User Manual — Original Language

Allen-Bradley

Guardmaster 440C-CR30 Configurable Safety Relay

Catalog Number 440C-CR30-22BBB

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- who should use this manual
- the purpose of this manual
- related documentation
- conventions used in this manual

Who Should Use this Manual

Use this manual if you are responsible for designing, installing, configuring, or troubleshooting control systems that use the CR30 safety relay.

You should have a basic understanding of electrical circuitry and familiarity with safety related control systems. If you do not, obtain the proper training before using this product.

Purpose of this Manual

This manual is a reference guide for the CR30 safety relay, plug-in modules and accessories. It describes the procedures you use to install, wire, and troubleshoot your relay. This manual:

- explains how to install and wire your relay
- gives an overview of the CR30 safety relay system

Refer to the Online Help provided with Connected Components Workbench™ software for more information on configuring your CR30 safety relay.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
2711C-UM001_-EN-P	PanelView™ Component HMI Terminal User Manual
440C-QS001_-EN-P	Guardmaster® 440C-CR30 Software Configurable Safety Relay Quick Start Guide
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.
Allen-Bradley Industrial Automation Glossary, AG-7.1	A glossary of industrial automation terms and abbreviations.

You can view or download publications at http:/www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

You can download the latest version of Connected Components Workbench for your CR30 at http://compatibility.rockwellautomation.com/Pages/MultiProductDownload.aspx?Keyword=Free&crumb=112

Definitions

Publication AG-7.1 contains a glossary of terms and abbreviations used by Rockwell Automation to describe industrial automation systems. Below is a list of specific terms and abbreviations used in this manual.

- **CCW** – The Connected Components Workbench. This is a software package that allows the user to configure a CR30, program a Micro800® controller and configure a PanelView™ HMI.
- **CR30** – Is the Cat. No. 440R-CR30-22BBB software configurable safety relay, described in this user manual.
- **HI** – Logic state of being ON.
- **LO** – Logic state of being OFF.
- **Logic Block** – On the CCW grid, a logic block resides in any of the four columns. A logic block is either: 1) a Safety Monitoring Function, 2) Logic Level A, 3) Logic Level B, or 4) Safety Output Function.
- **Logic Level A (LLA)** – This column is used to perform logic processes on a number of inputs to create a desired output state.
- **Logic Level B (LLB)** - This column is used to perform logic processes on a number of inputs to create a desired output state.
- **N.C. (Normally Closed)** – An electrical contact whose normal state (i.e., no pressure or electrical potential applied) is in the closed position.
- **N.O. (Normally Open)** – An electrical contact whose normal state (i.e., no pressure or electrical potential applied) is in the open position.
- **OSSD (Output Signal Switching Device)** – This is typically a pair of solid state signals that are pulled up to the DC source supply. The signals are usually tested for short circuits to the DC power supply, short circuits to the DC common and shorts circuits between the two signals.
- **Reaction Time** - Describes the time between the true states of one input to the ON state of the output.
- **Recovery Time** - Describes the time required for the input to be in the LO state before returning to the HI state.
- **Response Time** - Describes the time between the trigger of one input to the OFF state of the output.
- **Safety Function** – This describes the complete sensing of the action (e.g. open a safety gate) to execution the final output device (e.g. turning off a pair of contactors).
- **Safety Monitoring Function (SMF)** – This is the input block on the Connected Components Workbench for the CR30.
- **Safety Output Function (SOF)** – This is the output block on the Connected Components Workbench for the CR30.
- **Single Wire Safety (SWS)** – This is a unique, safety rated signal sent over one wire to indicate a safety status. The SWS can be used in Category 4, Performance Level e, per ISO 13849-1 and Safety Integrity Level (SIL) 3, per IEC 62061 and IEC 61508.

Chapter 9

Safety Monitoring Functions

Chapter 10

Logic Levels A and B

Chapter 11

Safety Outputs

Chapter 12

Plug-in Modules

Chapter 13

Automation Controller Communications

Chapter 14

LEDs

Chapter 15

Modbus Communication

Chapter 16

Troubleshooting

Chapter 17

Security and Password

Chapter 18

Using the Memory Module

Chapter 19

Reports

Appendix A

Specifications

Appendix B

Regulatory Approvals

Appendix C

Configuration Reference Document

Appendix D

ControlFLASH Firmware Upgrade

Appendix E

EtherNet/IP I/O Assemblies

Appendix F

Tag Definitions

Overview

Intended Use

The Cat. No. 440C-CR30-22BBB (CR30) relay is a software-configurable safety relay. This device is intended to be part of the safety-related control system of a machine. The CR30 must be configured using a personal computer (PC) running the Allen-Bradley Connected Components Workbench™ (CCW). The CR30 accommodates up to 24 safety monitoring functions. Examples of safety monitoring functions are single channel input, dual channel input, two hand control, reset, and feedback.

It is based on the Micro800 platform. The housing is red to signify it as a safety device and to distinguish it from the grey-colored standard controllers.

Hardware Features

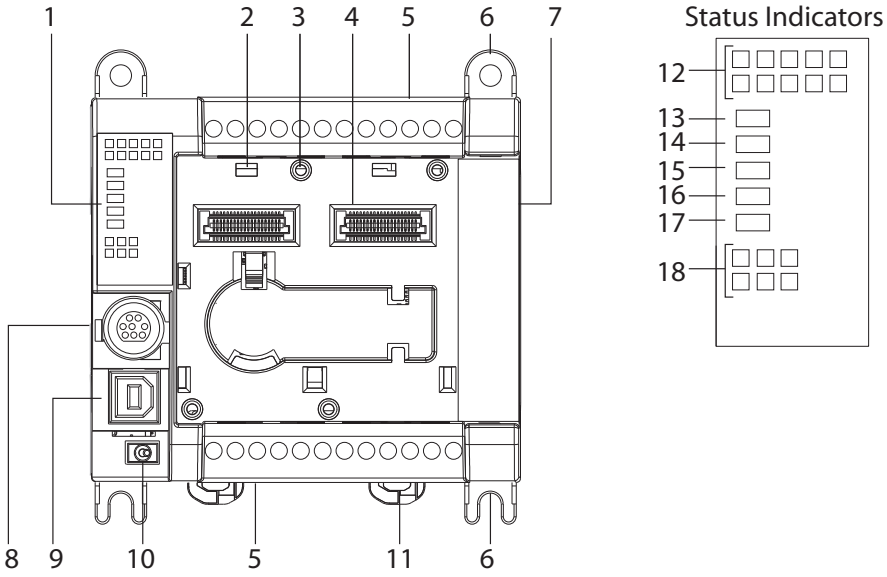
Figure 1 - CR30 Relay

The CR30 has 22 embedded safety rated inputs and outputs and accepts up to two plug-in modules, each of which has four standard inputs and four standard outputs.

The CR30 can be configured to accept two single-wire safety inputs and to provide two single-wire safety outputs. This feature allows the CR30 to be an integral part of an extensive machine safeguarding system.

CR30 Hardware Details

Figure 2 - Hardware Details



	Description
1	Status indicators
2	Plug-in latch
3	Plug-in screw hole
4	40-pin high-speed plug-in connector
5	I/O and Power terminal blocks
6	Mounting screw hole/mounting foot
7	Right-side cover
8	RS-232 non-isolated serial port
9	Type B connector USB

	Description
10	Verification button
11	Din Rail mounting latch
12	Input status
13	Power status
14	Run status
15	Fault status
16	Lock status
17	Serial communications status
18	Output status

Max Number of Inputs and Outputs

Many of the inputs and outputs can be configured for different roles. The following table shows the maximum number of terminals for a specific function. Assigning a configurable terminal to one role reduces the risks of its use as another role and reduce the allowed maximum number of terminals for other functions.

Function	Max Allowed
Safety inputs, normally closed	up to 18
Safety inputs, normally open	up to 6
Single-wire safety input	up to 2
Single-wire safety output	up to 2

Function	Max Allowed
Pulse test outputs	up to 6
OSSD safety outputs	up to 10
Non-pulsed (standard) outputs	up to 6

Software

The CR30 is software configurable using the Rockwell Automation Connected Components Workbench (CCW). Connected Components Workbench is a set of collaborative tools that supports the CR30 safety relays. CCW is based on Rockwell Automation and Microsoft® Visual Studio® technology. The CCW is used to configure the CR30, program the Micro800 controllers, and configure many PowerFlex® drives and PanelView™ graphic display terminals.

Obtain Connected Components Workbench

The Connected Components Workbench is free and can be downloaded from: http://compatibility.rockwellautomation.com/Pages/MultiProductDownload.aspx?Keyword=Free&crumb=112

To help you configure your relay through the Connected Components Workbench software, you can refer to the Connected Components Workbench Online Help (provided with the software).

USB Connection

The CR30 has a USB interface for connection to a personal computer for configuration. Use a standard USB A Male to B Male cable for connecting to the relay.

Serial Port Connection

The embedded serial port is used to transfer control and status to other Allen-Bradley products. The CR30 only supports RS-232 protocol. The connection is not isolated. The RS-232 signals are referenced to the relay power ground.

