mechanical button input to two-hand control, etc.

Option 5: Dual-Channel OSSD

Dual (equivalent) OSSD input with the odd test output (pin 1) set to Power Supply and the even test output (pin 5) set to Not Used can be used with the first dual-channel input circuit from "Solid State Inputs" on page 51. Use the link to see wiring and pinout information.

The odd test output (pin 1) supplies 24 volts with 2 amps of current to power the active device. The inputs are set to receive OSSD signals, so they only monitor for 24 V or not. The RSio block inputs expect the input device's outputs to perform short testing with their own test pulses.

The input port will ensure that the two OSSD outputs maintain their equivalent state within the set discrepancy time.

When Option 5 is selected, the inputs monitor for ISD signals. If ISD information is detected on the inputs, the port performs an autodetect function to assess the ISD chain's number and order of devices. It then passes this information on to the PLC over the non-safe Ethernet IP connection. For more information, see "ISD Inputs" on page 32.

Pin 5, the even test output, must be set to Not Used so that it can act as an input. This way it can be used to monitor signals such as the weak signal output of a Banner S4B.

This preset can be used with any active OSSD or PNP output device; for example, light curtains, laser scanners, RFID sensors, etc.

Option 6: Dual-Channel Complementary OSSD

Dual-channel complementary OSSD input with the odd test output (pin 1) set to Power Supply and the even test output (pin 5) set to Not Used can be used with the second dual-channel input circuit from "Solid State Inputs" on page 51. Use the link to see wiring and pinout information.

The odd test output (pin 1) supplies 24 volts with 2 amps of current to power the active device. The inputs are set to receive OSSD signals, so they only monitor for 24 V or not. The RSio block inputs expect the input device's outputs to perform short testing with their own test pulses.

The input port will ensure that the two OSSD outputs maintain their complementary state within the set discrepancy time.

This preset can be used with any active device with complementary OSSD or PNP outputs; for example, Banner's STBVP touch buttons.

Option 7: Door Locking and Monitoring

Door (solenoid) Lock with the odd test output (pin 1) set to Standard and the even test output (pin 5) set to Power Supply can be used to control a locking solenoid switch while monitoring an individual contact.

The PLC can control the odd test output (pin 1) which can supply 24 volts with 2 amps of current to lock/unlock the solenoid of a locking interlock switch(es), with the return line going either to the odd input terminal (pin 2) or pin 3 (DC common).

The even test output (pin 5) and even input terminal (pin 4) can be used to monitor a contact, such as an actuator contact, to signify that the door has been closed and can be locked. No short detection would be performed on this input.

This preset can be used with any locking-style interlock switch.

Option 8: Door Locking and Monitoring (Test Pulsed)

Door (solenoid) Lock with the odd test output (pin 1) set to Standard and the even test output (pin 5) set to Test Pulse can be used to control a locking solenoid switch while monitoring an individual contact.

The PLC can control the odd test output (pin 1) which can supply 24 volts with 2 amps of current to lock/unlock the solenoid of a locking interlock switch(es), with the return line going either to the odd input terminal (pin 2) or pin 3 (DC common).

The even test output (pin 5) and even input terminal (pin 4) can be used to monitor a contact, such as an actuator contact, to signify that the door has been closed and can be locked. When the input (IN) is receiving a 24 V signal, it will monitor for the correct test pulse sequence. Thus, the input is checking for wiring shorts to power or wiring errors to the wrong test output.

This preset can be used with any locking-style interlock switch.

Option 9: Two Standard Outputs

Two standard outputs can be used to configure an input port to act as a couple of hard-wired status outputs. The test outputs are set to Standard (24 V ON/OFF controlled by PLC, no test pulses) while the Inputs are set to Not Used. See "Figure: Hookup: Test Points Controlled by the PLC" on page 43. This allows the PLC to control when the test outputs are ON and when they are OFF. The return of the test outputs should be wired to pin 3 (DC common).

Option 10: Dual-Channel Complementary (Single Test Pulsed)

Complementary (Single Test Output) Dual complementary relay input with the odd test output (pin 1) set to Power Supply and the even test output (pin 5) set to Test Pulse can be used with the fifth complementary input circuit from "Complementary Contact Inputs: 2-, 3-, 4-, and 5-Terminal" on page 50. Use the link to see wiring and pinout information. The odd test output (pin 1) supplies 24 volts with 2 amps of current to power the active device. When the inputs (INs) are receiving a 24-volt signal, they monitor for the correct test pulse sequence. Thus, each input is checking for wiring shorts to power and wiring errors to the wrong test output.

The input port will ensure that the two contacts maintain their complementary state within the set discrepancy time. One input must be open while the other input must be closed for an acceptable state. When one contact changes state, the port monitors that the other contact changes state within the set discrepancy time. If this does not happen both inputs will be set to OFF because a fault has occurred.

This preset can be used with any active device with complementary relay contact outputs; for example, Banner's STBVR81 touch buttons.

Option 15: User-Configured Settings

User-configured settings can be used when the user desires to set all the port input parameters themselves (or none of the presets work for the user’s circuit desires).

6.6.2 Output Port Presets

The following is a brief description of each output port preset.

For pinouts, see "Output: A-Code M12 Connection" on page 46.

The detailed information about each output port preset follows after the table. The option numbers are used only for reference between the table and the descriptions, and also with the wiring examples.

Option	Description
21	Dual-Channel
22	Dual-Channel OSSD
23	Two Single-Channel (Test Pulsed)
24	Two Standard
30	User-Configured Settings

NOTE:
Pin 1 is +24 Vdc (2 amps).[18]

Pin 3 is a DC common.

Pin 5 is a DC common.

NOTE: The PLC software lists the presets in alphabetical order.

Option 21: Dual-Channel

Dual-Channel is used when the item being controlled is sensitive to test pulses. The outputs (pins 2 and 4) supply 24 volts when turned on via the PLC. Because the outputs do not have test pulses, they do not check for shorts to external power sources.

The user must ensure that the cable route excludes the possibility of the output lines shorting to power sources. If the possibility of the outputs shorting to a power source cannot be excluded, a lower level of safety (from Cat 4 PL e) results for the system. To ensure safety, cycle the outputs periodically to ensure they are functioning correctly.

WARNING:
- Dual-channel outputs without test pulses are not recommended for use in Safety Critical Applications
- Failure to incorporate proper fault exclusion methods when using dual-channel outputs without test pulses in safety critical applications may cause a loss of safety control and result in serious injury or death.
- If a dual-channel output without test pulses is used in a safety critical application the fault exclusion principles must be incorporated to ensure Category 3 safety operation. Routing and managing output wires so shorts to other outputs or other voltage sources are not possible is an example of a proper fault exclusion method

Pin 1 of the output port is set to supply 24 volts with 2 amps of current. Pins 3 and 5 are DC common inputs for the returns of the output lines (pins 2 and 4). Using these returns helps prevent ground loop issues.

Option 22: Dual-Channel OSSD

Dual-Channel OSSD is the typical setting for the outputs. The outputs (pins 2 and 4) supply 24 volts when turned ON via the PLC. With this setting, outputs also have test pulses to ensure that they are not shorted to each other or to an external power source. If a short is detected, the outputs switch to the OFF state and report a fault.

Pin 1 of the output port is set to supply 24 volts with 2 amps of current. Pins 3 and 5 are DC common inputs for the returns of the output lines (pins 2 and 4). Using these returns helps prevent ground loop issues.

This preset can be used only in Cat 3, PL d applications because turning off the output test pulses also disables some internal testing of the unit.

Option 23: Two Single-Channel (Test Pulsed)

Two Single-Channel (Test Pulsed) can be used to provide more outputs to a system with a lower level of risk. Each split safety output is sufficient for Category 3 PL d applications due to an internal series connection of two switching devices. However, an external short must be prevented. Because each output does have test pulses, they actively monitor to detect short circuits to power sources but are unable to perform any actions (besides turning off). Take extreme care in the routing of wires to avoid the possibility of shorts to other voltage sources, including other Safety Outputs.

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.

Pin 1 of the output port is set to supply 24 volts with 2 amps of current. Pins 3 and 5 are DC common inputs for the returns of the output lines (pins 2 and 4). Using these returns helps prevent ground loop issues.

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[18] Ideally, pin 1 (DC24) should be settable to either Not Used (off) or Power Supply (24 V).

Option 24: Two Standard

Two Standard (no test pulses, see warning under Option 22) can be used to provide more outputs to a system with a lower level of risk when the item being controlled is sensitive to test pulses. Each split safety output is sufficient for Category 3 PL d applications due to an internal series connection of two switching devices. However, an external short must be prevented. Take extreme care in the routing of wires to avoid the possibility of shorts to other voltage sources, including other Safety Outputs.

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.

Pin 1 of the output port is set to supply 24 volts with 2 amps of current. Pins 3 and 5 are DC common inputs for the returns of the output lines (pins 2 and 4). Using these returns helps prevent ground loop issues.

Option 30: User-Configured Settings

User-Configured Settings can be used when the user desires to set all the port output parameters themselves (or none of the presets work for the user's circuit desires).

6.7 Manually Configure the Block Inputs

Use the following instructions to configure the block input parameters on the **Module Properties** window **Input Configuration** tab in the Studio 5000® software[19].

1. Select the **Point Operation Mode**.

Mode	Description
Single Channel	Inputs are treated as single channels. In many cases, dual-channel safety inputs are configured as two individual single channels. This configuration does not affect pulse testing because it is handled on an individual channel basis.
Dual-channel Equivalent	Inputs are treated as a dual-channel pair. The channels must match within the discrepancy time or an error is generated.
Dual-channel Complementary	Inputs are treated as a dual-channel pair. They must be in opposite states within the discrepancy time or an error is generated.

2. If **Type** is set to Equivalent or Complementary, set the **Point Operation Discrepancy Time** (in ms).
3. Select the **Point Mode**.

Mode	Description
Not Used	The input is disabled. It remains logic 0 if 24 V is applied to the input terminal.
Safety Test Pulse	Pulse testing is performed on this input circuit. A test source on the block must be used as the 24 V source for this circuit. The test source is configured by using the test source pull-down. The pulse test detects shorts to 24 V, and channel-to-channel shorts to other inputs.
Safety	A safety input is connected but there is no requirement for the block to perform a pulse test on this circuit. An example is a safety device that performs its own pulse tests on the input wires, such as a light curtain.
Standard	A standard device, such as a reset switch, is connected. This point cannot be used in dual-channel operation.

[19] Studio 5000 is a registered trademark of Rockwell Automation, Inc.

4. Define the **Test Source**. The default is None.

Test Source	Description
None	No test source defined.
Test Output #	If pulse testing is being performed on an input point, then the test source that is sourcing the 24 V for the input circuit must be selected. If the incorrect test source is entered, the result is pulse test failures on that input circuit. Test Output 0 to Test Output 11 are available, depending on model.

5. Set the **Input Delay Off>On** time from 10 ms to 1000 ms.
   This is the filter time for OFF to ON transition. Input must be high after input delay has elapsed before it is set logic 1.
6. Set the **Input Delay On>Off** time from 6 ms to 1000 ms.
   This is the filter time for ON to OFF transition. Input must be low after input delay has elapsed before it is set logic 0.
7. Set the **Input Error Latch Time** from 0 ms to 65,530 ms, in increments of 10 ms. The default is 1000 ms.
   The purpose for latching input errors is to make sure that intermittent faults that can only exist for a few milliseconds are latched long enough for the PLC to read the fault. The amount of time to latch the error must be based on the Requested Packet Interval (RPI), the safety task watchdog, and other application-specific variables.
8. Click **OK**.

6.8 Manually Configure the Block Outputs

Use the following instructions to configure the block output parameters on the **Module Properties** window **Safety Configuration** tab in in the Studio 5000® software[20].

1. Select the **Point Operation Type**. The default is Dual.

Value	Description
Single	The Safety Outputs are treated separately.
Dual	The Safety Outputs are treated as dual-channel.

2. Select the **Point Mode**. The default is Not Used.

Value	Description
Not Used	The output is disabled.
Safety	The output point is enabled, and it does not perform a pulse test on the output.
Safety Test Pulse	The output point is enabled and performs a pulse test on the output. When the output is energized, the output pulses low briefly. The pulse test detects if 24 V remains on the output terminal during this low pulse due to a short to 24 V. The pulse test also detects if the output is shorted to another output terminal.

3. Set the **Output Error Latch Time** from 0 ms to 65,530 ms, in increments of 10 ms. The default is 1000 ms.
   The purpose for latching output errors is to make sure that intermittent faults that can only exist for a few milliseconds are latched long enough for the controller to read. The amount of time to latch the errors is based on the requested packet interval (RPI), the safety task watchdog, and other application-specific variables.
4. Click **Apply**.

[20] Studio 5000 is a registered trademark of Rockwell Automation, Inc.

6.9 Download the Configuration to an Allen Bradley PLC

NOTE:
- User testing is the means by which all downloads are validated.
- Test safety connection configurations after they are applied in an originator to confirm the target connection is operating as intended.
- Verify that all originator-configured safety devices have their ownership assignments as part of the final verification process.
- Visually verify that all configuration data was downloaded correctly.

1. Select the **Download** option in Studio 5000 to download the configuration to the PLC.

   If the RSio block is at the factory default state, the PLC links with the RSio block and sets the Safety Network Number (SNN) and the Safety Configuration Signature.
2. If the RSio block had been previously linked to a different PLC, manually reset the Safety Configuration Ownership. See "Manually Reset Safety Configuration Ownership" on page 75.

6.10 Manually Reset Safety Configuration Ownership

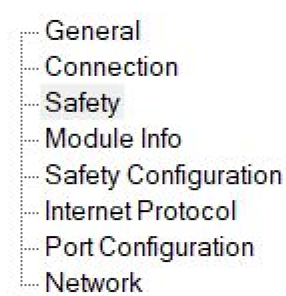
1. In Studio 5000, open the properties for the RSio block.
2. Select the **Connection** option.
3. Select the **Inhibit Module** checkbox.

Figure 52. Inhibit Module Checkbox Selected

4. Click **Apply**.

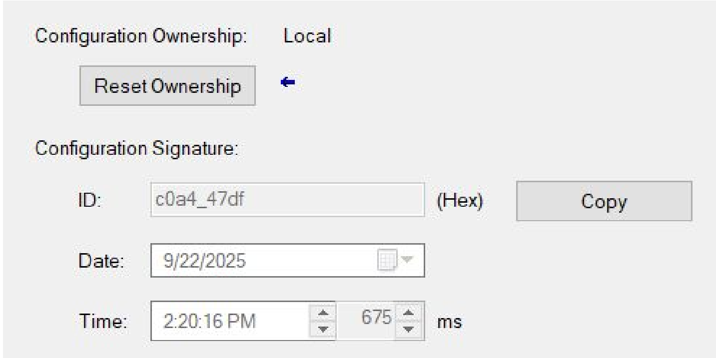
   This opens a message about the danger of inhibiting the connection if the machine is in operation.
5. If the machine is in a safe state to continue, click **Yes**.
6. Click **Safety** on the **Module Definition** window.

Figure 53. Module Definition—Safety



7. Click **Reset Ownership**.

Figure 54. Reset Ownership



A message window opens, warning of danger and that the reset should not be performed on a module in operation.

8. If the RSio block is not being used, click **Yes** to continue.

   After a few seconds, a message might open that says, "Reset message timed out." This is normal because the connection was inhibited earlier in the process.
9. Click **OK** to continue.
10. Go back to the Connection area and deselect the **Inhibit Module** checkbox.
11. Click **Apply**.

    The connection between the PLC and RSio block is reactivated. An error might display, but after a few seconds it should automatically clear and the RSio block should be in the Run state.

The Safety Configuration Ownership Reset is complete.

6.11 ISD User-Defined Data Type (UDT) for ISD Non-Safety Data

Use the following instructions to install and use the ISD User-Defined Data Type (UDT). This UDT takes the raw data from the RSio block and converts it into usable information for the ISD chains.

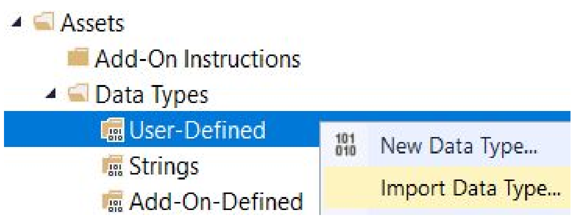
The following example includes screen captures from Studio 5000®[21].

The following steps assume that a connection to the RSio block has already been created. See "Create a Connection to the RSio" on page 60.

1. Download the files for the RSio block from www.bannerengineering.com.

   The file is called *RSio AOI and UDT Files*.
2. In the **Controller Organizer** window, expand the **Data Types** folder, right-click on the **User Defined** folder, and select the **Import Data Type** option.

   Figure 55. Select Import Data Type

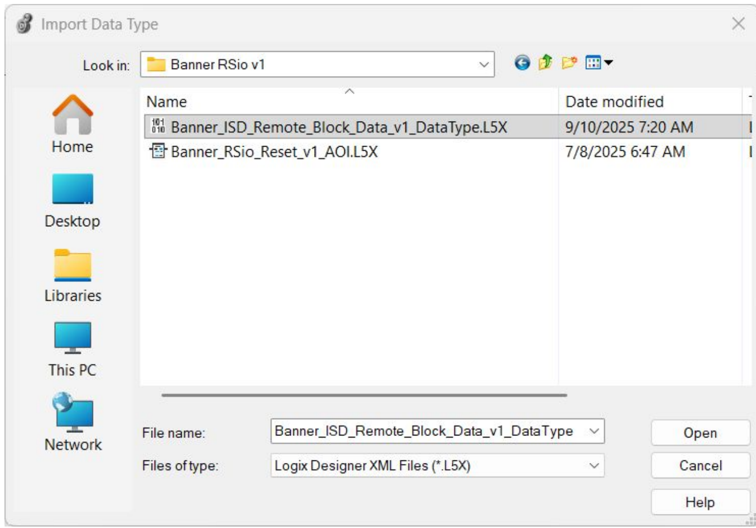
   

3. Navigate to the correct file location and select the L5X to be installed.

   In this example, select *"Banner_ISD_Remote_Block_Data_v1_DataType.L5X"* .

(21) Studio 5000® is a registered trademark of Rockwell Automation, Inc.

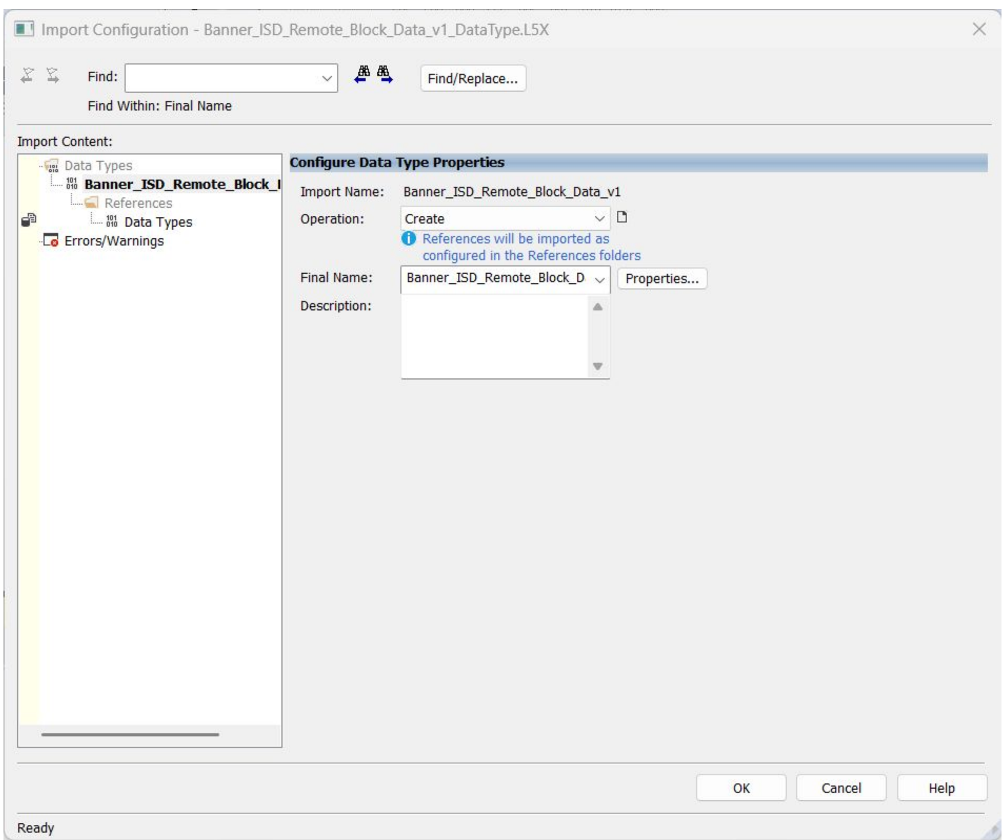
Figure 56. Import Data Type Window



4. Click **Open**.

   The **Import Configuration** window opens.

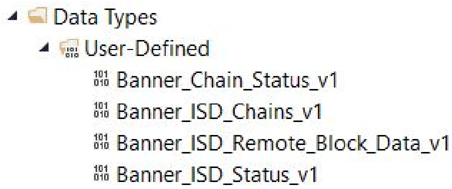
Figure 57. Import Configuration Window



5. Click **OK** to complete the import process

   Four data types are imported into the project.

Figure 58. UDT in the Controller Organizer Window



The UDT is added to the **Controller Organizer** window and should look like the figure. UDT installation into Studio 5000 is complete.

6. Write down what the Remote Safe I/O block was labeled when the connection was created. This information will be used in another step.

   In this example, it was called "RSio".

7. Create a new tag.

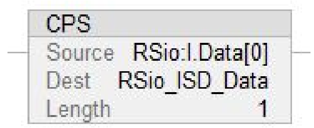
   This example uses the tag name "RSio_ISD_Data" with the Data Type of "Banner_ISD_Remote_Block_Data_v1".

   Figure 59. Example Tag

8. Create a Copy File (COP) or Synchronous Copy File (CPS) instructions in the non-safe programming area.
   - Source: Link this to the Standard data input from the RSio block. In this example that is RSio:I.Data[0].
   - Dest: Link this to the tag just created. In this example that is RSio_ISD_Data.
   - Length: Set the length to 1.

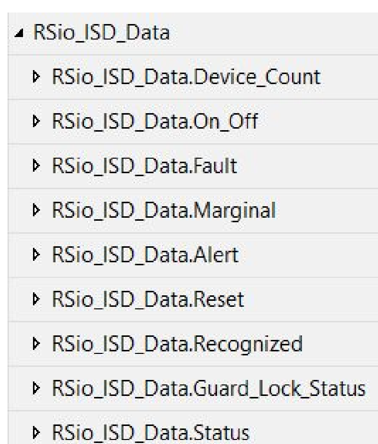
   Figure 60. Example CPS

   The raw data is converted into useful information.

9. Download the COP or CPS file to the PLC.
10. In **Controller Tags** go to the tag "RSio_ISD_Data" and expand the tag to see all of the possible data from an ISD chain in the block.

    Figure 61. Example ISD Chain Data

Device Count

Shows the number of ISD units attached to the ISD Chain. C1 through C6 represent the six possible ISD chains. In this example only Port 0 has ISD devices detected. There are three.

Figure 62. Example Device Count Element

◢ RSio_ISD_Data.Device_Count	{...}
▷ RSio_ISD_Data.Device_Count.C1	3
▷ RSio_ISD_Data.Device_Count.C2	0
▷ RSio_ISD_Data.Device_Count.C3	0
▷ RSio_ISD_Data.Device_Count.C4	0
▷ RSio_ISD_Data.Device_Count.C5	0
▷ RSio_ISD_Data.Device_Count.C6	0

On_Off

C1 through C6 can be expanded to see the current state of the ISD devices. Because there are three ISD devices in C1, the second figure shows the status of the units. They are all in the ON state in this example. Keep in mind that element 0 would be device 1 in the chain itself.

Figure 63. Example On_OFF Element

◢ RSio_ISD_Data.On_Off	{...}
▷ RSio_ISD_Data.On_Off.C1	7
▷ RSio_ISD_Data.On_Off.C2	0
▷ RSio_ISD_Data.On_Off.C3	0
▷ RSio_ISD_Data.On_Off.C4	0
▷ RSio_ISD_Data.On_Off.C5	0
▷ RSio_ISD_Data.On_Off.C6	0

Figure 64. Example On_OFF C1 Expanded

◢ RSio_ISD_Data.On_Off.C1	7
RSio_ISD_Data.On_Off.C1.0	1
RSio_ISD_Data.On_Off.C1.1	1
RSio_ISD_Data.On_Off.C1.2	1
RSio_ISD_Data.On_Off.C1.3	0
RSio_ISD_Data.On_Off.C1.4	0

Fault

Example Fault element: RSio_ISD_Data.Fault.C1.

Marginal

Example Marginal element: RSio_ISD_Data.Marginal.C1.

Alert

Example Alert element: RSio_ISD_Data.Alert.C1.

Reset

Example Reset element: RSio_ISD_Data.Reset.C1.

Recognized

Example Recognized element: RSio_ISD_Data.Recognized.C1.

Status

Provides information about the ISD chain. See "ISD Chain System Status" on page 104 for additional information.

Figure 65. Example Status Element

◢ RSio_ISD_Data.Status	Banner_ISD_Status_v1
▷ RSio_ISD_Data.Status.C1_Status	Banner_Chain_Status_v1
▷ RSio_ISD_Data.Status.C2_Status	Banner_Chain_Status_v1
▷ RSio_ISD_Data.Status.C3_Status	Banner_Chain_Status_v1
▷ RSio_ISD_Data.Status.C4_Status	Banner_Chain_Status_v1
▷ RSio_ISD_Data.Status.C5_Status	Banner_Chain_Status_v1
▷ RSio_ISD_Data.Status.C6_Status	Banner_Chain_Status_v1

Expand each chain to see the following status information:

Status.Device_Count_Mismatch
Status.Device_Order_Mismatch
Status.No_Diagnostics_Data_Detected
Status.bit3
Status.Incompatible_Device
Status.ISD_Terminator_Missing
Status.ISD_Acutuator_Not_Taught
Status.ISD_Wrong_Actuator
Status.ISD_Internal_Error
Status.ISD_Output_Fault_Detected
Status.ISD_Chain_Change_Detected
Status.bit11
Status.ISD_OSSD_Status

The UDT installation is complete.

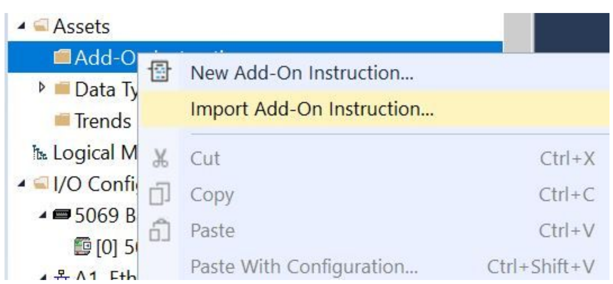
6.12 Read Safety Fault AOI

This AOI (Add-On Instruction) allows for an HMI or the PLC to gather current Fault information for the Safety Inputs, Safety Outputs, or Test Outputs.

The following example includes screen captures from Studio 5000.

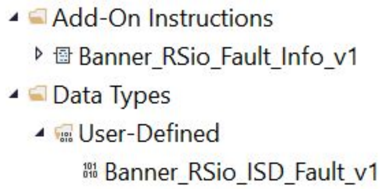
1. In the **Controller Organizer** window, right-click on the **Add-On Instruction** folder and select **Import Add-On Instruction**.

   Figure 66. Import Add-On Instruction Folder Selection

   The **Import Add-On Instruction** window opens.
2. Navigate to the correct file location and select the AOI to be installed.
   In this example, select the “Banner_RSio_Fault_Info_v1_AOI.L5X”.
3. Click **Open**.
   The **Import Configuration** window opens. The default selection creates all necessary items for the AOI.
4. Click **OK** to complete the import process.
   The AOI is added to the **Controller Organizer** window and should look like the following figure.

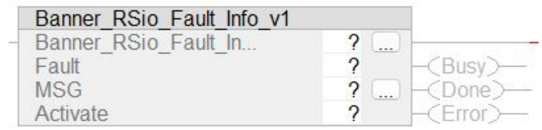
*Figure 67. AOI in **Controller Organizer** Window*



The AOI is now available in Studio 5000.

5. Add the "Banner_RSio_Fault_Info_v1" to the ladder logic program.

Figure 68. Banner_RSio_Fault_Info_v1



6. For each question mark shown in the instruction, create and link a new tag array using the following instructions. The AOI includes new types of User Defined Tag (UDT): custom arrays of tags meant specially for this AOI. This example uses the following names for the tags:

Tag	Example Name	Description
Banner_RSio_Fault_Info_v1	Fault_Status	This tag is for the status of the AOI.
Fault	Fault	This is the tag that the user accesses to control the AOI.
MSG	MSG_Fault	This tag is the message instruction for the AOI.
Activate	Activate.4	This tag controls when the AOI performs its operation.

   a. In the AOI, right-click on **?** on the first line and click **New Tag**.

      The **New Tag** window opens.

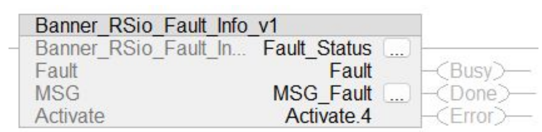
   b. Enter a **Name** for the tag (see the table above).
   c. Click **Create**.

      The **New Tag** window closes.

   d. Repeat these steps for each line.

This creates the necessary tags to complete the operation.

Figure 69. Banner_RSio_Fault_Info_v1 Tags Created

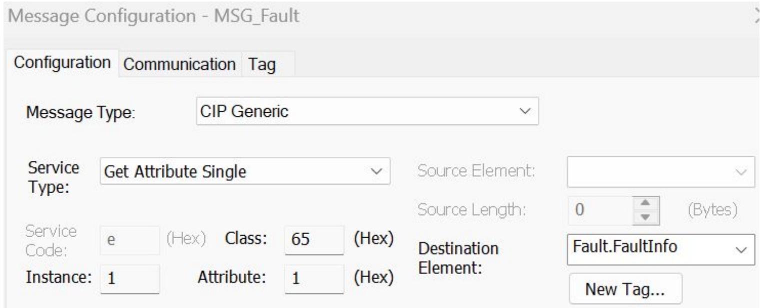


7. Configure the Message Command.
   a. Click the **...** next to the MSG tag.

      The **Message Configuration** window opens.

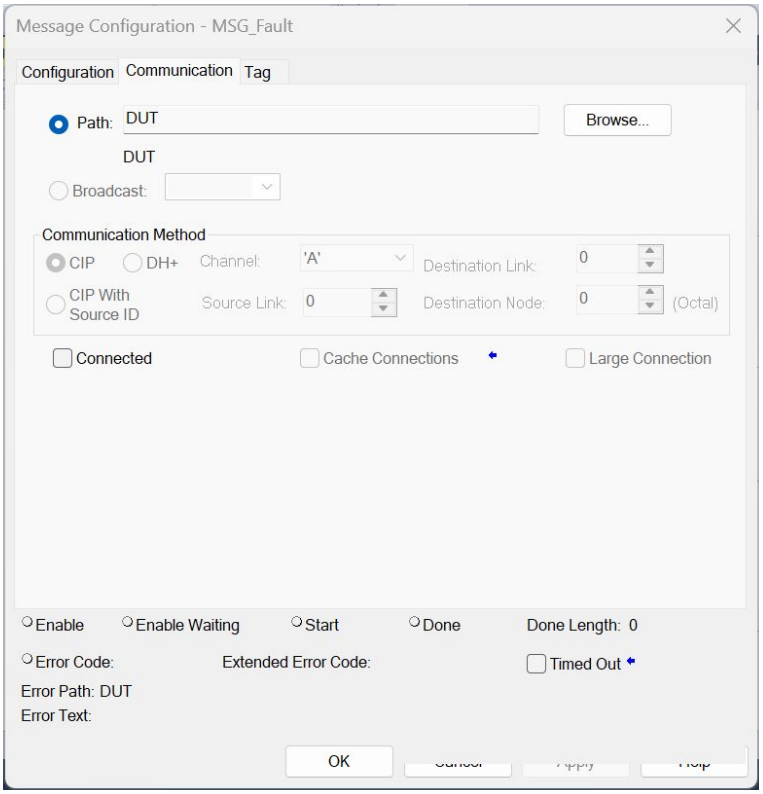
   b. Configure the following:
      - Message Type: CIP Generic
      - Service Type: Get Attribute Single
      - Class: 65
      - Instance: 1
      - Attribute: 1
      - Source: Not used
      - Destination: Fault.FaultInfo

*Figure 70. **Message Configuration - MSG_Fault** Window, **Configuration** Tab*



c. Click the **Communications** tab.

*Figure 71. **Message Configuration - MSG_Fault** Window, **Communications** Tab*



d. Click the Browser and select the RSio block from the Ethernet connection.
Here the RSio block is called DUT.

e. Click **OK** to finalize the updates for the message.