Notes:

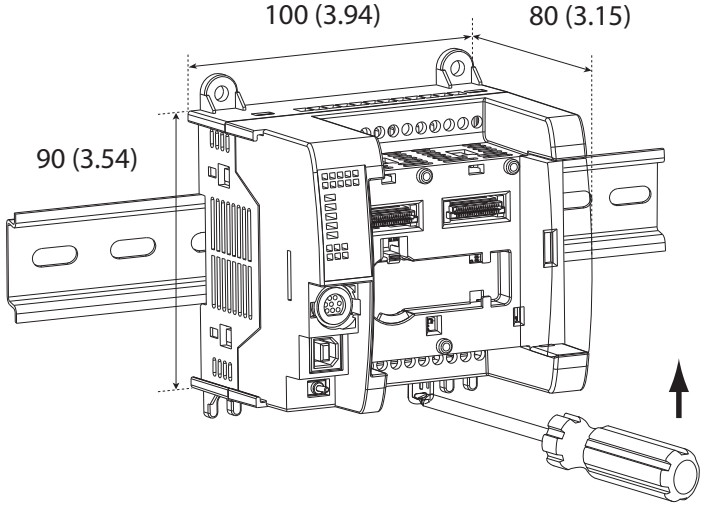
Installation

Mounting Dimensions

DIN Rail Mounting

Mounting dimensions exclude mounting feet or DIN Rail latches.

Figure 3 - DIN Rail Mounting [mm (in.)]



Maintain spacing from objects such as enclosure walls, wireways, and adjacent equipment. Allow 50.8 mm (2 in.) of space on all sides for adequate ventilation. If optional accessories/modules are attached to the relay, such as the power supply Cat. No. 2080-PS120-240VAC, make sure that there is 50.8 mm (2 in.) of space on all sides after attaching the optional parts.

The module can be mounted using the following DIN Rails:
35 x 7.5 x 1 mm (EN 50 022 - 35 x 7.5).

To mount the module on a DIN Rail:

1. Use a flat-blade screwdriver in the DIN Rail latch and pry it downwards until it is in the unlatched position.
2. Hook the top of the DIN Rail mounting area of the relay onto the DIN Rail, and then press the bottom until the relay snaps onto the DIN Rail.
3. Push the DIN Rail latch back into the latched position.

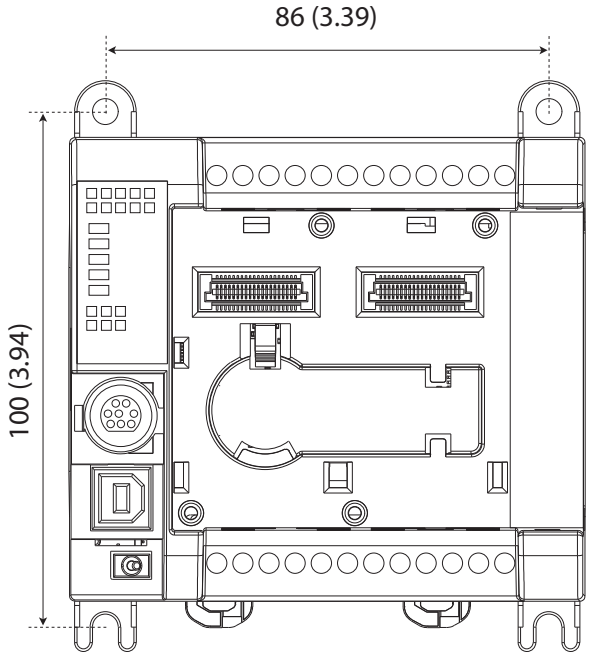
Use DIN Rail end anchors (Allen-Bradley Cat. Nos. 1492-EAJ35 or 1492-EAHJ35) for vibration or shock environments.

To remove the module from the DIN Rail, pry the DIN Rail latch downwards until it is in the unlatched position.

For environments with greater vibration and shock concerns, use the panel mounting method, instead of DIN Rail mounting.

Panel Mounting

Figure 4 - Panel Mounting [mm (in.)]



The preferred mounting method is to use four M4 (#8) screws per module. Hole spacing tolerance: ±0.4 mm (0.016 in.).

Follow these steps to install your relay using mounting screws.

1. Place the relay against the panel where you are mounting it. Make sure that the relay is spaced properly.
2. Mark drilling holes through the mounting screw holes and mounting feet then remove the relay.
3. Drill the holes at the markings, then replace the relay and mount it.

Leave the protective debris strip in place until you are finished wiring the relay and any other devices.

Enclosure Considerations

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference and environmental exposure. Pollution Degree 2 is an environment where normally only non-conductive pollution occurs except that occasionally temporary conductivity that is caused by condensation can be expected. Overvoltage Category II is the load level section of the electrical distribution system. At this level, transient voltages are controlled and do not exceed the impulse voltage capability of the product insulation.

This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating. This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there could be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that are present. It must also be appropriately designed to prevent personal injury as a result of accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if non-metallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication contain more information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

For more information, see:

- *Industrial Automation Wiring and Grounding Guidelines,* publication 1770-4.1, for more installation requirements.
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection that is provided by different types of enclosure.

Preventing Excessive Heat

For most applications, normal convective cooling keeps the controller within the specified operating range. Verify that the specified temperature range is maintained. Proper spacing of components within an enclosure is usually sufficient for heat dissipation.

In some applications, other equipment inside or outside the enclosure produce a substantial amount of heat. In this case, place blower fans inside the enclosure to help with air circulation and to reduce “hot spots” near the controller.

More cooling provisions are necessary when high ambient temperatures are encountered. Do not bring in unfiltered outside air. Place the controller in an enclosure to help protect it from a corrosive atmosphere. Harmful contaminants or dirt could cause improper operation or damage to components. In extreme cases, you may need to use air conditioning to help protect against heat buildup within the enclosure.

Notes:

Power, Ground, and Wiring

Wiring Requirements and Recommendation

WARNING: Before you install and wire any device, disconnect power to the system.

WARNING: Calculate the maximum current in each power and common wire. Observe all electrical codes dictating the maximum current allowable for each wire size. Current above the maximum ratings can cause wiring to overheat, which can cause damage.

- Allow for at least 50 mm (2 in.) between I/O wiring ducts or terminal strips and the relay.
- Route incoming power to the relay by a path separate from the device wiring. Where paths must cross, their intersection must be perpendicular.
- Do not run signal or communications wiring and power wiring in the same conduit. Wires with different signal characteristics should be routed by separate paths.
- Separate wiring by signal type. Bundle wiring with similar electrical characteristics together.
- Separate input wiring from output wiring.
- Label wiring to all devices in the system. Use tape, shrink-tubing, or other dependable means for labeling purposes. In addition to labeling, use colored insulation to identify wiring based on signal characteristics. For example, you can use blue for DC wiring and red for AC wiring.
- Disabling pulse testing on safety-related terminals, including dedicated safety outputs and test-pulse source evaluating input signals, requires protection (for example, cable conduit) and separated wiring of safety signals to exclude potential cross loop faults.

IMPORTANT Fault exclusions for conductors and wiring must follow the requirements according to EN ISO 13849-2 Table D.3 and D.4. A fault exclusion can reduce the overall safety rating of the related safety function to a maximum of PL_d per EN ISO 13849-1

Wire Size

Table 1 - Wiring Requirements

	Wire Size			
	Type	**Min**	**Max**	
Copper	Stranded	0.326 mm^2 (22 AWG)	1.31 mm^2 (16 AWG)	Rated @ 90 °C (194 °F) insulation min.

Terminal Assignments

Some terminals are designed to have one specific function. Some terminals can perform multiple functions; these terminals must be configured in the application software.

Table 2 - Terminal Assignments

Terminal	Function
00	Safety Input (N.C.)
01	Safety Input (N.C.)
02	Safety Input (N.C.)
03	Safety Input (N.C.)
04	Safety Input (N.C.)
05	Safety Input (N.C.)
06	Safety Input (N.C.)
07	Safety Input (N.C.)
08	Safety Input (N.C.)
09	Safety Input (N.C.)
10	Safety Input (N.C.) or Single Wire Safety Input
11	Safety Input (N.C.) or Single Wire Safety Input
+24V DC	A1 Power Supply (+24V, -15%, +10%)
COM 0V	A2 Power Supply (0V)
12	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
13	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
14	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
15	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
16	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
17	Test Output or OSSD High Side or Safety Input (N.C.) or Safety Input N.O. or standard diagnostic.
18	OSSD High Side
19	OSSD High Side
20	OSSD High Side or Single-wire Safety Output
21	OSSD High Side or Single-wire Safety Output

Grounding the Configurable Safety Relay

WARNING: All devices that are connected to the RS-232 communication port must be referenced to controller ground, or be floating (not referenced to a potential other than ground). Failure to follow this procedure can result in property damage or personal injury.

This product is intended to be mounted to a grounded mounting surface such as a metal panel. See the *Industrial Automation Wiring and Grounding Guidelines*, publication 1770-4.1, for more information.

Connecting a Power Supply

Power for the relay is provided by an external 24V DC power supply source.

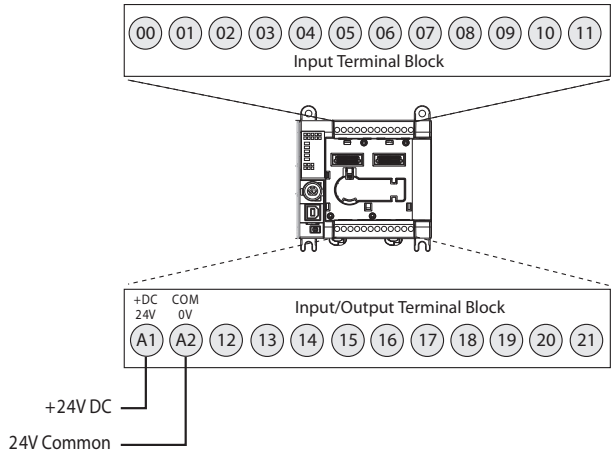
To comply with the CE Low Voltage Directive (LVD), the I/O must be powered by a DC source compliant with Safety Extra Low Voltage (SELV) or Protected Extra Low Voltage (PELV).