8. Set the parameters as needed when gathering fault information. The fault tag was created in step 6.
   a. Set the **Operation** parameter:
      - Safety Inputs: 1
      - Safety Outputs: 2
      - Test Points: 3
   b. Set the **Point** parameter:
      - Safety inputs and Test Points: Use 1 to 12 for In0 to In11
      - Safety Outputs: Use 1 to 4 for Out0 to Out3

Figure 72. Fault Tag Expanded

◢ Fault	{...}
▷ Fault.Operation	1
▷ Fault.Point	3

9. Set the Activate bit to 1 to begin the fault read.

   When the bit resets to 0, the operation is complete.
10. Check to see if the Error bit is ON or OFF.

    If it is OFF, continue to the next step. If it is ON, then the operation failed.
    If the operation failed, verify that the correct parameters are used, fix any errors, and repeat the operation.
11. Open the **FaultInfo** tag located under the Fault tag that was created in step 5b.

    The Point value returned should match the value sent in Step 7b.

    Figure 73. Fault.FaultInfo Tag Expanded

◢ Fault.FaultInfo	{...}	
▷ Fault.FaultInfo[0]	3	Error Code
▷ Fault.FaultInfo[1]	3	Point

12. Compare the Error Code against the "RSio Fault Code Tables" on page 119, using the table for the operation used (Output, Input, Test Point).

    This example uses the Input Fault Error Codes.
13. Resolve the fault and follow the Reset operation. See "Using the Reset AOI" on page 90.

6.13 Connection Control

It is best practice to inhibit the connection to the RSio block before a reset is activated. Use the following instructions to use the PLC to control the connection. Change the Tag names as necessary for your specific application.

The following example includes screen captures from Studio 5000.

1. Add a Set System Variable (SSV) command to a rung.

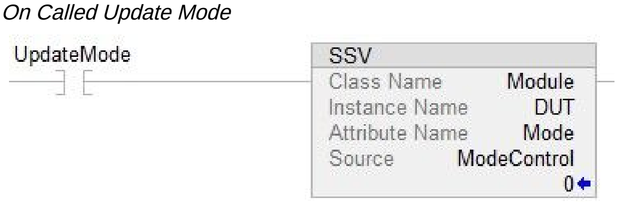
   Figure 74. SSV

   a. Class Name: Click on the location and select the drop-down button. Select the **Module** option.
   b. Instance Name: Link this to the connection (DUT in this example).
   c. Attribute Name: Select **Mode** from the drop-down list.
   d. Source: Right-click on **?** and select **New Tag..**. Create a tag for this. In this example, ModeControl is used.
2. Add an Examine On in front of the SSV command.

   In this example, a tag called **Update Mode** is used.

   Figure 75. Add an Examine On Called Update Mode

> **NOTE:** ModeControl should have a value of 4 to inhibit the connection and a value of 0 to allow the connection.

3. Inhibit or establish the connection.
    - To inhibit the connection, set **ModeControl** to `4` and turn ON the **UpdateMode** tag. This inhibits the connection within one or two seconds.
    - To establish the connection, set **ModeControl** to `0` and turn ON the **UpdateMode** tag. This establishes the connection within one or two seconds.
4. Turn OFF **Update Mode** after the connection has been inhibited or established.

6.14 RSio Ownership Reset AOI

This AOI (Add-On Instruction) allows for an HMI or the PLC to initiate an Ownership Reset. Ownership Reset allows the PLC to update the TUNID and the Safety Configuration ID between the PLC and the Remote Safe I/O block.

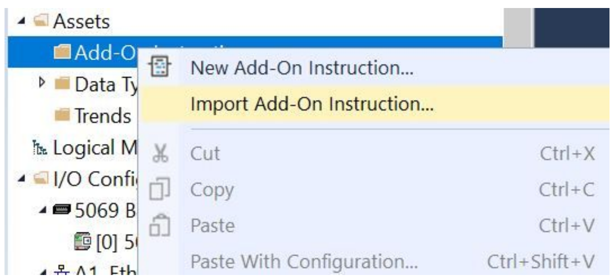
This AOI also acts as a Type 1 reset. A system reset requires a Type 1 reset.

The following example includes screen captures from Studio 5000®[22].

NOTE: It may be necessary to first inhibit the connection for the Ownership Reset to work correctly.

1. In the **Controller Organizer** window, right-click on the **Add-On Instruction** folder and select **Import Add-On Instruction**.

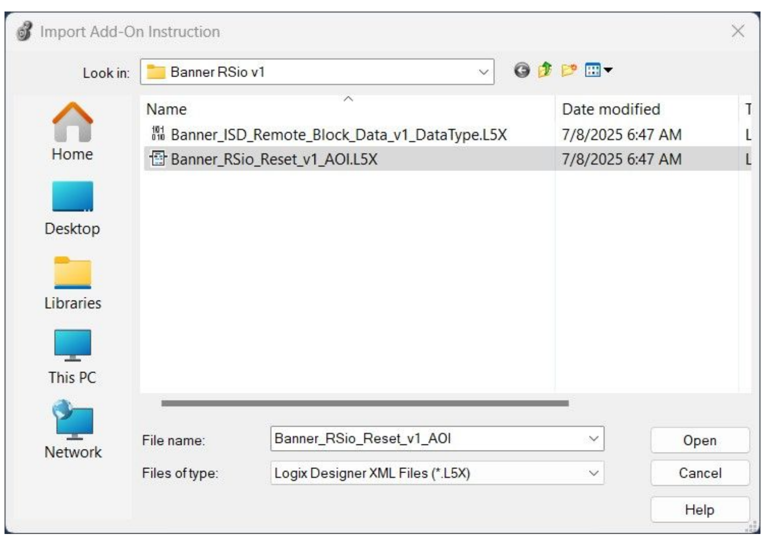
Figure 76. Import Add-On Instruction Folder Selection



The **Import Add-On Instruction** window opens.

2. Navigate to the correct file location and select the AOI to be installed.
In this example, select "*Banner_RSio_Reset_v1_AOI.L5X*".

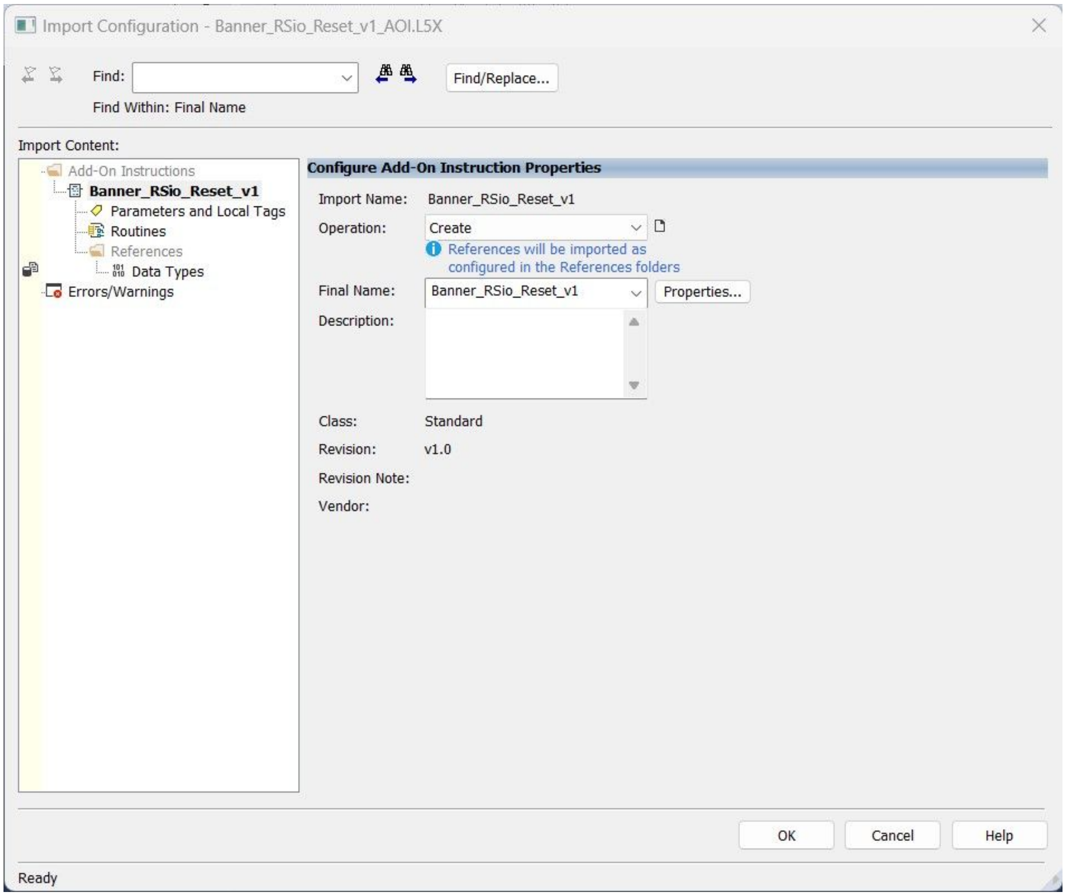
Figure 77. Select the AOI File



3. Click **Open**.
The **Import Configuration** window opens. The default selection creates all necessary items for the AOI.

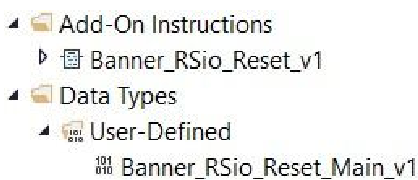
[22] Studio 5000® is a registered trademark of Rockwell Automation, Inc.

*Figure 78. **Import Configuration** Window*



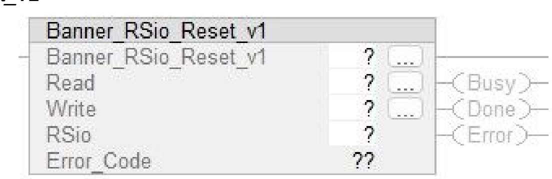
4. Click **OK** to complete the import process.
   The AOI is added to the **Controller Organizer** window and should look like the following figure.

   *Figure 79. AOI in the **Controller Organizer** Window*

   The AOI is now available in Studio 5000.
5. Add the "Banner_RSio_Reset_v1" AOI to the ladder logic program.

   Figure 80. Banner_RSio_Reset_v1

6. For each question mark shown in the instruction, create and link a new tag array using the following instructions. The AOI includes new types of User Defined Tag (UDT): custom arrays of tags meant specifically for this AOI. This example uses the following names for the tags:

Tag	Example Name	Description
Banner_RSio_Reset_v1	RSio_Status	This tag is for the status of the AOI.

Continued on page 86

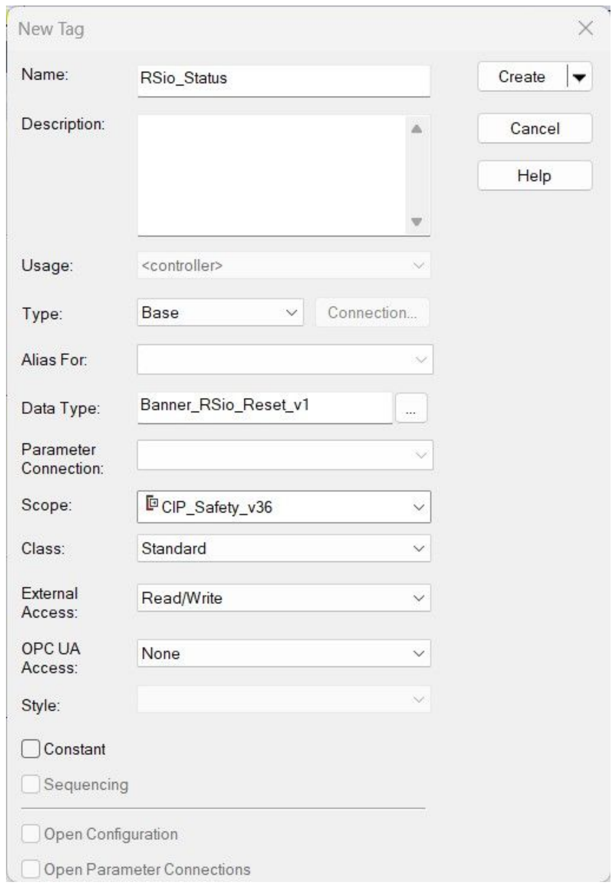
Continued from page 85

Tag	Example Name	Description
Read	RSio_Read	This tag is for the read message instruction.
Write	RSio_Write	This tag is for the write message instruction.
RSio	RSio	This is the tag that the user accesses to control the AOI.

a. In the AOI, right-click on **?** on the first line and click **New Tag**.

The **New Tag** window opens.

*Figure 81. **New Tag** Window "RSio_Status" Example*



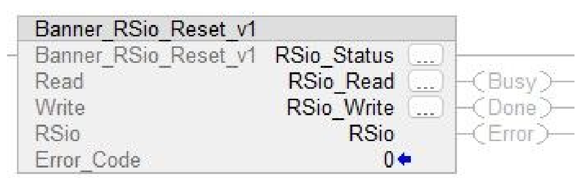
b. Enter a **Name** for the tag (see the table above).
c. Click **Create**.

The **New Tag** window closes.

d. Repeat these steps for each line.

This creates the necessary tags to complete the operation.

Figure 82. Banner_RSio_Reset_v1 Tags Created

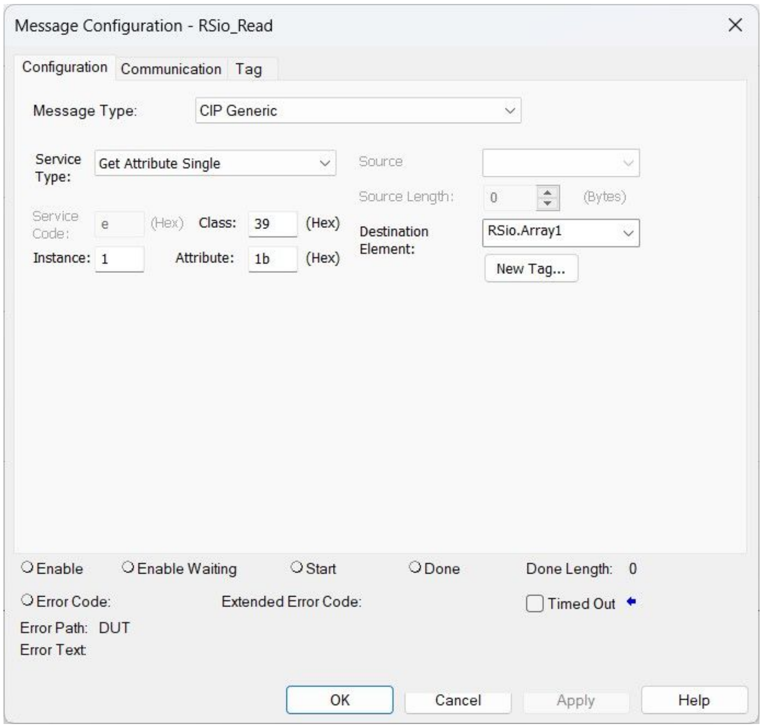


7. Configure the Read Message command.
   a. Click the **...** next to the RSio_Read tag.

   The **Message Configuration** window opens.

b. Configure the following:
   - Message Type: CIP Generic
   - Service Type: Get Attribute Single
   - Class: 16#39
   - Instance: 1
   - Attribute: 16#1b
   - Destination Element: RSio.Array1 (this is the tag created during step 6).

*Figure 83. **Message Configuration - RSio_Read** Window, **Configuration** Tab*

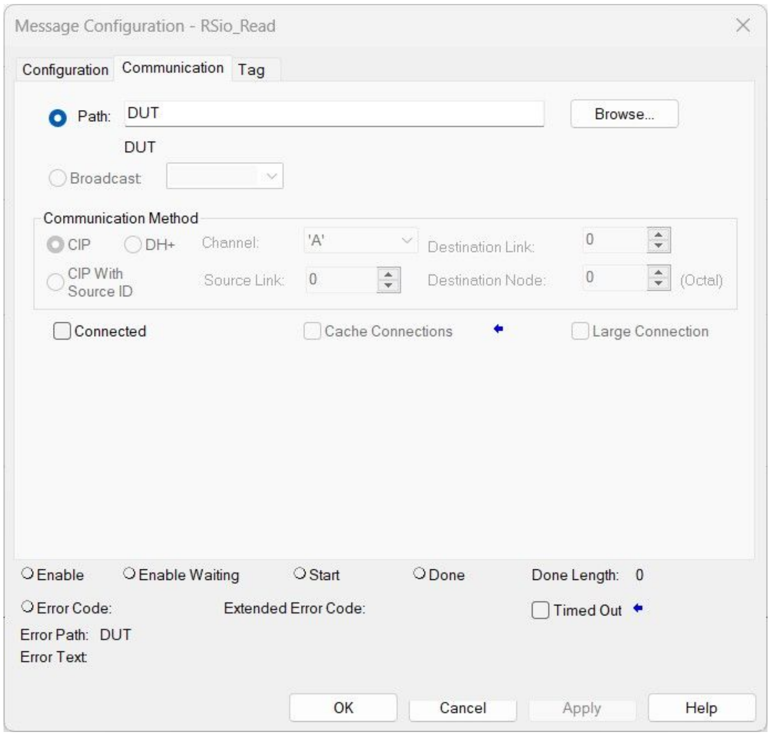


c. Click the **Communications** tab.

d. Click **Browse** and select the RSio block from the Ethernet connection.

   Here the RSio block is called DUT.

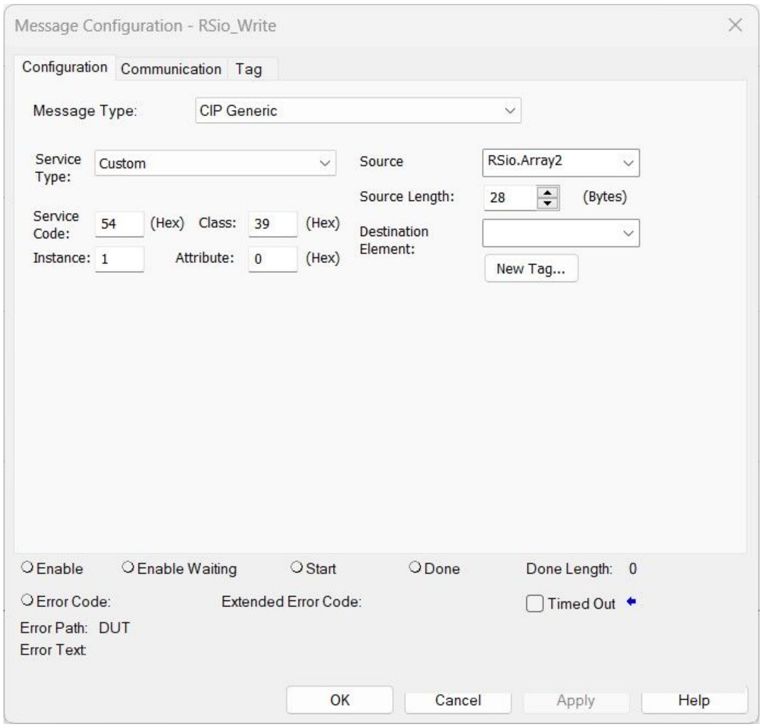
*Figure 84. **Message Configuration - RSio_Read** Window, **Communication** Tab*



e. Click **OK** to finalize the updates for the Read message.

8. Configure the Write Message command.
   a. Click the **…** next to the RSio_Write tag.
      The **Message Configuration** window opens.
   b. Configure the following:
      - Message Type: CIP Generic
      - Service Type: Custom
      - Service Code: 16#54
      - Class: 16#39
      - Instance: 1
      - Attribute: 0
      - Source: RSio.Array2 (this is the tag created during step 5d).
      - Source Length: 28

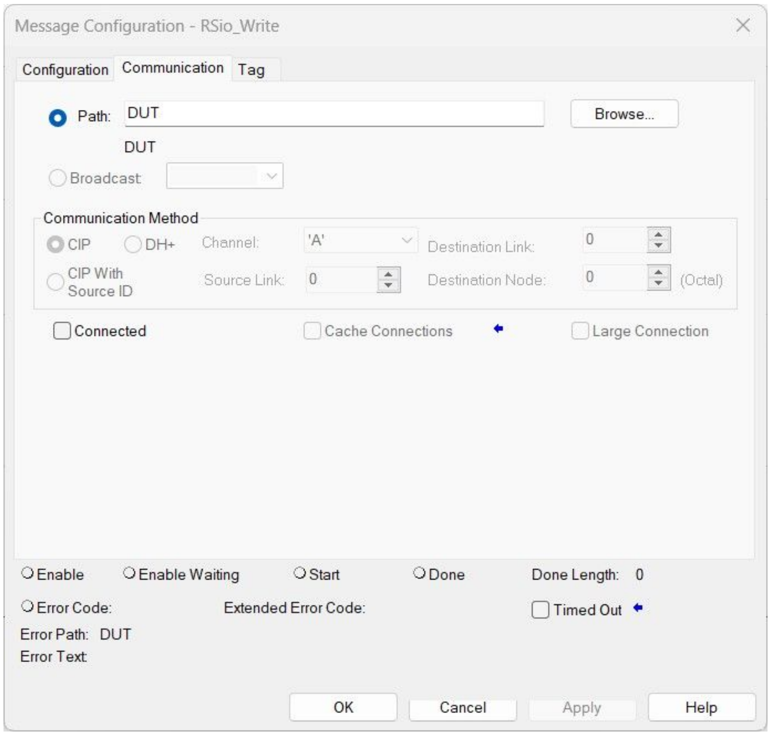
*Figure 85. **Message Configuration RSio_Write** Window, **Configuration** Tab*



c. Click the **Communications** tab.
d. Click **Browse** and select the RSio block from the Ethernet connection.

Here the RSio block is called DUT.

*Figure 86. **Message Configuration RSio_Write** Window, **Communication** Tab*



e. Click **OK** to finalize the updates for the Write message.

The AOI setup is complete.

6.15 Using the Reset AOI

When an Ownership Reset or System Fault Reset is necessary, use the following instructions to activate this process.

> **NOTE:** Make sure that the connection can be inhibited before using this procedure.

1. Inhibit the connection. See Connection Control.
2. Set the ModeControl tag to 4 to inhibit the connection.
3. Set the UpdateMode tag to a value of `1`.
4. Set the “Reset_Ownership” to a value of `1` (True).

   The AOI cycles through the steps needed for the reset. The connection updates if the Error bit hasn’t been set to True (in the RSio tag created in step 6 of "RSio Ownership Reset AOI" on page 84).

   Figure 87. RSio.Reset_Ownership

5. Set the ModeControl tag to `0` to reset the connection.
6. Wait until the connection is detected and then turn OFF the UpdateMode tag by setting it to a value of `0`.

Chapter Contents

Chapter 7 AutoDetect ISD

The AutoDetect ISD feature is always enabled on the Banner Remote Safe I/O block.

AutoDetect ISD allows the RSio block to monitor the length and composition of In-Series Diagnostics (ISD) chains. With AutoDetect ISD the RSio block updates the configuration to match the new chain configurations (chain changes). The RSio block provides this composition to a PLC (non-safety communications side) so that it can be verified as a valid configuration.

> **NOTE:** The safety response of the RSio block is based on the state of the OSSDs of the ISD inputs, not the ISD information carried on the OSSDs. The ISD information is non-safety chain and/or device status information.

With AutoDetect ISD, the RSio block queries each of the input ports to determine whether ISD information is present. If ISD information is present, the RSio block determines their device count, position, and type and sets this as the baseline configuration of the chain. The RSio block provides this information to the attached PLC to verify it is correct for the given system.

Under the **Safety Configuration** tab for the block (in the Studio 5000 software), the automatic baseline at power-up can be replaced with **Manual Baseline**. The **Manual Baseline** feature is a universal selection affecting all of the connected ISD chains. Remember that the RSio block's safety response is based on the state of the OSSDs of the ISD inputs, not the ISD information.

The RSio block notifies the attached PLC that a chain has changed. The Chain Change Detected bit of the data for the affected chain is set to 1. It is cleared by the attached PLC acknowledging the change.

Because the RSio block does not know if the ISD chain connected to any input pair is correct, it is the responsibility of the user to make sure that the detected chain of ISD devices is correct. This can be done by:

- Physically checking the number of devices against the documentation
- Reading the data into the PLC and comparing it to the loaded information for the specific machine structure

It can take the RSio block a few seconds to detect a change in the number of ISD devices in a chain. The RSio block detects the removal of the terminating plug and/or loss of the ISD information (for example, when the chain is severed between units). This information is part of the cyclic data that is passed between the RSio block and the PLC (non-safety communication side).

> **NOTE:** The ISD chain's OSSDs quickly turn off in either of these situations (within the response time of the ISD chain).

In most situations, the RSio block cannot detect a change in chain length until the chain has been completed (for example, the terminating plug removed, devices added, then the terminating plug re-installed). The OSSD outputs can be returned to the ON state after the terminating plug has been re-installed. The ISD information takes a few seconds to begin transmitting again because the starting device may have changed.

The simplest way to ensure that the machine cannot start after a chain configuration change is to require a manual reset function in the PLC program every time the ISD chain OSSDs turn off then back on. This requires operator action to re-arm the safety system every time the chain's OSSD outputs turn OFF then back ON. Then the operator has to re-start the machine. However, this process does not require the operator (or anything else) to verify that the new ISD chain structure is correct.

If a user desires to keep the machine in an OFF state until the operator has verified that the chain's length is correct for the current machine structure, configure the PLC to require a specific operator action every time the Terminating Plug Missing flag is turned ON for a chain. This operator action is either manually verifying the configuration is correct or selecting a function on the PLC for it to verify the configuration is correct.

> **NOTE:** It is the responsibility of the machine builder (user) to ensure the wiring/cabling is not easily manipulated by an operator to defeat the safety function(s); for example, cannot remove a switch from the system.

For a system where the ISD chains should not change, that is, the ISD chains are taught at machine installation, the machine builder (user) must ensure the wiring/cabling is not easily manipulated by an operator to defeat the safety function(s) of ISD devices.

For a system where the ISD chains can change during operation (for example, adding and removing carts from a trolley system), the machine builder (user) must ensure that the only changes that can be made to the wiring/cabling are those involved in the addition or removal of the appropriate machine sections. Perform a system verification after each machine change either automatically via a PLC or manually by an operator.

> **NOTE:** Device #1 is closest to the RSio block. The device numbers increase the further they are away from the RSio block, toward the terminating plug.

> **NOTE:** For information on the ISD inputs, see "ISD Inputs" on page 32.

7.1 Request Information about an Individual Device via ISD

There are two ways to request information about an individual device via ISD: manually or using an AOI.

Use the following instructions to request information. These instructions are optional.

7.1.1 Manually Request Information about an Individual Device via ISD

1. In Studio 5000, add a Message (MSG) Instruction.
   This is used to create an explicit connection to the RSio block.

   Figure 88. Message (MSG) Instruction

2. Right click on **?** and select **New Tag**.
3. Create a tag for the Message Instruction. This example uses `MSG`.

   Figure 89. MSG Tag

4. Create two tags needed for the Message Instruction.
   a. Create a tag array of SINT[2]. This example uses `AccessChainDevice`.
      This tag is used by MSG to request data from a specific chain and device for the RSio block.
   b. Element [0] handles the Chain. Enter a value of 1 to 6, which represents port 0 to 5.
   c. Element [1] is set to the device in the chain for which data should be gathered. Enter a value of 1 to 32.

   Figure 90. SINT[2] Tag–AccessChainDevice

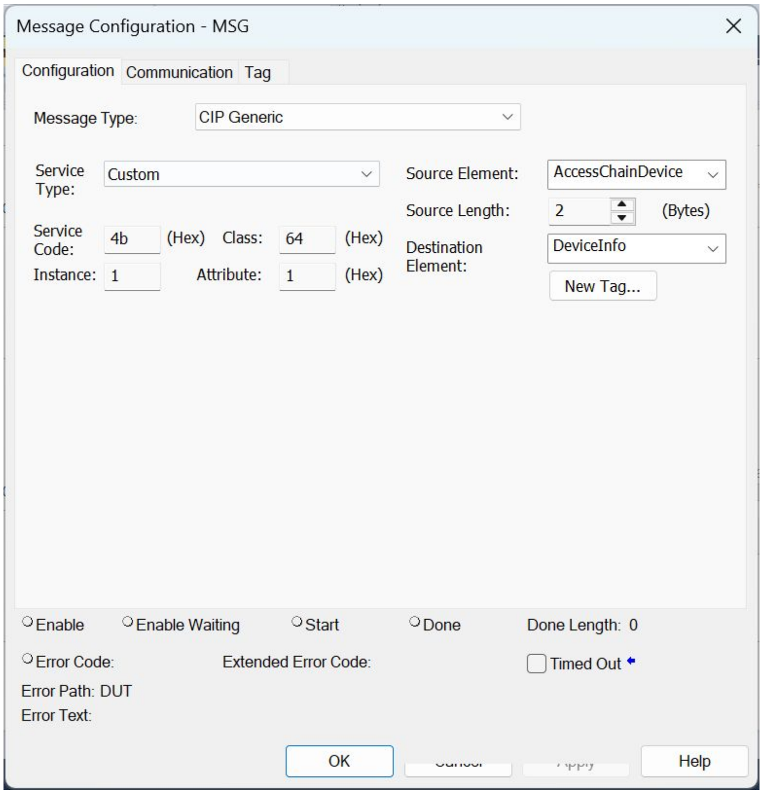
◢ AccessChainDevice	{...}	Decimal	SINT[2]	Standard	
▸ AccessChainDevice[0]	1	Decimal	SINT	Standard	Chain
▸ AccessChainDevice[1]	2	Decimal	SINT	Standard	Device in Chain

d. Create a tag array of SINT[20]. This example uses `DeviceInfo`.
   This is used to store the response for the RSio ISD device being accessed.

Figure 91. SINT[20] Tag–DeviceInfo

5. Click **...** to the right of MSG.
   The **Message Configuration - MSG** setup screen opens.
6. Enter the following information on the **Configuration** tab:
   - Service Code: 4b
   - Class: 64
   - Instance: 1
   - Attribute: 1

*Figure 92. **Message Configuration - MSG** Window, **Configuration** Tab*



7. Link the **Source Element** to the tag created in step 4a (AccessChainDevice).
8. Link the **Destination Element** to the tag created in step 4d (DeviceInfo).
9. Set the Source Length to `2`.
10. Click the **Communication** tab.
    The **Communication** tab opens.
11. Set the path to the name of the RSio block in the system.
12. Click **OK** or **Apply** to finalize the changes.
13. Add an **Examine On** in front of the **Message Instruction**.
    This will control when the acyclic communication to the RSio block is allowed.
14. Create a Boolean to control this. This example uses `Control.1`.

Figure 93. Control.1

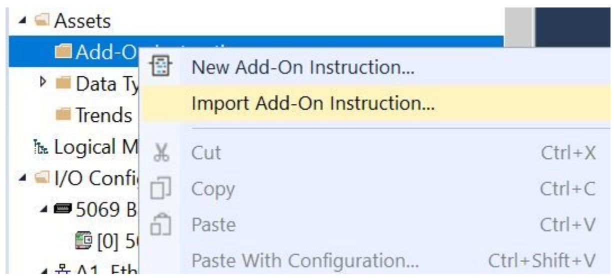
The data received in DeviceInfo is the raw information. The table in "ISD Individual Device-Specific Data" on page 105 shows how the data is organized.

7.1.2 Set Up an AOI to Request Information about an Individual Device via ISD

Download the AOI file for the RSio block from www.bannerengineering.com. The AOI is setup so that the process is more automated than just using the message instruction.

1. In the **Controller Organizer** window, right-click on the **Add-On Instruction** folder, and select the **Import Add-On Instruction** option.

   Figure 94. Import Add-On Instruction Folder Selection

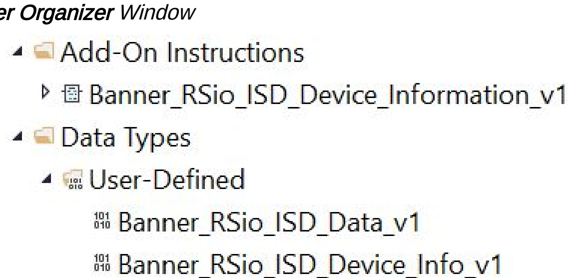
   The **Import Add-On Instruction** window opens.
2. Navigate to the correct file location and select the AOI to be installed.

   In this example, "*Banner_RSio_ISD_Device_Information_v1*" file is selected.
3. Click **Open**.

   The **Import Configuration** window opens. The default selection creates all necessary items for the AOI.
4. Click **OK** to complete the import process.

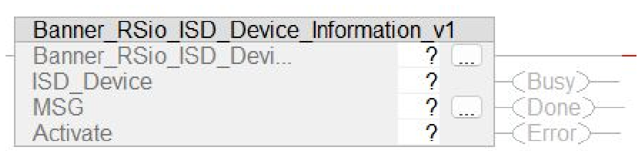
   The AOI is added to the **Controller Organizer** window and should look like the following figure.

   *Figure 95. AOI in the **Controller Organizer** Window*

   The AOI is now available in Studio 5000.
5. Add the "Banner_RSio_ISD_Device_Information_v1" AOI to a rung in Studio 5000.