To comply with UL restrictions, I/O must be powered by DC sources whose secondary circuits are isolated from the primary circuit by double insulation or reinforced insulation. The DC power supply must satisfy the requirements for Class 2.

The following Rockwell Automation power supplies are SELV- and PELV-compliant, and they meet the isolation and output hold-off time requirements of the CR30 relay:

- 2080-PS120-240VAC
- 1606-XLP30E
- 1606-XLP50E
- 1606-XLP50EZ
- 1606-XLP72E
- 1606-XLP95E
- 1606-XLDNET4
- 1606-XLSDNET4

Figure 5 - Power Supply



Wire Input Devices

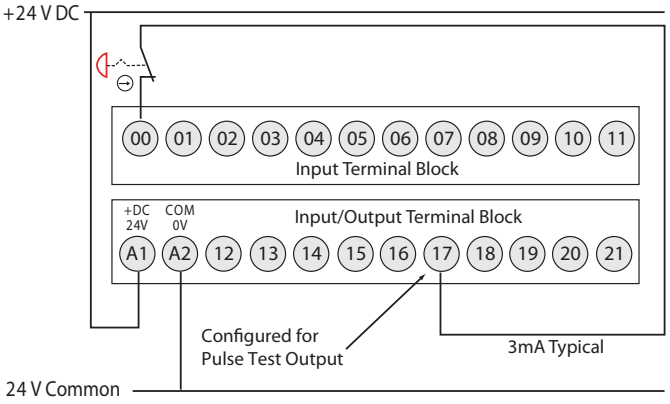
Input Devices with Mechanical Contacts

WARNING: Applying an inappropriate DC or any AC voltage can result in a loss of safety function, product damage, or serious injury. Properly apply only the specified voltage to relay inputs.

Input devices with mechanical contact outputs, such as emergency stop buttons and safety limit switches, use both a safety input terminal and a test output terminal. This enables the circuit to achieve a Category 4 rating.

When safety devices are connected via test outputs to an input circuit on the CR30 relay, the recommended wire length is 30 m (98.4 ft) or less.

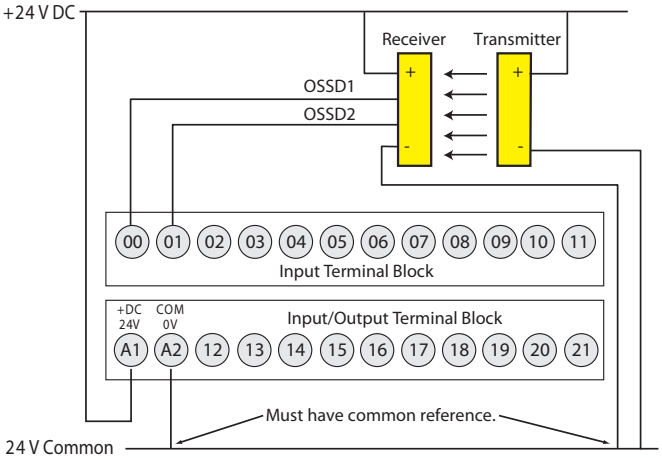
Figure 6 - Input Devices with Mechanical Contacts



Input Devices with OSSD Outputs

Devices, such as light curtains, laser scanners, and solid-state interlocks, having current-sourcing PNP semiconductor outputs (OSSD) have built-in test pulses (or other method of detecting faults). These devices are connected directly to the inputs of the CR30 relay safety and do not use a test output. These devices must have a common reference with the CR30.

Figure 7 - Input Devices with OSSD Outputs



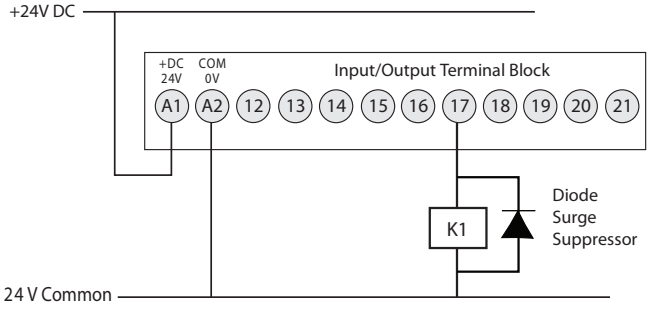
Wire Output Devices

Use Surge Suppressors

Because of the potentially high current surges that occur when switching inductive load devices, such as motor starters and solenoids, the use of some type of surge suppression to help protect and extend the operating life of the relays output is required. By adding a suppression device directly across the coil of an inductive device, you prolong the life of the outputs. You also reduce the effects of voltage transients and electrical noise from radiating into adjacent systems.

The following diagram shows an output with a suppression device. We recommend that you locate the suppression device as close as possible to the load device. Since the outputs are 24V DC, we recommend 1N4001 (50V reverse voltage) to 1N4007 (1000V reverse voltage) diodes for surge suppression for the OSSD safety outputs, as shown in Figure 8. Connect the diode as close as possible to the load coil.

Figure 8 - Surge Suppressors



Example suppressors include:

- 100-FSD250 for Bulletin 100S Contactors
- 1492-LD4DF terminal block with built-in 1N4007 diode

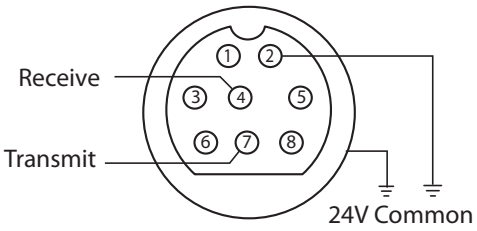
Embedded Serial Port Wiring

The embedded serial port is a non-isolated RS-232 serial port that is targeted to be used for short distances (<3 m) to devices such as HMIs (for example, PanelView). Pin 2 and the shield are both internally connected to the -24V Common (A2) terminal of the CR30.

The CR30 uses the minimal RS-232 connection; only transmit (TxD), receive (RxD) and ground connections are required. The CR30 does not require nor perform any handshaking, therefore the Request To Send (RTS), Clear To Send (CTS), and Carrier Detect (DCD) are not used.

The CR30 only supports RS-232. The RS485 signals, which are used by some products with the 8-pin mini DIN connector, are not used.

Figure 9 - Pinouts



Pin	RS-232 Example
1	RS-485 (not used)
2	GND (green)
3	RTS (not used, red)
4	RxD (orange)

Pin	RS-232 Example
5	DCD (not used, yellow)
6	CTS (not used, white)
7	TxD (brown)
8	RS-485 (not used)

Table 3 shows a recommended list of cables for the serial connection between the CR30 and other Allen-Bradley products. They may also be suitable for third-party products.

DIN connectors were originally standardized by the Deutsches Institut für Normung (DIN), the German national standards organization. Many variations of this connector exist. To help ensure compatibility, select a cable from the following table.

Table 3 - Cables

Cat. No.	Description	Length
1761-CBL-AM00	8-pin Mini DIN to 8-pin Mini DIN	0.5 m (1.5 ft)
1761-CBL-HM02	8-pin Mini DIN to 8-pin Mini DIN	2 m (6.5 ft)
1761-CBL-AP00	8-pin Mini DIN to 9-pin D-shell	0.5 m (1.5 ft)
1761-CBL-PM02	8-pin Mini DIN to 9-pin D-shell	2 m (6.5 ft)

The CR30 is categorized as Data Communications Equipment (DCE). The PanelView HMI's are Data Terminal Equipment (DTE). This is important when point-to-point wiring connections are made. When DTE communicates with DCE, the connections are pin x to pin x. When DTE communicates with other DTE, a cross over is required (for example, TxD must be connected to RxD).

Power Cycling

The state of the CR30 upon power-up depends on its state when power was turned off. The Run LED indicates the state of the CR30.

1. Program Mode (RUN LED off)
   The CR30 is in program mode upon power-up.
2. Run Mode with Program Not Verified (RUN LED flashing)
   The CR30 returns to Run mode. Run mode without verification is good for only 24 hours on continuous running.
3. Run Mode with Program Verified (RUN LED solid green)
   The CR30 returns to Run mode with no limitation on the run duration.