   Figure 96. Banner_RSio_ISD_Device_Information_v1

6. For each question mark shown in the instruction, create and link a new tag array using the following instructions. This example uses the following names for the tags:

Tag	Example Name	Description
Banner_RSio_ISD_Device	Device_Info_Status	This is the tag for the status of the AOI.
ISD_Device	Device_Info	This tag tells which chain and which device will be accessed.
MSG	MSG_Device_Info	This tag controls a Read message operation.
Activate	Activate.1	This tag controls when the AOI performs its operation.

a. In the AOI, right-click on **?** on the first line and click **New Tag**.

   The **New Tag** window opens.

b. Enter a **Name** for the tag (see the table above).

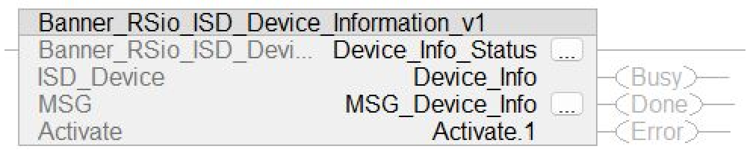
c. Click **Create**.

   The **New Tag** window closes.

d. Repeat these steps for each line.

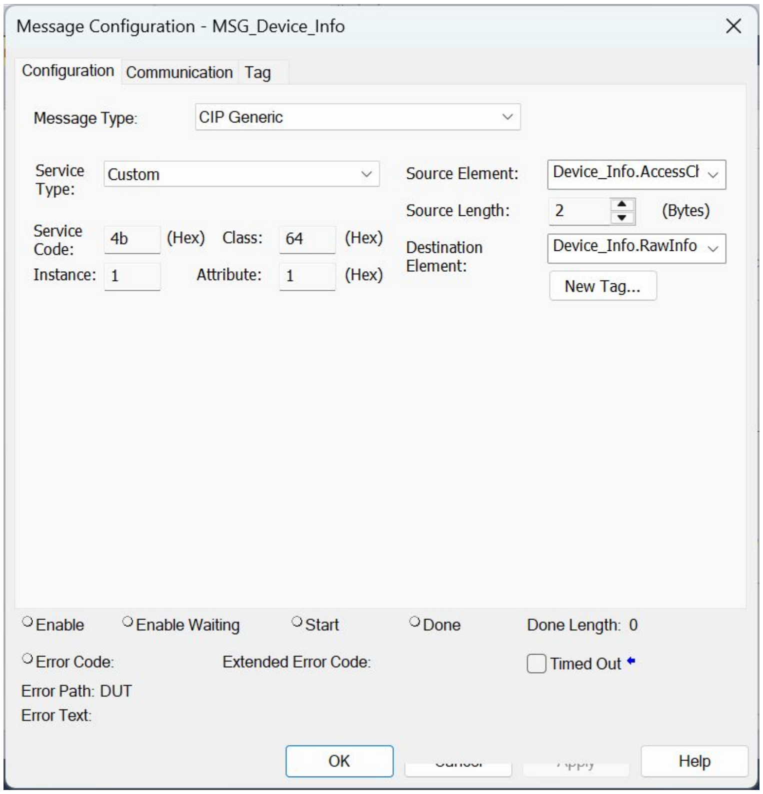
This creates the necessary tags to complete the operation.

Figure 97. Banner_RSio_ISD_Device_Information_v1 - Tags Created



7. Click **...** to the right of MSG_Device_Info.
   The **Message Configuration - MSG_Device_Info** window opens.
8. Enter the following information:
   - Service Code: 4b
   - Class: 64
   - Instance: 1
   - Attribute: 1

Figure 98. Message Configuration—MSG_Device_Info



9. Link the **Source Element** to the tag created in step 5b sub-element "AccessChainDevice" located in Device_Info.
10. Link the **Destination Element** to the tag created in step 5b sub-element "RawInfo" located in Device_Info.
11. Set the **Source Length** to `2`.
12. Click the **Communication** tab.
13. Set the path to the name of the RSio block in the system.
14. Click **OK** or **Apply** to finalize the changes.

The setup is complete.

7.1.3 Use an AOI to Request Information about an Individual Device via ISD

1. In Studio 5000, expand the **Device_Info** tag and set the chain and device.
   a. Set the chain that will be accessed.
      Chains 1 to 6 represent Ports 0 to Port 5. This example uses 1 for Chain 1 Port 0.
   b. Set the device that will be accessed (1 to 32).
      This example accesses ISD device 2.
2. Turn Activate.1 to 1 or ON.
   This starts the process for accessing the Device Information.
3. Wait until the Done bit turns ON.
4. Make sure that the Error bit is OFF. If it is OFF, the data can be looked at.
5. Expand the **DeviceInfo** tag.
6. Examine the data as needed.
   The following figure shows only a partial list of what is possible.

Figure 99. Device List

Device_Info.DeviceInfo	{...}
Device_Info.DeviceInfo.Safety_Input_Fault	0
Device_Info.DeviceInfo.Reserved	0
Device_Info.DeviceInfo.Sensor_not_Paired	0
Device_Info.DeviceInfo.ISD_Data_Error	0
Device_Info.DeviceInfo.Wrong_Actuator	0
Device_Info.DeviceInfo.Marginal_Range	0
Device_Info.DeviceInfo.Actuator_Detected	1

7.2 Request Device List

There are two ways to request the device list of an ISD Chain: manually or using an AOI.

Use the following instructions to request the list. These instructions are optional.

7.2.1 Manually Request a list of the Device Types in an ISD Chain

1. In Studio 5000, add a Message (MSG) Instruction.
   This is used to create an explicit connection to the RSio block.
   Figure 100. Message (MSG) Instruction
   

2. Right click on **?** and select **New Tag**.
3. Create a tag for the Message instruction. This example uses `MSG`.
   Figure 101. MSG Tag
   

4. Create two tags needed for the Message Instruction.
   a. Create a tag array of SINT. This example uses `AccessChain`.
      This tag is used by MSG to request data types of ISD in the chain.
   b. Enter a value of 1 to 6, which represents port 0 to 5, for the chain to be accessed is set in this tag.
      Figure 102. SINT Tag–AccessChain

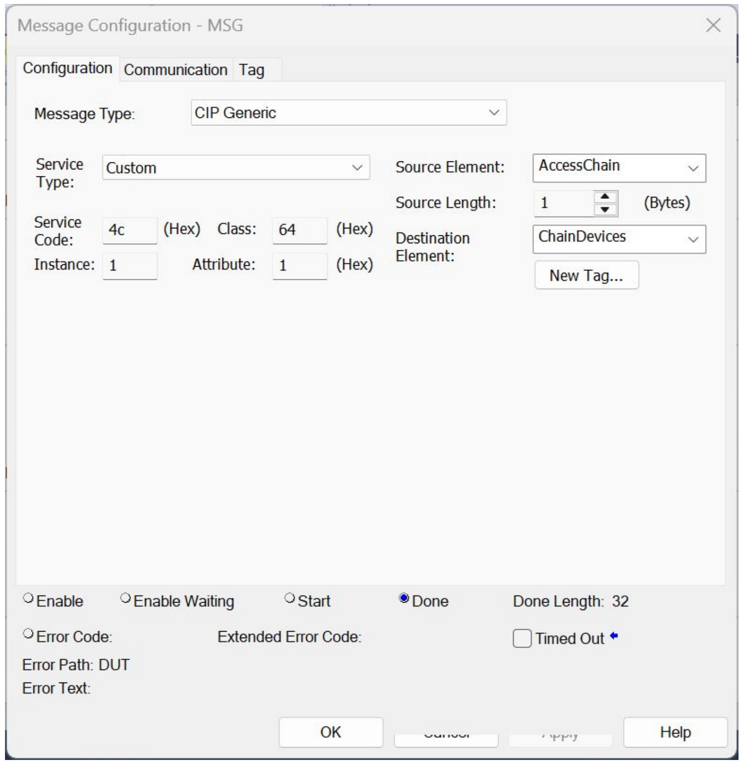
AccessChain	1	Decimal	SINT

   c. Create a tag array of SINT[32]. This example uses `ChainDevices`.
      This is used to store the response for the RSio ISD chain being accessed.
      Figure 103. SINT[32] Tag– ChainDevices.

ChainDevices	{...}	Decimal	SINT[32]

5. Click **...** to the right of MSG.
   The **Message Configuration - MSG** setup screen opens.
6. Enter the following information on the **Configuration** tab:
   - Service Code: 4c
   - Class: 64
   - Instance: 1
   - Attribute: 1

*Figure 104. **Message Configuration - MSG** Window, **Configuration** Tab*

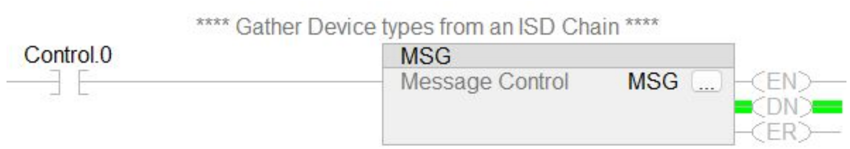


7. Link the **Source Element** to the tag created in step 4a (AccessChain).
8. Link the **Destination Element** to the tag created in step 4c (ChainDevices).
9. Set the Source Length to `1`.
10. Click the **Communication** tab.

    The **Communication** tab opens.
11. Set the path to the name of the RSio block in the system.
12. Click **OK** or **Apply** to finalize the changes.
13. Add an **Examine On** in front of the **Message Instruction**.

    This will control when the acyclic communication to the RSio block is allowed.
14. Create a Boolean to control this. This example uses `Control.0`.

    Figure 105. Control.1



The data received in ChainDevices gives the device type information back. In this example the data of 1, 1, 9, 9, 9 is received. Chain[0] represents device 1 for the chain.

Figure 106. ChainDevices

ChainDevices	{...}	Decimal	SINT[32]
ChainDevices[0]	1	Decimal	SINT
ChainDevices[1]	1	Decimal	SINT
ChainDevices[2]	9	Decimal	SINT
ChainDevices[3]	9	Decimal	SINT
ChainDevices[4]	9	Decimal	SINT
ChainDevices[5]	0	Decimal	SINT

The number returned represents the type of ISD device that is in that location of the chain.

1 = ISD SI-RF
7 = ISD E-Stop
9 = ISD Connect

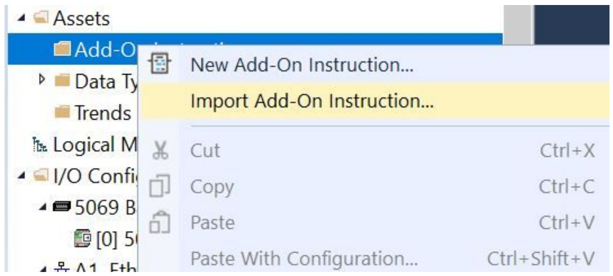
In this example, there are two SI-RF switches at the start of the chain followed by three ISD connect units.

7.2.2 Set Up an AOI to Request a list of the Device Types in an ISD Chain

Download the AOI file for the RSio block from www.bannerengineering.com. The AOI is setup so that the process is more automated than just using the message instruction.

1. In the **Controller Organizer** window, right-click on the **Add-On Instruction** folder, and select the **Import Add-On Instruction** option.

Figure 107. Import Add-On Instruction Folder Selection



   The **Import Add-On Instruction** window opens.

2. Navigate to the correct file location and select the AOI to be installed.

   In this example, "*Banner_RSio_ISD_Device_Type_in_Chain_v1*" file is selected.

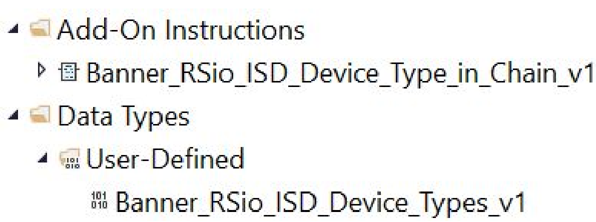
3. Click **Open**.

   The **Import Configuration** window opens. The default selection creates all necessary items for the AOI.

4. Click **OK** to complete the import process.

   The AOI is added to the **Controller Organizer** window and should look like the following figure.

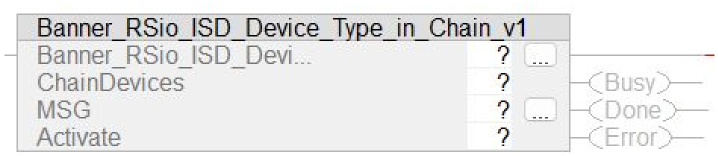
*Figure 108. AOI in the **Controller Organizer** Window*



   The AOI is now available in Studio 5000.

5. Add the "Banner_RSio_ISD_Device_Type_in_Chain_v1" AOI to a rung in Studio 5000.

Figure 109. Banner_RSio_ISD_Device_Information_v1



6. For each question mark shown in the instruction, create and link a new tag array using the following instructions. This example uses the following names for the tags:

Tag	Example Name	Description
Banner_RSio_ISD_Device	Device_Type_Status	This is the tag for the status of the AOI.
ChainDevices	Device_Type	This tag stores the tags used to process the ISD Device Type operation.

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Tag	Example Name	Description
MSG	MSG_Device_Type	This tag creates a message data type used to communicate to the RSio via an explicit connection.
Activate	Activate.0	This tag controls when the AOI is active.

a. In the AOI, right-click on **?** on the first and click **New Tag**.

   The **New Tag** window opens.

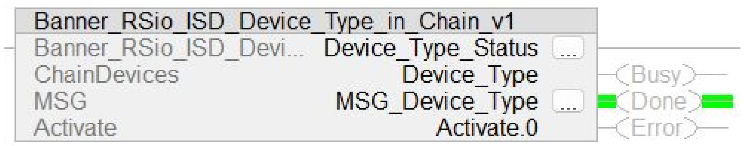
b. Enter a **Name** for the tag (see the table above).
c. Click **Create**.

   The **New Tag** window closes.

d. Repeat these steps for each line.

This creates the necessary tags to complete the operation

Figure 110. Banner_RSio_ISD_Device_Type_in_Chain_v1 Tags Created



The setup is complete.

7.2.3 Use an AOI to Request a list of the Device Types in an ISD Chain

1. In Studio 5000, expand the **Device_Type** tag.
2. Set the chain that will be accessed.

   Chains 1 to 6 represent Ports 0 to Port 5. This example uses `1` for Chain 1.

   Figure 111. Device_Type.Chain

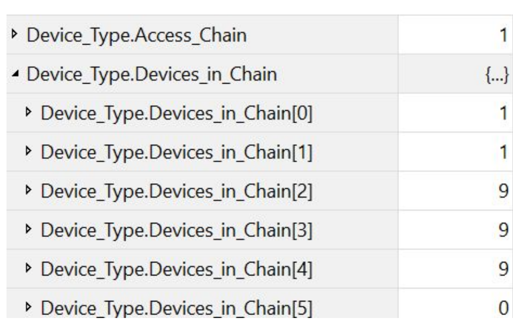
3. Turn Activate.0 to 1 or ON.

   This starts the process for accessing the Device Type.

4. Wait until the Activate.0 is turned OFF by the AOI. The Done bit will also be turned ON.
5. Ensure that the Error bit is not ON. If this is true, the data can be looked at.
6. Expand the **Device_in_chain** tag.
7. Examine the data as needed.

   The following figure shows only a partial list of what is possible.

   Figure 112. Device List

Device_Type.Access_Chain	1
Device_Type.Devices_in_Chain	{...}
Device_Type.Devices_in_Chain[0]	1
Device_Type.Devices_in_Chain[1]	1
Device_Type.Devices_in_Chain[2]	9
Device_Type.Devices_in_Chain[3]	9
Device_Type.Devices_in_Chain[4]	9
Device_Type.Devices_in_Chain[5]	0

In this example the [0] is for ISD Device 1, while [3] is for Device 4. The number returned represents the type of ISD device that is in that location of the chain.

1 = ISD SI-RF
7 = ISD E-Stop
9 = ISD Connect

In this example, the first two devices are SI-RF units while the next three are ISD Connect devices.

7.3 Request ISD Baseline

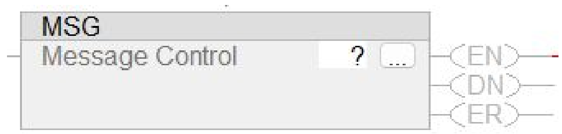
There are two ways to request an ISD baseline: manually or using an AOI.

Use the following instructions to request the baseline. These instructions are optional.

7.3.1 Manually Request ISD Baseline

1. In Studio 5000, add a Message (MSG) Instruction.
   This is used to create an explicit connection to the RSio block.

   Figure 113. Message (MSG) Instruction

2. Right click on **?** and select **New Tag**.
3. Create a tag for the Message instruction. This example uses `MSG`.

   Figure 114. MSG Tag

4. Create two tags needed for the Message Instruction.
   a. Create a tag array of SINT. This example uses `AccessBaseChain`.
      This tag is used by MSG to request data types of ISD in the chain.
   b. Set to 1 to 6 to access one of the six chains.
      These chains are linked to ports 0 to 5. For example, Port 0 represents Chain 1.