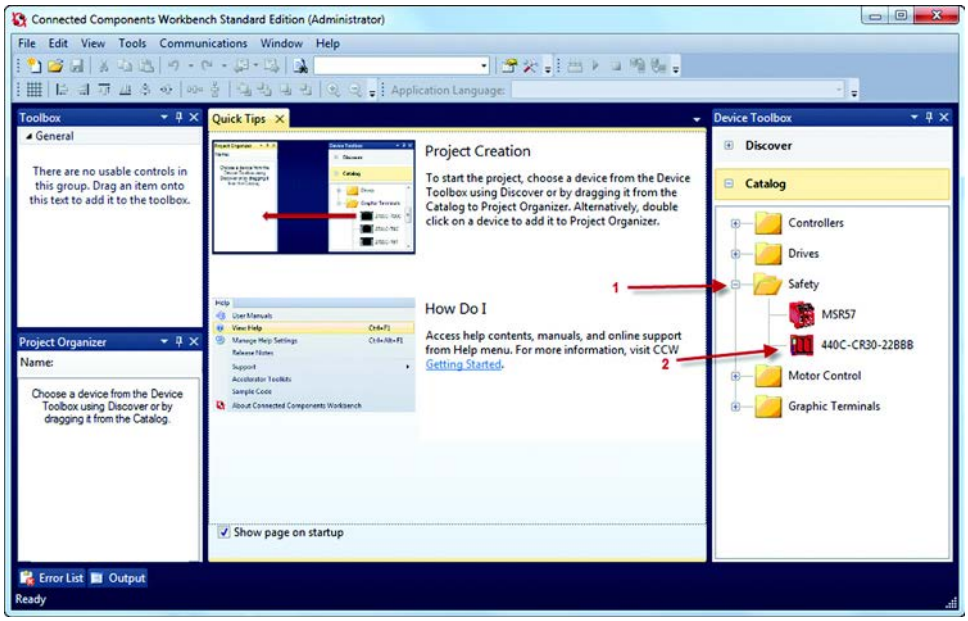
Configuring the CR30

This manual assumes that the Connected Components Workbench has been loaded and describes basic operations. Use the online help for configuring the safety functions.

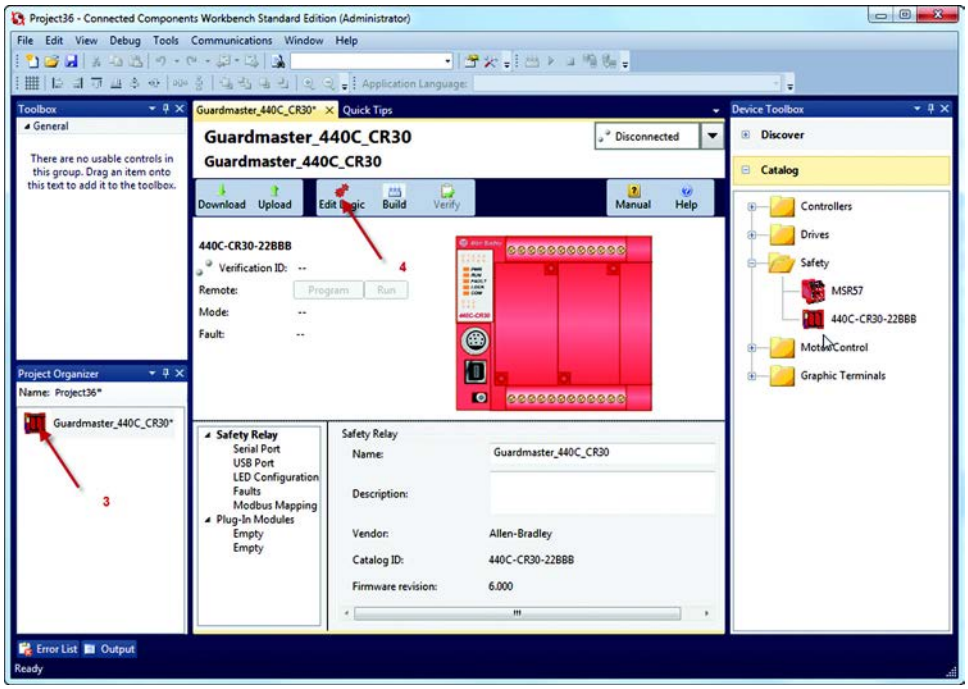
ATTENTION: Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be conducted by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner that is not specified by the manufacturer, the protection that is provided by the equipment can be impaired.

Begin Configuration

1. In the Device Toolbox, expand the Safety Catalog.
2. Double-click the **440C-CR30-22BBB** to open it in the Project Organizer.



3. Double-click the icon in the Project Organizer to open the project.
4. Click the **Edit Logic** button to begin the configuration process.

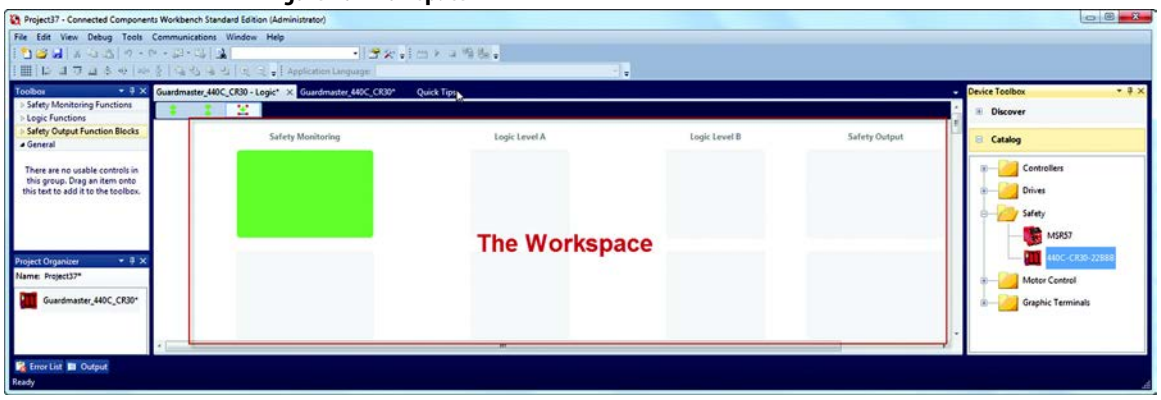


The Workspace

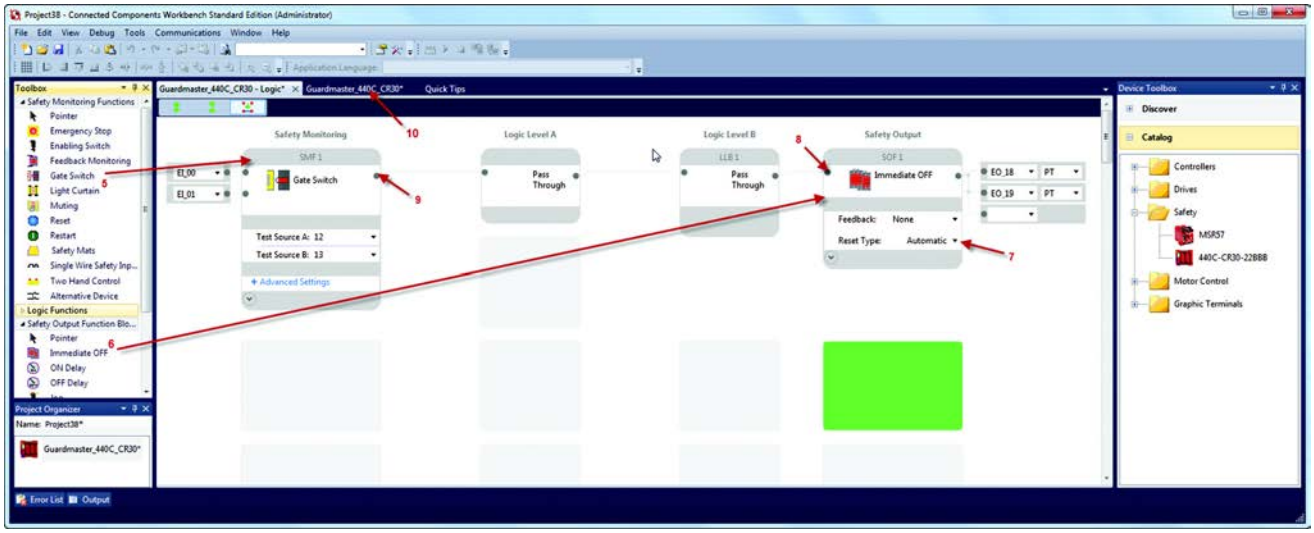
The workspace is split into a grid of four columns: Safety Monitoring (the inputs), Logic Level A, Logic Level B, and Safety Output.

By expanding the Toolbox on the left, blocks can be added to the Workspace and safety functions can be created.

Figure 10 - Workspace



5. Click and drag the Gate Switch function block to the first block in the work space.
   The CCW automatically assigns embedded input terminals EI_00 and EI_01 to the function block. The terminal connection parameters can be changed by you.
6. Click and drag the immediate Output to the first Safety Output block in the workspace.
   The CCW automatically assigns embedded output terminals EO_18 and EO_19 to the output block. In addition, the output terminals are pulse tested (PT). The terminal connection parameters can be changed by you.
7. Use the pull-down menu to change the Immediate Output Reset from Manual to Automatic.
8. Click the input connection (shown in blue when no connection is made) of the Immediate Off output block.
9. Click the output connection of the Emergency Stop button (shown in blue when no connection is made).
   The CCW automatically creates two Pass Through blocks in Logic Level A and Logic Level B and makes the connection.
10. Click the second tab to compile and download the configuration.

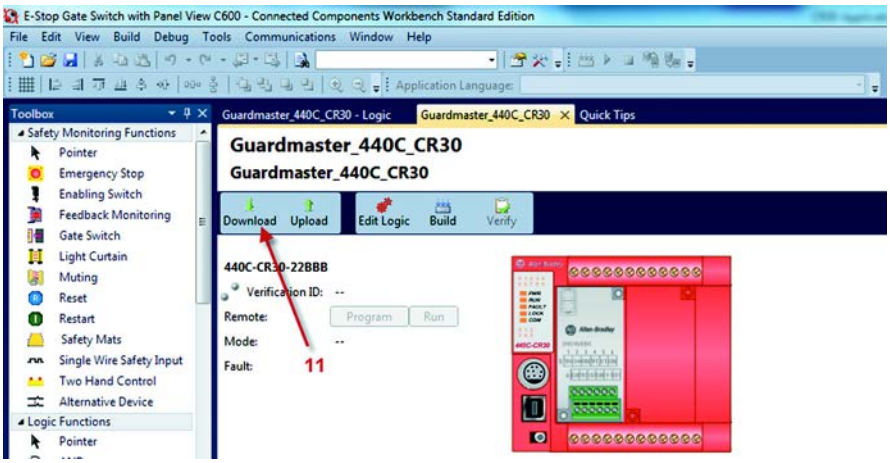


Download the Configuration

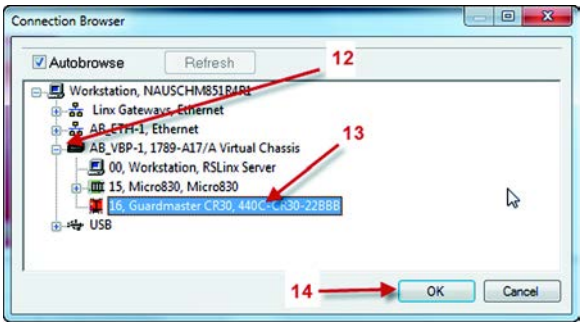
Download initiates the transfer of the configuration file of your CR30 project to the CR30 safety relay. The download process automatically performs a file transfer verification to help ensure that the project configuration and configuration in the CR30 is valid and equal. Successful file transfer verification allows you to change the CR30 operation mode to Run and execute the safety function.

IMPORTANT	Transfer file verification only checks inconsistency of the configuration in the project and the relay such as connection errors and corrupted files. After file transfer, the configured safety function itself is still not verified. The responsible personnel must check whether the configured safety function meets the safety requirements according to the risk assessment and fulfills all applicable standard and regulations

11. Click the **Download** icon to build and download the configuration to the CR30.

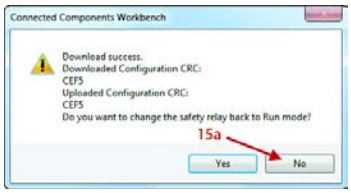


12. Expand the navigation tree.
13. Select the CR30.
14. Click **OK**.

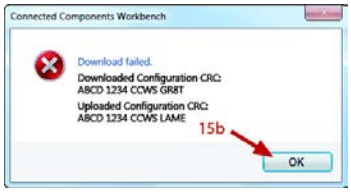


15. File transfer successful or failed.

    a. File transfer successful.
    Click **Yes** to change the relay to Run mode. For unverified configuration, this allows the CR30 to operate for a maximum duration of 24 hours to perform relevant tests to validate the safety function. Click **No** to maintain the relay in Program mode and continue with the verification process.



    b. File transfer failed.
    If the transfer file verification failed, the following message occurs. Click **OK** and repeat steps 11...15.



Validation and Verification

To complete the safety system requirements, the configuration of the CR30 must be validated and verified. At the first download, any configuration is in an unverified state. This means that you have not confirmed that the configuration and installation meets all specified operational and environmental requirements of the machine to which CR30 is to be fitted.

ATTENTION: Before installation, a risk assessment must be performed to determine whether the specifications of this device are suitable for all foreseeable operational and environmental characteristics of the machine to which it is to be fitted. At regular intervals during the life of the machine, check whether the characteristics foreseen remain valid.

Validation

You must perform appropriate testing to validate the configured safety function of the CR30. Entering Run mode after first download enables operation of a maximum duration of 24 hours to execute relevant tests of the safety function. The CR30 displays the execution of an unverified configuration by a flashing Run LED. After 24 hours, the CR30 stops operation and the power to the CR30 must be cycled to restore the operation for another 24 hours.

Verification

After validation, you can assign a unique verification ID to the current configuration in Connected Components workbench. Any change to a verified configuration invalidates the verification ID and requires a new validation and verification process.

To complete the validation and verification, you finally have to acknowledge that the safety configuration and installation meets the operational and environmental specification of the machine. Relevant documentation:

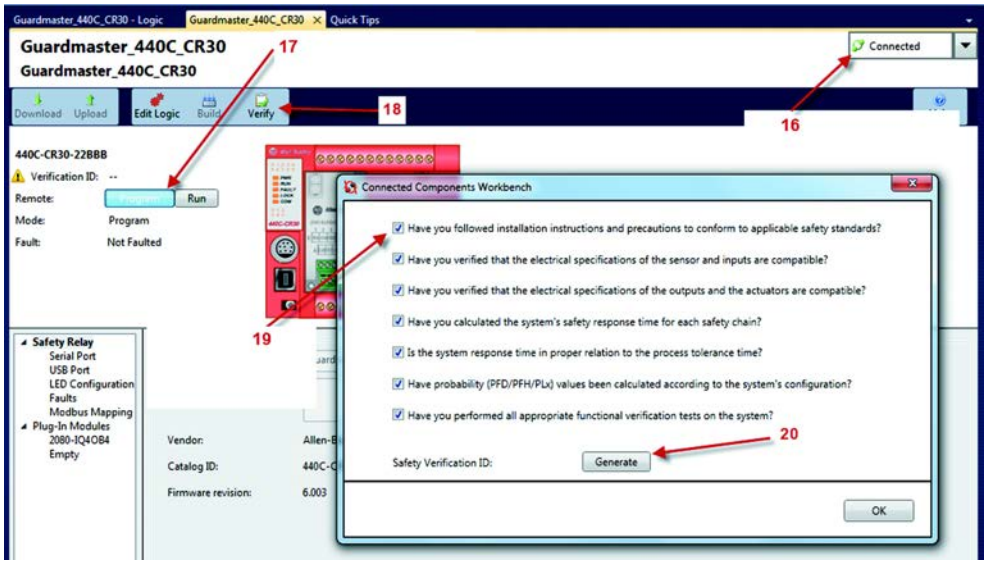
- Details of the authorized and responsible personnel
- Revision of the firmware of the CR30
- Version of the Connected Components workbench
- Identification of the configured safety function and project

IMPORTANT The verification process must be documented in the safety system technical file.

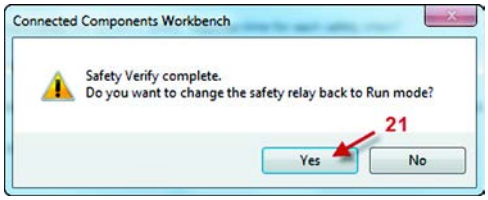
Use the Configuration Reference Document on page 151 or the verification report feature in CCW release 7 or higher.

16. The CCW must be connected to the CR30 during verification.
17. The CR30 must be in Program mode.
18. Click the **Verify** button (the Safety Verification window appears).
19. Answer all questions and check each box, if completed.
20. Click **Generate**.

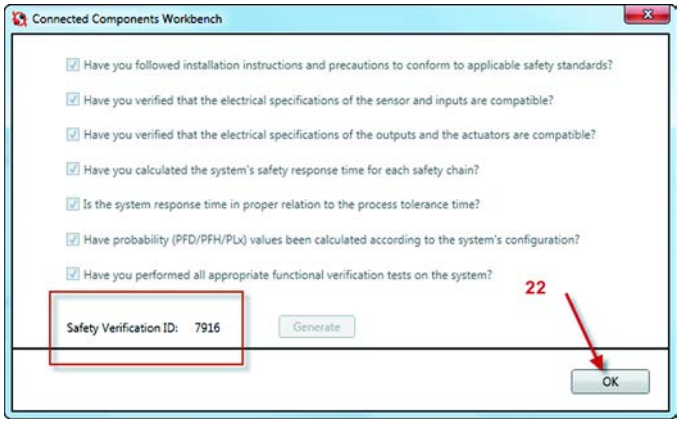
ATTENTION: The verification process should be documented in the safety system technical file.



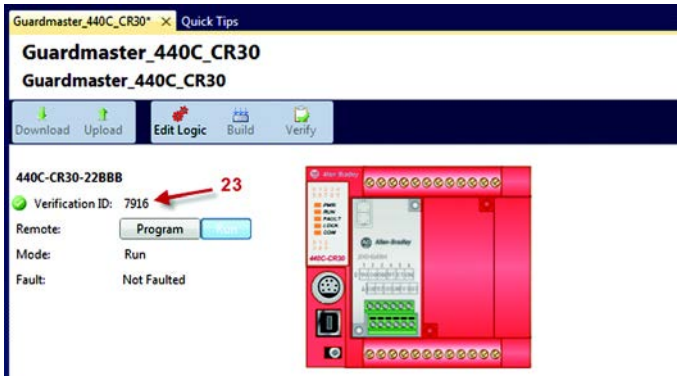
21. Click **Yes** to change the safety relay back to Run mode.



22. The CCW generates a Safety Verification ID. Click **OK** to continue.



23. Confirm the Verification ID in the CCW.
    The ID is stored in the CR30. During power-up, the CR30 uses this number during its self-testing to help ensure its internal processors are functioning properly. When the configuration is uploaded from the CR30, the CCW shows the Verification ID.
    The ID is not stored with the CCW project file.