      Figure 115. SINT Tag–AccessBaseChain

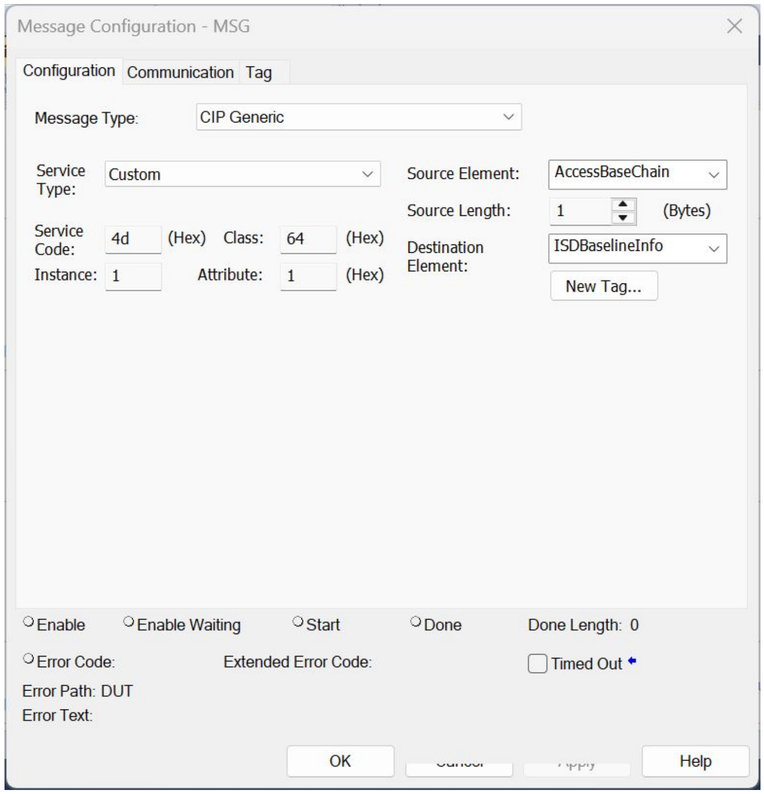
   c. Create a tag array of SINT[40].
      This is used to store the response for the RSio ISD device being accessed. This example uses `ISDBaselineInfo`.

      Figure 116. SINT[40] Tag–ISDBaselineInfo

5. Click **...** to the right of MSG.
   The **Message Configuration - MSG** setup screen opens.
6. Enter the following information on the **Configuration** tab:
   - Service Code: 4d
   - Class: 64
   - Instance: 1
   - Attribute: 1

*Figure 117. **Message Configuration - MSG** Window, **Configuration** Tab*



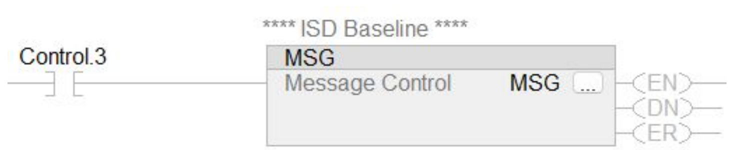
7. Link the **Source Element** to the tag created in step 4a (AccessBaseChain).
8. Link the **Destination Element** to the tag created in step 4c (ISDBaselineInfo).
9. Set the Source Length to `1`.
10. Click the **Communication** tab.

    The **Communication** tab opens.
11. Set the path to the name of the RSio block in the system.
12. Click **OK** or **Apply** to finalize the changes.

    If the AccessBaseChain has been set to the chain that needs to be accessed, then the operation can be activated.
13. Add an **Examine On** in front of the **Message Instruction**.

    This will control when the acyclic communication to the RSio block is allowed.
14. Create a Boolean to control this. This example uses `Control.3`.

    Figure 118. Control.3

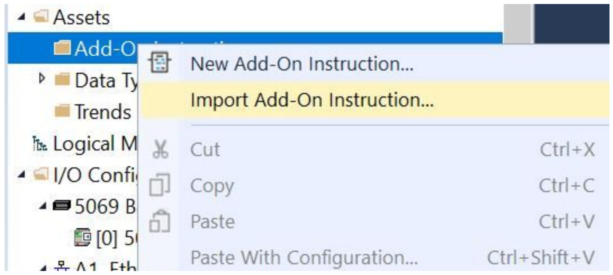
    When this MSG instruction is activated, there are two possible outcomes. It will be successful, or an error will be generated. If successful, then the ISDBaselineInfo tag returns with the device types in the chain. If the operation fails, then either the "AutoDetect at Power Up" is set to Auto Baseline or the chain doesn't require a baseline currently.

7.3.2 Set Up an AOI to Request ISD Baseline

Download the AOI file for the RSio block from www.bannerengineering.com. The AOI is setup so that the process is more automated than just using the message instruction.

1. In the **Controller Organizer** window, right-click on the **Add-On Instruction** folder, and select the **Import Add-On Instruction** option.

Figure 119. Import Add-On Instruction Folder Selection



The **Import Add-On Instruction** window opens.

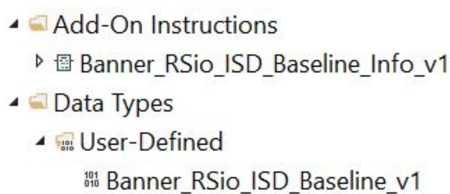
2. Navigate to the correct file location and select the AOI to be installed.

   In this example, "*Banner_RSio_ISD_Baseline_Info_v1*" file is selected.
3. Click **Open**.

   The **Import Configuration** window opens. The default selection creates all necessary items for the AOI.
4. Click **OK** to complete the import process.

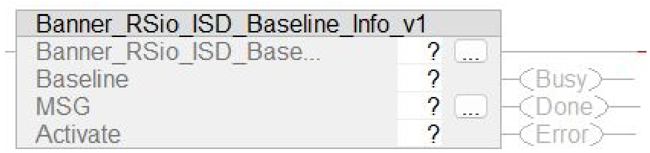
   The AOI is added to the **Controller Organizer** window and should look like the following figure.

   *Figure 120. AOI in the **Controller Organizer** Window*



   The AOI is now available in Studio 5000.
5. Add the "Banner_RSio_ISD_Baseline_Info_v1" AOI to a rung in Studio 5000.

   Figure 121. Banner_RSio_ISD_Baseline_Info_v1



6. For each question mark shown in the instruction, create and link a new tag array using the following instructions. This example uses the following names for the tags:

Tag	Example Name	Description
Banner_RSio_ISD_Device	Baseline_Status	This is the tag for the status of the AOI.
Baseline	Baseline	This tag stores the tags used to process the ISD Baseline operation.
MSG	MSG_Baseline	This tag creates a message data type used to communicate to the RSio via an explicit connection.
Activate	Activate.3	This tag controls when the AOI is active.

   a. In the AOI, right-click on **?** on the first line and click **New Tag**.

      The **New Tag** window opens.

   b. Enter a **Name** for the tag (see the table above).

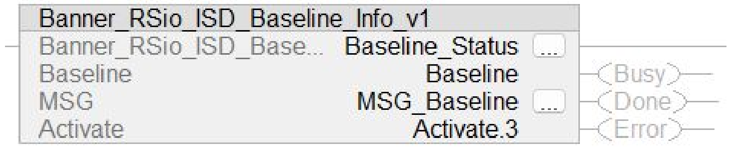
   c. Click **Create**.

      The **New Tag** window closes.

   d. Repeat these steps for each line.

This creates the necessary tags to complete the operation.

Figure 122. Banner_RSio_ISD_Baseline_Info_v1 - Tags Created



The setup is complete.

7.3.3 Use an AOI to Request ISD Baseline

1. In Studio 5000, expand the **Baseline** tag.
2. Set the chain that will be accessed.
   Chains 1 to 6 represent Ports 0 to Port 5. This example uses 1 for Chain 1.
   Figure 123. Baseline.AccessChain

▸ Baseline.AccessChain	1	Decimal

3. Turn Activate.3 to 1 or ON.
4. Wait until the Activate.3 is turned OFF by the AOI. The Done bit will also be turned ON.
5. Ensure that the Error bit is not ON. If this is true, the data can be looked at.
6. Expand the **BaselineInfo** tag.
7. Examine the data as needed.
   The following figure shows only a partial list of what is possible.
   Figure 124. Device List

◂ Baseline.BaselineInfo	{...}
▸ Baseline.BaselineInfo[0]	1
▸ Baseline.BaselineInfo[1]	1
▸ Baseline.BaselineInfo[2]	9
▸ Baseline.BaselineInfo[3]	9
▸ Baseline.BaselineInfo[4]	9
▸ Baseline.BaselineInfo[5]	0

   The number returned shows which type of ISD device is in that location of the chain.
   1 = ISD SI-RF
   7 = ISD E-Stop
   9 = ISD Connect
   Here the first two devices are Si-RF units while the next three are ISD Connect devices.

   If the Error bit is ON, there are few possible reasons:
   - There is a standard communications issue. Check that the device is present on the port and the Message instruction was configured correctly.
   - The **AutoDetect at Power Up** setting in the **Safety Configuration** tag for the block is not set for Manual Baseline. Check that setting.
   - The Manual Baseline is set, but the ISD Chain has already been baselined. If that is the case an error is generated.

7.4 ISD Chain System Status

Banner Engineering Corp. has created a couple of words that can be accessed quickly by the PLC to indicate if there are any problems with the ISD chain.

> **NOTE:** The ISD data is not immediately available upon power up. The ISD data can be delayed up to 10 seconds after the system power has been turned on.

This information has the following format:

Information	Type	Data Size	Steps to Resolve
ISD chain count does not match the configuration	Controller Alert	1 bit	Check the number of physical units against the number configured in the chain
ISD chain order does not match the configuration	Controller Alert	1 bit	Check the order of the physical units against the configured order. Note the location of the terminator plug and the controller.
ISD data update pending (no data or buffered data)	Controller Alert	1 bit	Caused by non-ISD devices in the chain or a buffering situation If the data is not present from power up (never present): • Verify that all devices in ISD Chain are ISD-enabled devices If data was present but then lost: • Verify that the chain has not been broken • Data could be disrupted and will return in a few seconds
Invalid (non-ISD) device in the ISD chain	Controller Alert	1 bit	Incorrect data types are being received • Verify that all devices in the chain are Banner ISD devices
ISD chain terminator plug is missing	ISD Status	1 bit	• Verify that the terminator plug has not come loose • Verify that the chain has not been broken (loose connections)
SI-RF high or unique sensor not taught an actuator	ISD Fault	1 bit	An SI-RF switch (-UP8 or -HP8) have not been taught • Configure the unit to its actuator per instructions in Banner datasheet p/n 208885
Wrong actuator presented to a high or unique sensor	ISD Fault	1 bit	An SI-RF switch (-UP8 or -HP8) is seeing an actuator but not the one to which it was configured. • Check for tampering (wrong actuator being used) • Teach High coded sensor (-HP8) the new actuator
ISD Output fault detected, output turn off counter started	ISD Fault	1 bit	ISD device output will turn off in 20 minutes • Verify which device has the error, check wiring for shorts • Cycle power, if issue persists, replace the device
Change in ISD chain detected	ISD Status	1 bit	Because AutoDetect ISD is always configured and an ISD chain length or order has changed, this flag will be set and must be recognized by the PLC. See Request Device List.
ISD Count Change from Baseline Detected	ISD Status	1 bit	ISD device count has changed from the baseline count, verify the chain device count matches machine configuration. See Request ISD Baseline.
ISD Chain output signal switching device (OSSD) status	ISD Status	1 bit	

7.5 ISD Individual Device-Specific Data

NOTE: The ISD data is not immediately available upon power up. The ISD data can be delayed up to 10 seconds after the system power has been turned on.

Information	Data size	Applies to Banner Device (Y/N/ Reserved)		
		SI-RF	E-Stop	ISD Connect
Safety Input Fault	1 bit	Y	Y	Y
reserved	1 bit	*reserved*	*reserved*	*reserved*
Sensor Not Paired	1-bit	Y	N	N

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Information	Data size	Applies to Banner Device (Y/N/ Reserved)		
		SI-RF	E-Stop	ISD Connect
ISD Data Error	1-bit	Y	Y	Y
Wrong Actuator/Button Status/Input Status	1-bit	Y	Y	Y
Marginal Range/Button Status/Input Status	1-bit	Y	Y	Y
Actuator Detected	1-bit	Y	N	N
Output Error	1-bit	Y	Y	Y
Input 2	1-bit	Y	Y	Y
Input 1	1-bit	Y	Y	Y
Local Reset Expected	1-bit	Y	Y	N
Operating Voltage Warning	1-bit	Y	Y	Y
Operating Voltage Error	1-bit	Y	Y	Y
Output 2	1-bit	Y	Y	Y
Output 1	1-bit	Y	Y	Y
Power Cycle Required	1-bit	Y	Y	Y
Fault Tolerant Outputs	1-bit	Y	Y	Y
Local Reset Unit	1-bit	Y	Y	N
Cascadable	1-bit	Y	Y	Y
High Coding Level	1-bit	Y	N	N
Teach-ins Remaining	4-bit	Y	N	N
Device ID	5-bit	Y	Y	Y
Range Warning Count	6-bit	Y	N	N
Output Switch-off Time	5-bit	Y	Y	Y
Number of Voltage Errors	8-bit	Y	Y	Y
Internal Temperature [23]	8-bit	Y	Y	Y
Actuator Distance[23]	8-bit	Y	N	N
Supply Voltage[23]	8-bit	Y	Y	Y
Expected Company Name	4-bit	Y	N (always "6")	N (always "6")
Received Company Name	4-bit	Y	N	N
Expected Code	16-bit	Y	N	N
Received Code	16-bit	Y	N	N
Internal Error A	16-bit	Y	Y	Y
Internal Error B	16-bit	Y	Y	Y

[23] For conversion to Internal Temperature, Actuator Distance, and Supply Voltage, see "ISD: Temperature, Voltage, and Distance Conversion Information" on page 109.

7.6 SI-RF Device

In the case of the ISD-enabled gate switch (SI-RF), the ISD Individual Device-Specific Data coming back from the SI-RF device has the following format:

Information	Data size
Safety Input Fault	1 bit
reserved	1 bit
Sensor Not Paired	1-bit
ISD Data Error	1-bit
Wrong Actuator	1-bit
Marginal Range	1-bit
Actuator Detected	1-bit
Output Error	1-bit
Input 2	1-bit
Input 1	1-bit
Local Reset Expected	1-bit
Operating Voltage Warning	1-bit
Operating Voltage Error	1-bit
Output 2	1-bit
Output 1	1-bit
Power Cycle Required	1-bit
Fault Tolerant Outputs	1-bit
Local Reset Unit	1-bit
Cascadable	1-bit
High Level Coding	1-bit
Teach-ins Remaining	4-bit
Device ID	5-bit
Range Warning Count	6-bit
Output Switch-off Time	5-bit (value of 31 means Timer is OFF)
Number of Voltage Errors	8-bit
Internal Temperature(24)	8-bit
Actuator Distance(24)	8-bit
Supply Voltage(24)	8-bit
Expected Company Name	4-bit
Received Company Name	4-bit
Expected Code	16-bit
Received Code	16-bit
Internal Error A	16-bit
Internal Error B	16-bit

(24) For conversion to Internal Temperature, Actuator Distance, and Supply Voltage, see "ISD: Temperature, Voltage, and Distance Conversion Information" on page 109.

7.7 E-Stop Device and ISD Connect

In the case of the ISD-enabled E-stop or ISD Connect, the ISD Individual Device-Specific Data coming back from the device has the following format:

Information	Data Size
Safety Input Fault	1-bit
reserved	2-bit
ISD Data Error	1-bit
reserved	3-bit
Output Error	1-bit
Input 2	1-bit
Input 1	1-bit
Local Reset Expected	1-bit (always false for ISD Connect)
Operating Voltage Warning	1-bit
Operating Voltage Error	1-bit
Output 2	1-bit
Output 1	1-bit
Power Cycle Required	1-bit
Fault Tolerant Outputs	1-bit (always true for ISD E-Stop and Connect)
Local Reset Unit	1-bit (always false for ISD Connect)
Cascadable	1-bit (always true for ISD E-Stop and Connect)
reserved	5-bit
Device ID	5-bit (always value of 7 for ISD E-Stop) (always value of 9 for ISD Connect)
reserved	6-bit
Output Switch-off Time	5-bit (value of 31 means Timer is OFF)
Number of Voltage Errors	8-bit
Internal Temperature(25)	8-bit
reserved	8-bit
Supply Voltage(25)	8-bit
Expected Company Name	4-bit (always value of 6 for ISD E-Stop and Connect)
reserved	36-bit
Internal Error A	16-bit
Internal Error B	16-bit

(25) For conversion to Internal Temperature, Actuator Distance, and Supply Voltage, see "ISD: Temperature, Voltage, and Distance Conversion Information" on page 109.