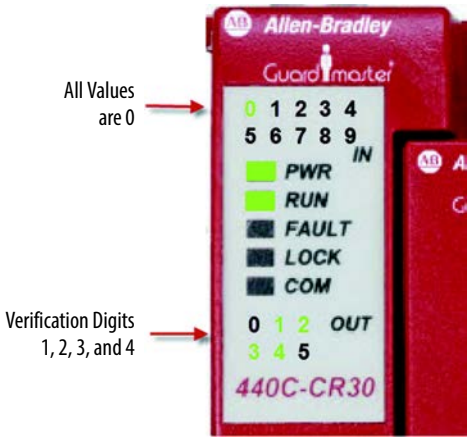


Viewing the Verification ID without CCW

During machine lifecycle, it is required to check whether the system requirements are still valid. The LEDs can be used to view the verification ID without the use of the CCW and compare the documented verification ID of the technical file of the machine.

If the CR30 configuration has not been verified, the ID is 0000. Press and release the Verification button. The IN 0 LED is green. The OUT 1, 2, 3, and 4 LEDs are green. After five seconds, the LEDS will revert to show the status of the inputs and outputs as configured in the CCW.

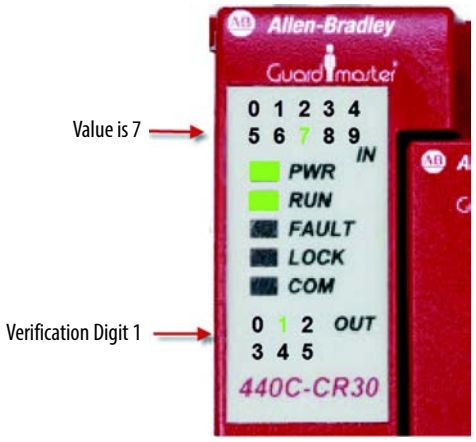
Figure 11 - Verification ID is 0000 (Not Verified)



If the CR30 configuration has been verified, pressing the Verification button will cycle the LEDs through each verification digit. In the following example, the Verification ID is 7916.

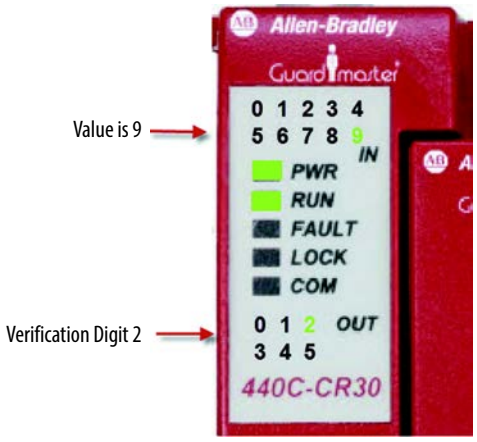
Press and release the verification button once.

Figure 12 - First Verification Digit



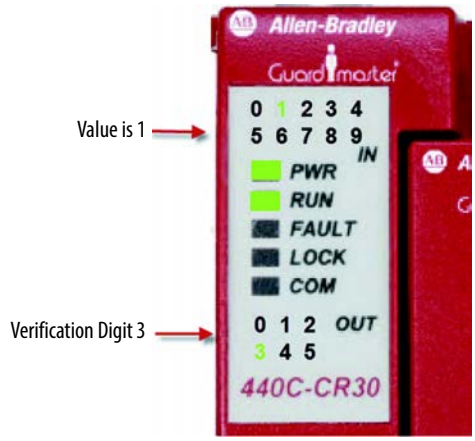
Press the Verification button within five seconds.

Figure 13 - Second Verification Digit



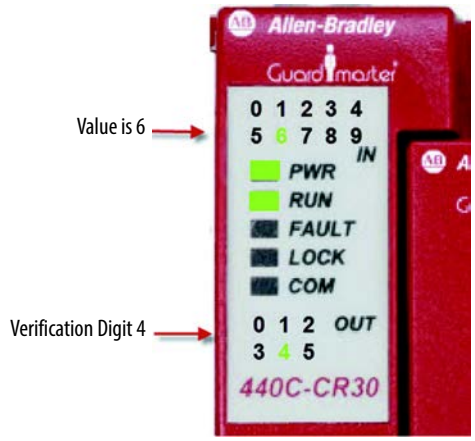
Press the Verification button within five seconds.

Figure 14 - Third Verification Digit



Press the Verification button within five seconds.

Figure 15 - Fourth Verification Digit



After five seconds, the LED will revert to show the status of the inputs and outputs as configured in the CCW.

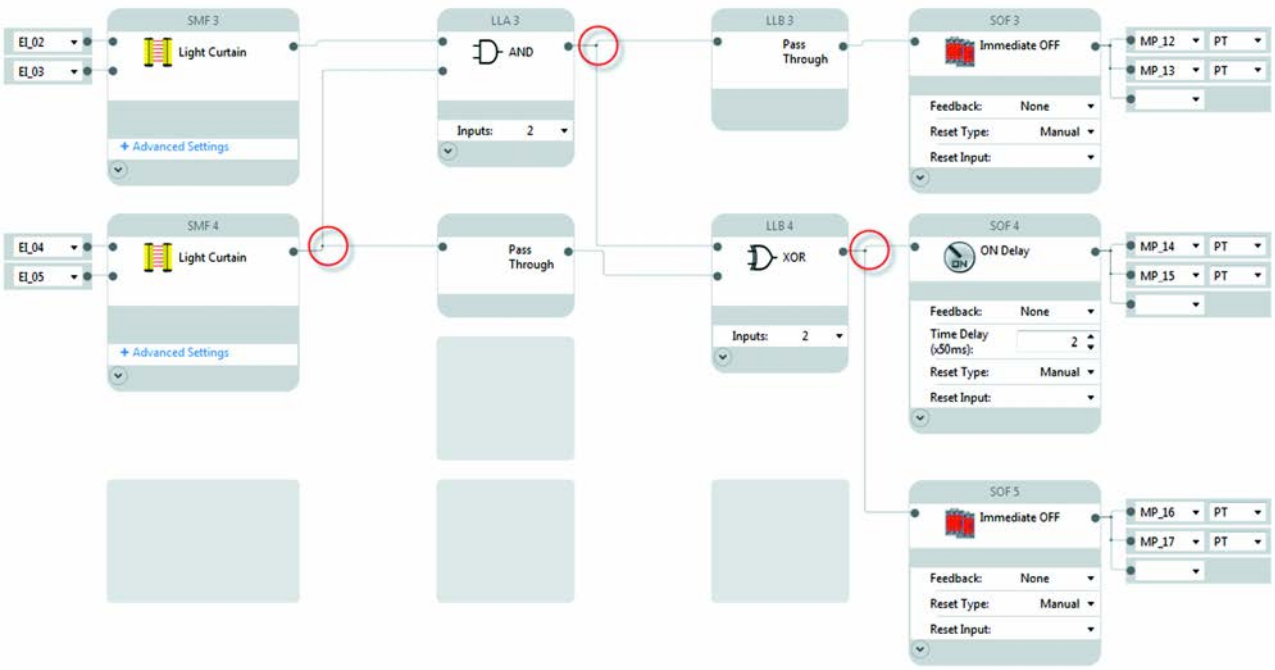
Multiple Block Connections

Multiple blocks can be connected between:

- Safety Monitoring Functions and Logic Level A
- Logic Level A and Logic Level B, and
- Logic Level B and Safety outputs

This is done by clicking the desired input and output connection points. The CCW automatically determines whether the connection can be made.

Figure 16 - Multiple Block Connections



Pulse Testing

The CR30 performs three types of pulse testing functions:

- N.O. inputs
- N.C. inputs
- Outputs

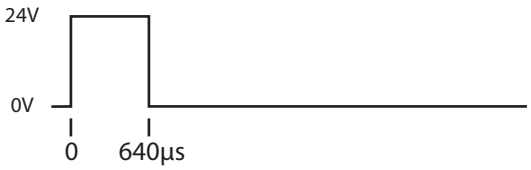
Normally Open Input Pulse Testing

When a safety input is configured for normally open (N.O.) operation, the CR30 periodically checks the status of the input. The purpose of the test pulse is to detect short circuits in the wiring to 24V DC, 0V and between two channels. This test is independent of the "Input Test Pulses". Six terminals (12...17) can be configured for normally open operation.

When a terminal is configured for N.O. operation, the CR30 tests the status of each terminal by generating a test pulse as shown in Figure 17.

The normally open input pulse testing cannot be configured to be on or off. If the terminal is configured to be N.O., the pulse testing is performed by the CR30.

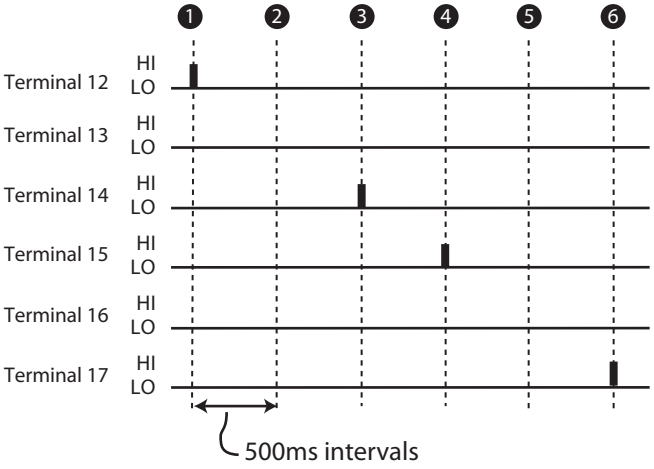
Figure 17 - N.O. Terminal Test Pulse



When multiple terminals are configured for normally open operation, the CR30 tests each one at 500 ms intervals. This test sequence is repeated every 6.4 seconds.

In Figure 18 on page 36, terminals 12, 14, 15, and 17 are configured for N.O. operation, and are tested. Terminals 13 and 16 are configured for normally closed (N.C.) operation, therefore the test pulse does not occur on these two terminals.

Figure 18 - Test Sequence



Normally Closed Input Pulse Testing

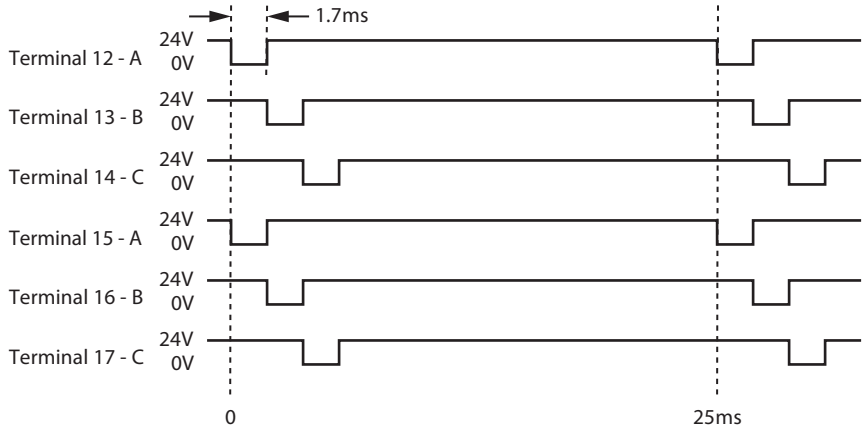
Terminals 12...17 can be configured to generate test pulse outputs. These signals are used to test for short circuits in the wiring to 24V DC, 0V and between two channels that are wired to separate test pulse sources (one channel that is sourced from an odd number terminal [13, 15, and 17], and the other one from an even number terminal [12, 14, and 16]).

IMPORTANT Safety systems requiring a Category 4 structure per ISO13849-1 and SIL 3 rating per IEC61508 must use pulse testing for the dual channel N.C. contacts. Pulse testing for Category 3, 2, and 1 structures and SIL 2 and 1 ratings is recommended.

The CR30 generates three distinct pulses, called A, B, and C. Each pulse is 1.7 ms wide. Pulse Test B immediately follows Pulse Test A. Pulse Test C immediately follows Pulse Test B. The pulse tests are repeated every 25 ms.

The timing diagram in Figure 19 shows an example of the pulse testing when the respective terminals are configured for A, B, and C.

Figure 19 - Timing Diagram



The purpose of the test pulses is to detect short circuits from the input signal to 24V DC, 24V common, and shorts from one input signal to another input signal. If one input signal is assigned to Test Pulse A and another signal is assigned to Test Pulse B (or C), then a short circuit from one input to the other is detected by the CR30, and the CR30 de-energizes the outputs of those safety functions using the two inputs. In this example, you cannot select terminal 12 as one test pulse source and terminal 15 as the second test pulse source, as both of these produce the "A" pulse.

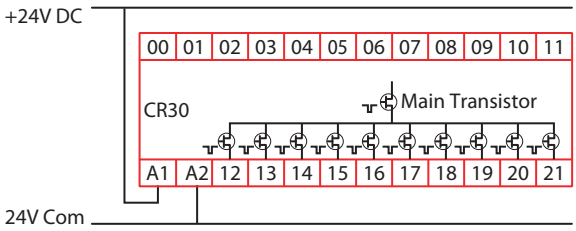
The CCW automatically prevents the user from selecting two of the same pulses when dual channel inputs and two test sources are selected.

Output Pulse Testing

Internally, the CR30 provides dual channel capability to turn off its safety outputs. Conceptually, think of this as a main output transistor feeding individual output transistors. The CR30 repeats a test process where it tests the main transistor twice and then sequentially tests each individual output twice. After successful completion of the tests, the CR30 repeats the test sequence.

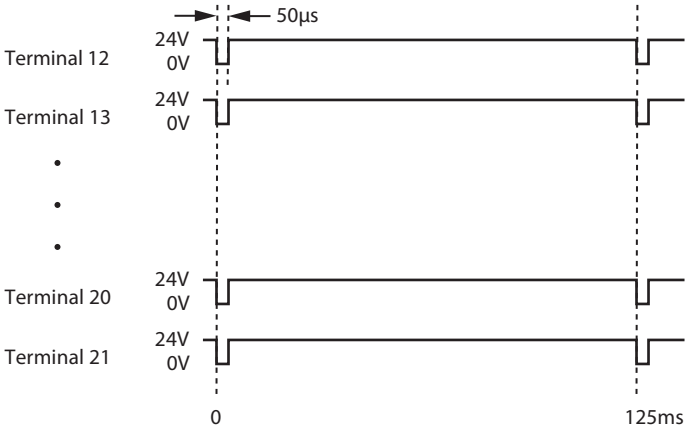
IMPORTANT Safety systems requiring a Category 4 structure per ISO13849-1 and SIL 3 rating per IEC61508 must use pulse testing for the dual channel outputs. Pulse testing for Category 3, 2, and 1 structures and SIL 2 and 1 ratings is recommended.

Figure 20 - Output Pulse Testing



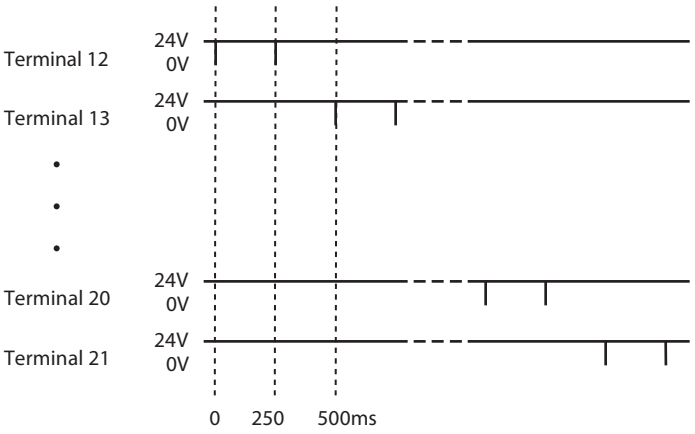
When the main transistor is tested, a 50 µs test pulse appears simultaneously on all outputs. The main transistor is tested again 125 ms later.

Figure 21 - Main Transistor Test



Then a sequence occurs in which each output is individually tested twice. The test pulse is 50 μs wide. The test pulses occur every 250 ms and switch to the next output configured with testing.

Figure 22 - Test Pulse Sequence



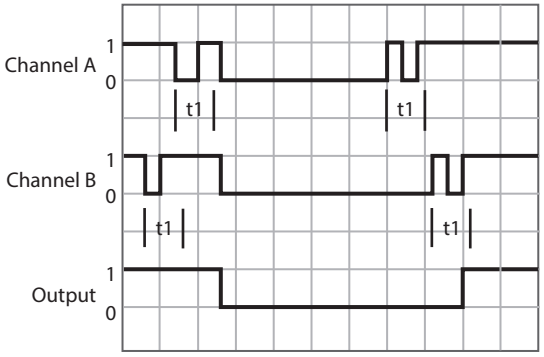
Input Filter

Input filtering gives the CR30 the ability to filter out noise and, in some cases, inadvertent operation.

Sometimes, an operator presses a push button and immediately realizes that they pressed the wrong button and immediately releases the button. In muting applications, an object, moving down a conveyor, might stop just at the point where the muting sensor is deactivated and then back off enough that the muting sensor is reactivated.

When an input filter time (t1) is specified, an input channel is allowed to go to the LO state while the other channel is in the HI state for that length of time without the output of the instruction going to the LO state. However, the output goes to the LO state when both input channels are in the LO state simultaneously. The input filter operates on both the leading edge and trailing edge of the input signals. If specified, the filter time must be included in the response time calculation.

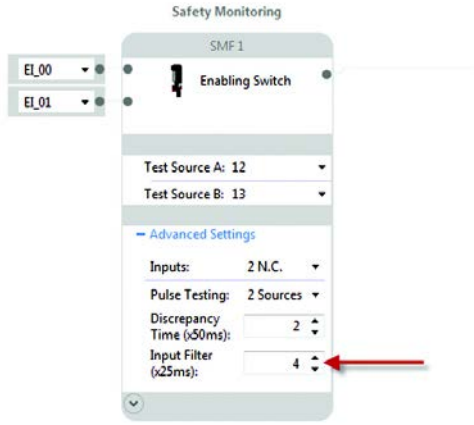
Figure 23 - Input Filtering



Input filtering can set in 25 ms increments, from 0...1000 ms. The default value is 0 ms.

The input filtering is set in the Advanced Settings of each safety monitoring block. Figure 24 shows that the Enabling Switch function with the input filter is set to 4 (4 x 25 = 100 ms).

Figure 24 - Enabling Switch

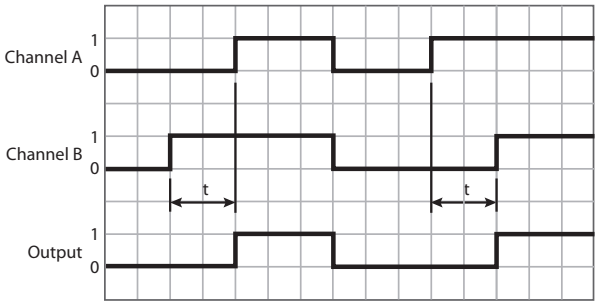


Discrepancy Time

Safety Monitoring functions using dual inputs have a feature that allows the CR30 to test for the timing of the operation of both channels. In most cases, the outputs of dual channel safeguarding devices change state within a few milliseconds of each other. In some cases, the second channel can change state much later than the first.