7.8 ISD: Temperature, Voltage, and Distance Conversion Information

Download an AOI from www.bannerengineering.com to insert into the PLC program to perform the conversions from the obtained values to the real values.

7.8.1 ISD: Supply Voltage

To obtain the actual voltage reading from the Analog to digital conversion (ADC) value sent to the PLC, multiple the ADC value by 0.1835.

Supply Voltage = ADC Value × 0.1835

7.8.2 ISD: Internal Temperature

First, shift the Analog to digital conversion (ADC) value left by 2 bits. Then, convert the binary reading into a number. If the number matches an ADC value in the following table, read the temperature. If the number is between the readings in the table, use the following formula to obtain the actual temperature.

Table 17. Temperature

```
Internal Temperature = ((A–L) / (H–L)) × 5 + T
```

A
: the ADC Value obtained from the controller

L
: the ADC value on the lookup table less than or equal to A

H
: the ADC value on the lookup table greater than A

T
: the temperature associated with the L value

ADC Reading	Temperature (°C)
41	-40
54	-35
69	-30
88	-25
110	-20
136	-15
165	-10
199	-5
237	0
278	5
321	10
367	15
414	20
461	25
508	30
554	35
598	40
640	45
679	50
715	55
748	60
778	65
804	70
829	75
850	80
869	85
886	90
901	95
914	100
926	105
936	110

7.8.3 ISD: Actuator Distance

Convert the binary reading into a number. If the number matches an Analog to digital conversion (ADC) value in the following table, read the distance. If the number is between the readings in the table, use the following formula to obtain the actual distance.

Table 18. Distance

<table>
<tr><th></th><th>ADC Reading</th><th>Distance (mm)</th></tr>
<tr><td rowspan="14">

```
Actuator Distance = ((A-L) / (H-L)) + D
```

A
the ADC Value obtained from the controller
L
the ADC value on the lookup table less than or equal to A
H
the ADC value on the lookup table greater than A
D
the distance associated with the L value</td><td><62</td><td><7</td></tr>
<tr><td>62</td><td>7</td></tr>
<tr><td>65</td><td>8</td></tr>
<tr><td>77</td><td>9</td></tr>
<tr><td>110</td><td>10</td></tr>
<tr><td>133</td><td>11</td></tr>
<tr><td>148</td><td>12</td></tr>
<tr><td>158</td><td>13</td></tr>
<tr><td>163</td><td>14</td></tr>
<tr><td>169</td><td>15</td></tr>
<tr><td>172</td><td>16</td></tr>
<tr><td>176</td><td>17</td></tr>
<tr><td>180</td><td>18</td></tr>
<tr><td>>180</td><td>>18</td></tr>
</table>

Chapter Contents

Chapter 8 System Checkout

8.1 Schedule of Required Checkouts

Verifying the configuration and proper functioning of the RSio block and Safety PLC 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.

Banner Engineering Corp. 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.

The checkout requirements of the Safety PLC should also be taken into account and included in the process.

WARNING:
- **Do not use the system until the checkouts are verified**
- Attempts to use the guarded/controlled machine before these checks are verified could result in serious injury or death.
- If all these checks cannot be verified, do not attempt to use the safety system that includes the Banner Engineering Corp. 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 RSio block and Safety PLC and the functionality of the intended configuration. Initial Setup, Commissioning, and Periodic Checkout Procedures 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). 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 must perform a safety system commissioning procedure before the safeguarded machine application is placed into service and after each RSio block and Safety PLC configuration is created or modified.

Periodic (Semi-Annual) Checkout: A Qualified Person 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 must also check the effectiveness of the risk reduction measures, per the device manufacturers' recommendation, each day that the safeguarded machine is in service.

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.

8.2 Commissioning Checkout Procedure

Before proceeding, verify that:

- All outputs of the complete RSio and the Safety PLC are not connected to the machine. Disconnecting all of the safety outputs cables on the RSio 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.

8.2.1 Verifying System Operation

The commissioning checkout procedure must be performed by a Qualified Person[26]. **It must be performed only after configuring the RSio block and Safety PLC and after properly installing and configuring** the safety systems and safeguarding devices connected to its inputs (see Safety Input Device Options and the appropriate standards).

The commissioning checkout procedure is performed on two occasions:

1. When the RSio block and Safety PLC are 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 RSio block and Safety PLC function (see Schedule of Required Checkouts).

For the initial part of the commissioning checkout, the RSio block, Safety PLC, and associated safety systems must be checked <u>without power being available to the guarded machine.</u> 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 per the configuration via the normally closed (NC) monitoring contacts of the device(s) connected to the safety outputs, as described in "External Device Monitoring (EDM)" on page 37 and the wiring diagrams
- All connections have been made according to the appropriate sections and comply with NEC and local wiring codes

This procedure allows the RSio block, Safety PLC, and the associated safety systems to be checked out, by themselves, before permanent connections are made to the guarded machine.

8.2.2 Initial Setup, Commissioning, and Periodic Checkout Procedures

To verify that the Safety Outputs are changing state at the appropriate times in the initial configuration check out phase: 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).

Startup Configuration

Outputs associated with Two-Hand Control, Bypass, 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.

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 RSio block and Safety PLC configuration to make sure that the loss of power to any safeguarding input device, the RSio block, the Safety PLC, or the inverted input signal from a safeguarding input device, do not cause an unintended Safety Output ON condition, mute condition, or bypass condition.

(26) See the Glossary for definitions.

NOTE: If an Input or Output indicator is flashing red, see "Troubleshooting" on page 119.

Safety Input Device Operation (E-stop, Rope Pull, Optical Sensor, Gate Switch, ISD Device Chain)

1. While the associated Safety Outputs are ON, actuate each safety input device, one at a time (including each device in a ISD chain or cascade series).
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 the Two-Hand Control function above.
2. Activate the Two-Hand Control actuators then activate the Mute sensors.
3. With the mute 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:
   - Mute sensor is 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 the defined time limit.
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.
   b. Change the muted safeguarding device to the Stop state.
   c. Activate Muting Sensor Pair 2.
   d. Deactivate Muting Sensor Pair 1.
2. Verify the associated Safety Output remains ON throughout the process. If a mute time limit has been configured, verify that the associated Safety Outputs turn OFF when the mute timer expires.
3. Repeat the test in the *wrong direction* (Mute Sensor Pair 2, then the safeguarding device, then Mute Sensor Pair 1).
4. Verify that when the safeguard changes to the Stop state the output turns OFF.

Mute Function with Power-Up Operation (not applicable for Two-Hand Control)

1. Turn the RSio block and the Safety PLC 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 RSio block and the Safety PLC.
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.

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

1. 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

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

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.

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Chapter 9 Status and Operating Information

9.1 LED Status

WARNING: LEDs are not reliable indicators and cannot be guaranteed to provide accurate information. They should be used only for general diagnostics during commissioning or troubleshooting. Do not attempt to use LEDs as operational indicators.

Table 19. LED Status

LED	Status	Meaning
V1 (Input Power Status)	OFF	No input power
	Green: Solid	Normal operation
	Yellow: Solid	The input power is out of specification
MOD (Module Status)	OFF	No power to the block
	Green: Solid	The block is operating in a normal state
	Green: Flashing	The block is operating in the idle or standby state
	Red: Flashing	The block has a recoverable fault
	Red: Solid	The block has an unrecoverable fault (may need to be replaced)
	Red/Green: Flashing	• The block is in self-test mode • The block needs commissioning due to the configuration • The UNID is missing, incomplete, or incorrect
LINK1 (Port 1 Ethernet Link Established)	OFF	No network link
	Green: Solid	Network link established
ETH1 (Port 1 Ethernet Activity)	OFF	No network activity
	Yellow: Flashing	Network activity
LINK2 (Port 2 Ethernet Link Established)	OFF	No network link
	Green: Solid	Network link established
ETH2 (Port 2 Ethernet Activity)	OFF	No network activity
	Yellow: Flashing	Network activity
NET (Ethernet Communication Status)	OFF	The block is not online or not powered
	Green: Flashing	The block is online but not connected
	Green: Solid	The block is online and connected to network
	Red: Flashing	One or more network connections are in the timed-out state
	Red: Solid	Failed communication (the block has detected an error that makes it incapable of communicating on the network)
	Red/Green: Flashing	The block has detected a network access error and is in the communication-faulted state

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LED	Status	Meaning
Ix (Input Status, 12 total)	OFF	The safety input is off (or the input is configured for "not used")
	Yellow: Solid	The safety input is ON
	All Input Status LEDs Red: Solid	A critical fault(27) is detected
	All Input Status LEDs Red: Flashing(28)	A system fault(29) is detected
	One Input Status LED for a Port is Red: Flashing(30)	Single channel input fault
	Both Input LEDs for a Port are Red: Flashing(30)	Dual channel input fault
Ox (Output Status, 4 total)	OFF	The safety output is OFF (or channel configured for not used)
	Yellow: Solid	The safety output is ON
	All Output Status LEDs Red: Solid	A critical fault(27) is detected
	All Output Status LEDs Red: Flashing(28)	A system fault(29) is detected
	One Output Status LED of a Port is Red: Flashing(30)	Single channel output fault
	Both Output Status LEDs for a Port are Red: Flashing(30)	Dual channel output faulted while in the OFF state
V2 (Output Power Status)	OFF	No power
	Green: Solid	Normal operation
	Yellow: Solid	The output power out is of specification

9.2 Reset to Factory Defaults

If the block is to be repurposed, use the following procedure to reset the device to the factory default settings.

1. Make sure power has been removed from the RSio block.
2. Remove the screws that secure the rotary switch cover, then remove the cover.
3. Set the rotary switches to 888.
4. Apply power to the block.
5. Remove power from the RSio block.
6. Set rotary switches to the desired setting. See "Set the IP Address of the RSio Block" on page 59 for additional details.
7. Re-install the rotary switch cover and torque the screws to 0.3 ± 0.03 Nm (2.5 ± 0.3 lb-in).

(27) A critical fault is an internal failure associated with the safety microprocessors or memory such that the RSio block can no longer function reliably. All safety outputs are turned OFF. A power cycle may restore the unit function, otherwise the unit must be replaced.
(28) Repeating sequence of 0.5 seconds on, 0.5 seconds off.
(29) A system fault is an internal issue serious enough that normal safety operation cannot continue. All safety outputs are turned OFF. A power cycle or a System Reset Type 0 from the Safety PLC will cause the RSio block to reset (assuming the fault has cleared).
(30) Repeating sequence of 0.1 seconds on, 0.1 seconds off.

9.2.1 Factory Default Settings

The following figure shows the factory default settings of the RSio block. Note that when using the EDS, as soon as the PLC connects to the RSio block, it will overwrite these settings with whatever is in the PLC configuration.

Figure 125. Factory Defaults

Safety Configuration

Name	R/W	Value
Input Port Presets		
Input Port 0	rw	Two Standard Inputs
Input Port 1	rw	Two Standard Inputs
Input Port 2	rw	Two Standard Inputs
Input Port 3	rw	Two Standard Inputs
Input Port 4	rw	Two Standard Inputs
Input Point 5	rw	Two Standard Inputs
Output Port Presets		
Output Port 6	rw	Dual Channel OSSD
Output Port 7	rw	Dual Channel OSSD

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Chapter 10 Troubleshooting

The RSio block 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-mechanical 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 cordsets attached to the RSio are tightly installed
- No high-voltage or high-frequency noise sources or any high-voltage power lines are routed near the RSio block or alongside cables that are connected to it
- Proper transient suppression is applied across the output loads
- The temperature surrounding the RSio block is within the rated ambient temperature specifications

10.1 Finding and Fixing Input/Output Faults

Depending on the configuration, the RSio block can detect a number of input, output, and system faults.

It will only pass the input and output faults to the PLC via Explicit Messages, see "Read Safety Fault AOI" on page 80.

NOTE: Only the current faults can be requested. The RSio block does not have a fault log of older faults.

10.2 RSio Fault Code Tables

The following tables lists the fault codes of the RSio and the steps to help resolve the fault.

Table 20. Output Faults

Code	Description	Steps to Resolve
0	No fault	
1	Output shorted to ground	Check for shorts to ground or DC common
2	Output appears ON when it should be OFF	• Check for shorts to an external voltage source • Check for shorts to other outputs • Check load device compatibility (does not remove OSSD test pulses) • Check the DC common wire size connected to the Safety Output loads. The wire must be 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 the DC common return part with other devices (see)
3	Internal Output fault	Internal Failure—Disconnect output cable and cycle power to see if fault clears

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Code	Description	Steps to Resolve
4	Turn ON test Failure	External short to voltage when trying to turn ON • Check for shorts to an external voltage source • Check for shorts to other outputs • Check load device compatibility (does not remove OSSD test pulses) • Check the DC common wire size connected to the Safety Output loads. The wire must be 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 the DC common return part with other devices (see)
5	Output Data error	Improper command received from the safety PLC; check the PLC program

Table 21. Input Terminal Faults

Code	Description	Steps to Resolve
0	No fault	
1	Fault in other dual channel input	
2	Concurrency fault	On a dual channel input both in the ON state, one output turned OFF then back ON while the other stayed ON • Check input wiring • Check input signaling devices • Consider adjusting the ON/OFF and OFF/ON discrepancy times
3	State mismatch fault	On a dual channel input both input are not in both ON or both OFF state • Check input wiring • Check input signaling devices
4	Input stuck at 24 V	Input tied to a Test Output Point but does not see any test pulses • Check for shorts to other inputs or other voltage sources • Check for input device compatibility to circuit selected • Check for wiring issues
5	Internal input fault	Internal Failure—Disconnect input cable and cycle power to see if fault clears

Table 22. Test Output Faults

Code	Description	Steps to Resolve
0	No fault	
1	Fault on specific input terminal	
2	Fault on associated input terminal, terminal unknown	

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Code	Description	Steps to Resolve
3	Overcurrent on Test Output	The current load on a test output has exceeded its current limit • Check for wiring issues • Check the input device for compatibility

10.3 Safety Module Faults

The following are some of the most common messages that may be encountered when using the Banner Remote Safe I/O block with an Allen Bradley PLC. The message is described along with how to resolve it.

Message	Reason	Solution
Safety network number not set, device out-of-box (16#080d)	This appears when the RSio block has not yet been configured.	Set the TUNID and Safety Configuration Signature.
Safety Network Number (SNN) mismatch (16#080e)	The SNN in the RSio block doesn't match the one in the PLC.	Set the SNN in the RSio block to the one in the PLC using the PLC Set function.
Safety configuration signature mismatch (16#080C)	The Safety Configuration doesn't match. Most likely the configuration in the PLC has been changed.	Press the Reset Ownership button. The PLC and RSio block renegotiate the connection, saving the current Safety Configuration.
Configuration invalid	The configuration sent to the RSio block is not valid.	Check the current configuration, find the section of the configuration that is not valid, and rework that section. Update the PLC and Reset the Link for the Safety Configuration because it has now been changed.
Connection request error (16#0204)	There is a network issue between the PLC and the RSio block.	Check the IP address of the block and ensure that the PLC is using that IP address. Use RSLinx to see what devices are present in the system or use PING to see if the plc and block are accessible.
Connection request error: Module in use (16#0100)	RSio block linked to another PLC. Need to link to new PLC.	Use the Reset Link button in the **Safety** tab. This links the RSio block to the current PLC.

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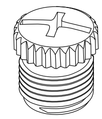
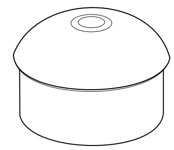
Chapter 11 Accessories

The following accessories are provided with the RSio block but can be ordered as a replacement hardware package.

ACC-CAP M12-10 (84719)
- 10 caps
- Polybutylene Terephthalate
- Seal and protect exposed, unterminated M12 quick-disconnect connectors

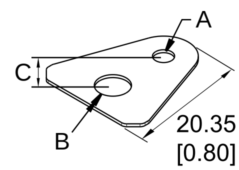


RSA-CAP-DUST-MA-1 (818229)
- MA Female port dust cover
- Vinyl

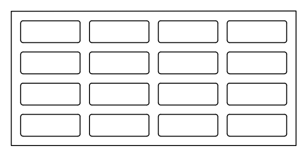


RSA-GT-2 (818355)
- 2 Grounding tabs
- 2 M3 screws

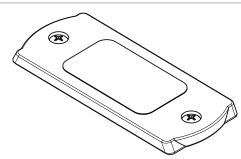
A = ø 3.1, B = ø 5.2, C = 10



RSA-PL-16 (818230)
- Port labels
- 1 sheet of 16 labels

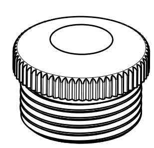


RSA-RSD-1 (818356)
- 1 Rotary switch door
- The door includes a gasket and 2 captive screws

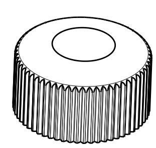


The following accessories are available but are not included with the RSio block. These caps are need to maintain IP67.

BCC-MAF-NPB (818216)
- Closure Cap
- Female Mini Cap used for Male Mini Products
- Nickel-Plated Brass

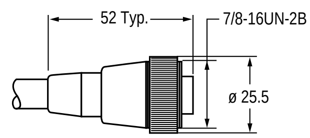
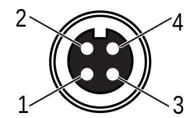


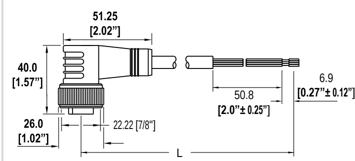
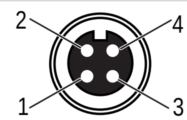
BCC-MAM-NPB (818215)
- Closure Cap
- Male Mini Cap used for Female Mini Products
- Nickel-Plated Brass



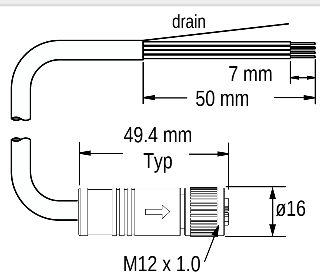
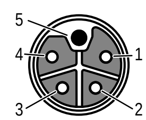
11.1 Cordsets

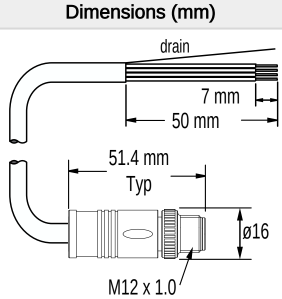
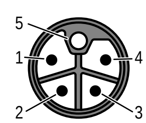
11.1.1 4-Pin Single-Ended Cordsets

4-Pin Single-Ended Mini Female Cordsets				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
MBCC-406	1.83 m (6 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black
MBCC-412	3.66 m (12 ft)			
MBCC-430	9.14 m (30 ft)			

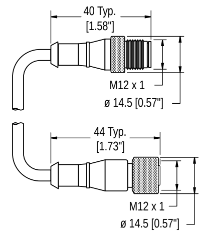
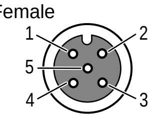
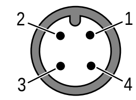
4-Pin Single-Ended Right-Angle Mini Female Cordsets				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
MBCC-412RA	4 m (13.12 ft)	Right-Angle		 1 = Brown 2 = White 3 = Blue 4 = Black
MBCC-430RA	9 m (29.5 ft)			
MBCC-433RA	10 m (32.8 ft)			

11.1.2 5-Pin Single-Ended Cordsets

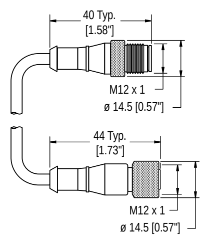
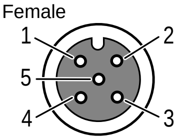
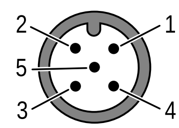
5-pin L-Code Single-Ended M12 Female Cordsets				
Model	**Length**	**Dimensions (mm)**	**Pinout (Female)**	
BCP-M12LF5-14-1	1 m (3.28 ft)			1 = Brown 2 = White 3 = Blue 4 = Black 5 = Yellow/Green Shell = Braid
BCP-M12LF5-14-2	2 m (6.56 ft)			
BCP-M12LF5-14-5	5 m (16.4 ft)			
BCP-M12LF5-14-10	10 m (32.8 ft)			
BCP-M12LF5-14-15	15 m (49.2 ft)			
BCP-M12LF5-14-20	20 m (65.6 ft)			

5-pin L-Code Single-Ended M12 Male Cordsets				
Model	**Length**	**Dimensions (mm)**	**Pinout (Male)**	
BCP-M12LM5-14-1	1 m (3.28 ft)			1 = Brown 2 = White 3 = Blue 4 = Black 5 = Yellow/Green Shell = Braid
BCP-M12LM5-14-2	2 m (6.56 ft)			
BCP-M12LM5-14-5	5 m (16.4 ft)			
BCP-M12LM5-14-10	10 m (32.8 ft)			
BCP-M12LM5-14-15	15 m (49.2 ft)			
BCP-M12LM5-14-20	20 m (65.6 ft)			

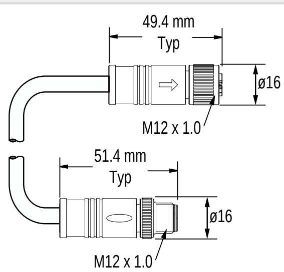
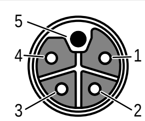
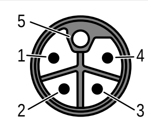
11.1.3 4-Pin Double-Ended Cordsets

4-pin A-Code Double-Ended M12 Female to M12 Male Cordsets (datasheet p/n 236186)				
Model	Length	Dimensions (mm)	Pinouts	
BC-M12F4-M12M4-22-1	1 m (3.28 ft)		Female  Male 	1 = Brown 2 = White 3 = Blue 4 = Black 5 = Unused
BC-M12F4-M12M4-22-2	2 m (6.56 ft)			
BC-M12F4-M12M4-22-3	3 m (9.84 ft)			
BC-M12F4-M12M4-22-4	4 m (13.12 ft)			
BC-M12F4-M12M4-22-5	5 m (16.4 ft)			
BC-M12F4-M12M4-22-10	10 m (30.81 ft)			
BC-M12F4-M12M4-22-15	15 m (49.2 ft)			

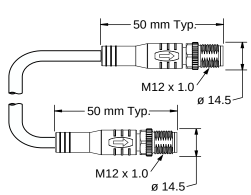
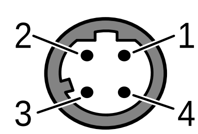
11.1.4 5-Pin Double-Ended Cordsets

5-pin A-Code Double-Ended M12 Female to M12 Male Cordsets (datasheet p/n 236183)				
Model	Length	Dimensions (mm)	Pinouts	
BC-M12F5-M12M5-22-1	1 m (3.28 ft)		Female  Male 	1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
BC-M12F5-M12M5-22-2	2 m (6.56 ft)			
BC-M12F5-M12M5-22-5	5 m (16.4 ft)			
BC-M12F5-M12M5-22-8	8 m (26.25 ft)			
BC-M12F5-M12M5-22-10	10 m (30.81 ft)			
BC-M12F5-M12M5-22-15	15 m (49.2 ft)			

11.1.5 Double-Ended Power Cordsets L-Code

5-pin L-Code Double-Ended M12 Female to M12 Male Cordsets				
Model	Length	Dimensions (mm)	Pinout (Female)	Pinout (Male)
BCP-M12LF5-M12LM5-14-1	1 m (3.28 ft)		 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Yellow/Green Shell = Braid	 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Yellow/Green Shell = Braid
BCP-M12LF5-M12LM5-14-2	2 m (6.56 ft)			
BCP-M12LF5-M12LM5-14-5	5 m (16.4 ft)			
BCP-M12LF5-M12LM5-14-10	10 m (32.8 ft)			
BCP-M12LF5-M12LM5-14-15	15 m (49.2 ft)			
BCP-M12LF5-M12LM5-14-20	20 m (65.6 ft)			

11.1.6 Ethernet Cordsets

4-pin D-Code Double-Ended M12 Male to M12 Male PVC Cordsets				
Model	Length	Dimensions (mm)	Pinout (Male)	
BCD-M12DM-M12DM-1	1 m			1 = White/Orange 2 = White/Blue 3 = Orange 4 = Blue Shell = Braid
BCD-M12DM-M12DM-2	2 m			
BCD-M12DM-M12DM-5	5 m			
BCD-M12DM-M12DM-8	8 m			
BCD-M12DM-M12DM-10	10 m			
BCD-M12DM-M12DM-15	15 m			
BCD-M12DM-M12DM-20	20 m			

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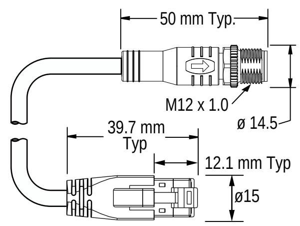
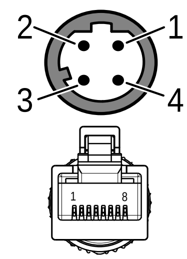
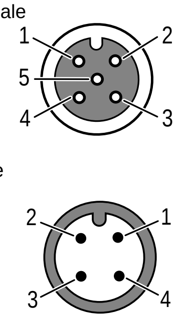
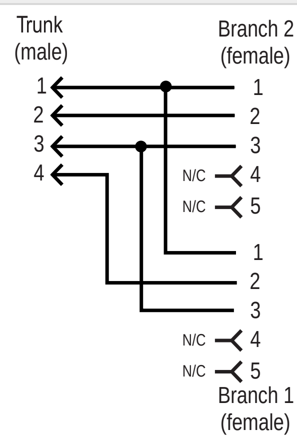
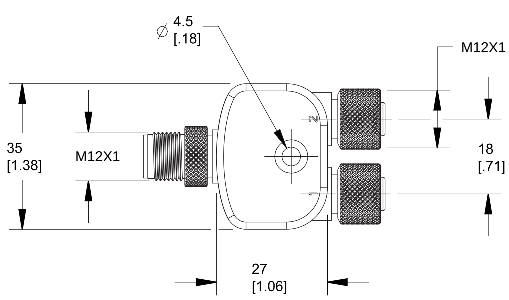
4-pin D-Code Double-Ended M12 Male to M12 Male PVC Cordsets				
Model	**Length**	**Dimensions (mm)**	**Pinout (Male)**	
BCD-M12DM-M12DM-25	25 m			

4-Pin Double-Ended M12 D-Code Male to RJ45 Ethernet Cordsets (datasheet p/n 244425)			
Model	**Length**	**Dimensions**	**Pinout**
BCD-M12DM-RJ45-1	1 m		*Figure 126. M12 Male*  1 = White/orange 2 = Orange 3 = White/green 4 = Green Shell = Braid
BCD-M12DM-RJ45-2	2 m		
BCD-M12DM-RJ45-5	5 m		
BCD-M12DM-RJ45-8	8 m		
BCD-M12DM-RJ45-10	10 m		
BCD-M12DM-RJ45-15	15 m		
BCD-M12DM-RJ45-20	20 m		
BCD-M12DM-RJ45-25	25 m		

11.1.7 Y Splitter for Splitting Inputs

4-Pin M12 Male Splitter to 4-pin M12 Female Cordset				
Model	**Trunk (Male)**	**Branches (Female)**	**Pinout**	**Wiring**
BY-M12M4-2M12F4-A2	No trunk	No branches	Female 	
				

Chapter Contents

Chapter 12 Product Support and Maintenance

12.1 Cleaning Instructions

Clean as necessary using only a lint-free cloth or a water-dampened lint-free cloth. Do not use any other chemicals for cleaning.

12.2 Repairs and Translations

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

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

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

Para reparaciones de productos, por favor contacte a su distribuidor local de Banner Engineering o llame a Banner directamente al 00 1 (763) 544-3164. Vea la literatura traducida en su idioma en el sitio web Banner en www.bannerengineering.com o comuníquese con Banner directamente al 00 1 (763) 544-3164.

Pour vous aider lors de la réparation de produits, contactez votre distributeur Banner local our appelez directement Banner au (763) 544-3164. La documentation traduite dans votre langue est disponible sur le site internet de Banner www.bannerengineering.com ou contactez directement Banner au (763) 544-3164.

请联系当地的 Banner Engineering Corp 经销商或直接致电 Banner +1 (763) 544-3164，以获得产品维修帮助。请访问邦纳网站 www.bannerengineering.com 或直接拨打 +1 (763) 544-3164 联系邦纳，获取翻译成您母语的资料。

제품 수리에 대한 지원은 지역 Banner Engineering Corp 대리점에 문의하거나 Banner에 직접 (763) 544-3164로 문의하실 수 있습니다. 사용자의 모국어로 번역된 자료는 Banner 웹사이트 www.bannerengineering.com에서 액세스하거나 Banner에 직접 (763) 544-3164로 문의하실 수 있습니다.

12.3 Contact Us

Banner Engineering Corp. | 9714 Tenth Avenue North | Plymouth, MN 55441, USA | Phone: + 1 888 373 6767

For worldwide locations and local representatives, visit www.bannerengineering.com.

12.4 Manufacturing Date

Every RSio produced is marked with a code that defines the week and year of manufacture and manufacturing location. The code format (U.S. Standard format) is: **YYWWL**

- YY = Year of manufacture, 2 digits
- WW = Week of manufacture, 2 digits
- L = Banner-specific code, 1 digit

Example: 2309H = 2023, Week 9.

12.5 Disposal

Devices that are no longer in use should be disposed of according to the applicable national and local regulations.

12.6 Banner Engineering Corp Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. **IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.**

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: www.bannerengineering.com.

For patent information, see www.bannerengineering.com/patents.

Chapter Contents

Chapter 13 Standards and Regulations

The list of standards below is included as a convenience for users of this Banner device. Inclusion of the standards below does not imply that the device complies specifically with any standard, other than those specified in the Specifications/Design Standards section of this manual. See the American National Standards Institute (ANSI) at https://webstore.ansi.org/ or another source for applicable documents.

13.1 Applicable U.S. Standards

Not inclusive

ANSI B11 Standards for Machine Tools Safety

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

ANSI/ASSP Z244.1-2024 The Control of Hazardous Energy – Lockout, Tagout, and Alternative Methods

OSHA 29 CFR 1910 Occupational Safety and Health Standards

13.2 Applicable European and International Standards

Not Inclusive

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

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

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

IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

IEC 62061 Safety of Machinery – Functional Safety of Safety-Related Control Systems

ISO 13850 Emergency Stop Devices, Functional Aspects – Principles for Design

ISO 13851 Two-Hand Control Devices – Principles for Design and Selection

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

ISO 13857 Safety of Machinery – Safety Distances to Prevent Hazard Zones Being Reached

ISO 14119 Interlocking Devices Associated with Guards – Principles for Design and Selection

ISO 14120 Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards

Acquire a type C standard for your specific machinery.

Index

Glossary

automatic reset

An automatic reset is the safety input device control operation setting where the assigned safety output automatically turns on when all of its associated input devices are in the Run state. No manual reset operation is required for the safety output to turn on when controlled only by safety input devices configured for automatic reset. When automatic reset is selected, the input device may be said to be configured to run in auto start/restart mode.

Designated Person

A Designated Person is a person or persons identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure.

dual-channel

A dual-channel device or configuration has redundant signal lines for each safety input or safety output.

external device monitoring

External device monitoring (EDM) is a means by which a safety device (such as a safety light curtain) actively monitors the state (or status) of external devices that are controlled by the safety device. A lockout of the safety device will result if an unsafe state is detected in the external device. External device(s) may include, but are not limited to: MPCEs, captive contact relays/contactors, and safety modules.

fault

A fault is 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

A final switching device (FSD) is 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.

In-Series Diagnostics

The In-Series Diagnostics (ISD) communication protocol provides performance and status information from each device in a chain to the PLC and/or HMI. Notification is sent for the opening or closing of a door, mismatched or misaligned sensors and actuators, and a range of additional system health attributes.

machine primary control element

A machine primary control element (MPCE) is an electrically powered element, external to the safety system, that directly controls the machine’s normal operating motion in such a way that the element is last (in time) to operate when the machine motion is either initiated or arrested.

manual reset

A manual reset is the safety input device control operation setting where the assigned safety output turns on only after a manual reset is performed and if the other associated input devices are in their run state. When manual reset is selected, the input device may be said to be configured to run in manual start/restart (latch) mode; meaning that the controlled output has latched to the off state and requires a manual reset to turn back on. This reset is sometimes called a manual latch reset.

output signal switching device

The output signal switching devices (OSSD) are the safety outputs that are used to initiate a stop signal.

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.

Qualified Person

A Qualified Person is 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.

safety distance

The safety distance is the minimum distance an engineered control (guard or device) is installed from a hazard such that individuals cannot reach the hazard point before it is stopped (or made safe). The safety distance required for an application depends on several factors, including the speed of the hand (or individual or object), 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).

single-channel

Single-channel refers to having only one signal line for a safety input or safety output.

supplemental guarding

Supplemental guarding is additional safeguarding device(s) or hard guarding, used to prevent a person from reaching over, under, through or around the primary safeguard or otherwise accessing the guarded hazard.

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