In these later cases, you want to allow (that is, make sure that) both channels return to their "safety" state within a specified time relative to each other. For example, the "safety" state of dual N.C. input is when both inputs are in the closed state. Channel A can close before Channel B or Channel B can close before Channel A. The CR30 allows you to specify a discrepancy time in 50 ms increments, from 0...3 seconds.

Figure 25 - Discrepancy Time

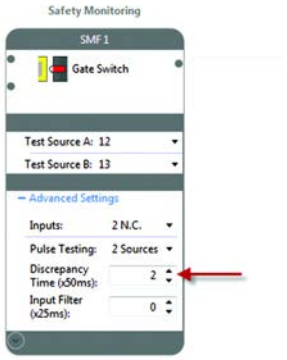


t <= Discrepancy Time

The discrepancy is set in the Advanced Settings of each safety monitoring block. The following example shows the Gate Switch function with the discrepancy time set to 2 (2 x 50 = 100 ms).

When the discrepancy setting is set to zero, the CR30 does not test for discrepancy. The duration between the operation of channel one and channel two is infinite. The default value 100 ms.

Figure 26 - Setting Discrepancy Time



Notes:

Safety Block Renaming

General

With Release 7 of the Connected Components Workbench (CCW) and Release 7 of the CR30 firmware, the names of both the safety monitoring functions and safety output functions can be edited. The editing rules follow IEC 61131-3, section 2.1.2.

This feature is important because it allows you to distinguish between multiple occurrences of the same function blocks during the design, wiring, and troubleshooting phases.

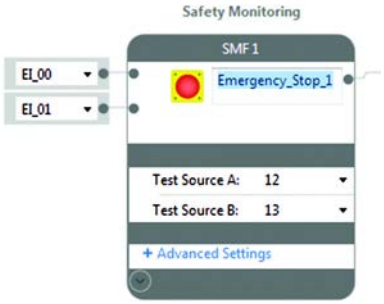
The name change is initiated in one of two ways:

1. Simply double-click the name inside the block
2. Highlight the block and press F2.

The typical editing keys (Home, End, Backspace, Delete, Left Arrow, Right Arrow, Page Up, Page Down, and Mouse Click) can be used to edit the name.

When the block is selected for editing, the name appears in a light blue box, and the name is highlighted in light blue background, as shown in Figure 27.

Figure 27 - Block Name Selected for Editing



Follow these simple rules for naming the blocks:

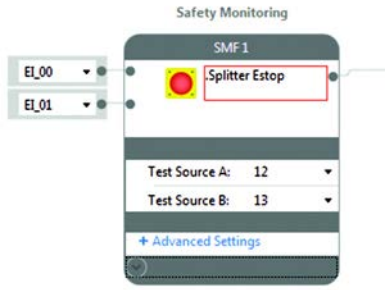
- Names must begin with a letter (upper or lower case) or an underscore
- Names cannot have spaces
- Names can contain letters, numbers, and underscores (no special characters)
- Name length can be anywhere from 1...30 characters
- Letter case is not significant
- Multiple leading or consecutive embedded underscores are not allowed
- Trailing underscores are not allowed

Naming Error Indication

After tabbing off, pressing enter, or mousing off the block, the CCW evaluates the integrity of the name. If valid, the name appears in black letters. If invalid, the CCW shows a naming error in two ways:

1. A red box around the name
2. An error message in the build results

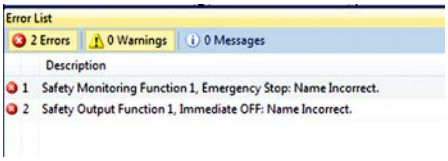
Figure 28 - Red Box Indicates Naming Error



This example block has two errors:

1. The name starts with a period (“.”).
2. The name contains a space.

Figure 29 - Build Error List



After clicking the Build button, the Error List shows the name errors. In the example above, SMF1 and SOF1 have naming errors.

When a naming error occurs, the project cannot be built and downloaded to the CR30. Then naming errors must be corrected. However, the project can be saved and reopened with the naming errors.

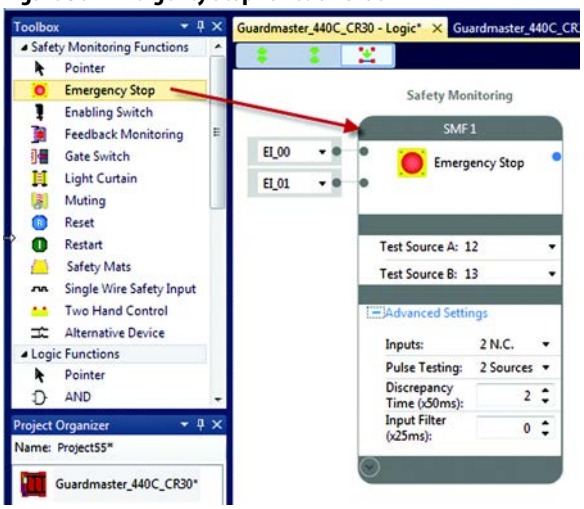
Safety Monitoring Functions

Many types of safeguarding and safety devices and safety related signals can be connected as inputs to the CR30. The Connected Components Workbench (CCW) facilitates the selection and connection of the device. Each block is assigned the next available settings for input terminals, test sources number of inputs, pulse testing, discrepancy time, and input filter.

Emergency Stop

The Emergency Stop function block sets the parameters for typical emergency stop push buttons. In the CCW, click and drag (or double-click) the block to an available Safety Monitoring Function spot. When mechanical operated contacts are used, these contacts must be direct-acting contacts.

Figure 30 - Emergency Stop Function Block



The available input selections for the Emergency Stop inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1 N.C.

Pulse testing can be disabled or set to 2 Sources. When 2 Sources is selected, the next available test sources are automatically selected. You can modify the sources afterward.

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 31 - Example Schematic of a Dual Channel E-stop Without Test Pulses

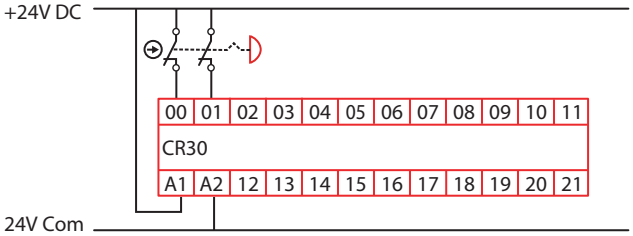
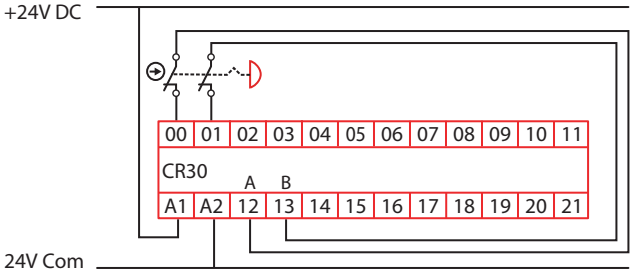


Figure 32 - Example Schematic of a Dual Channel E-stop Using Test Pulses A and B

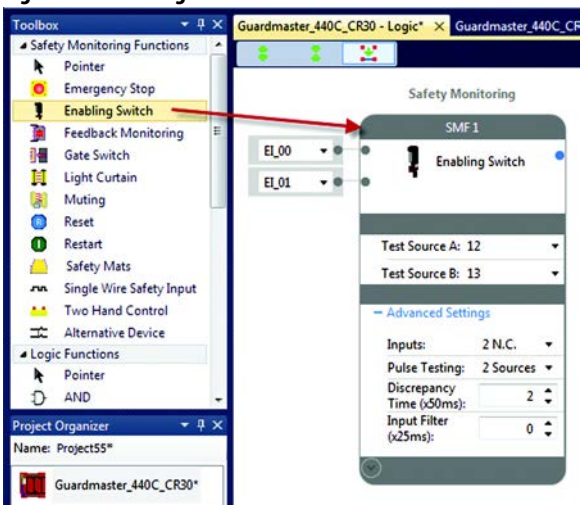


Enabling Switch

The Enabling Switch function block sets the parameters for typical enabling (or hold-to-run) devices. In the CCW, click and drag (or double-click) the block to an available Safety Monitoring Function spot. When mechanical operated contacts are used, these contacts must be direct-acting contacts.

> **Note:** This function block is intended to be used only in applications with a 3-position enabling switch that only allows activation of its outputs (closed contacts) when the operator presses and holds the switch into its middle position. The switch has to be designed using a mechanical force to reset to its default off (contact open) position.

Figure 33 - Enabling Switch Function Block



The available input selections for the Enabling Switch inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1 N.C.

Pulse testing can be disabled or set to 2 Sources. When 2 Sources is selected, the next available test sources are automatically selected. You can modify the sources afterward.

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 34 - Example Schematic of a Dual Channel Enabling Switch Without Test Pulses

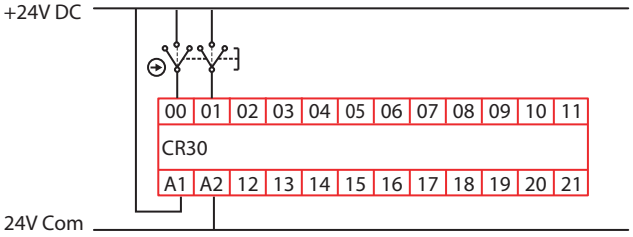
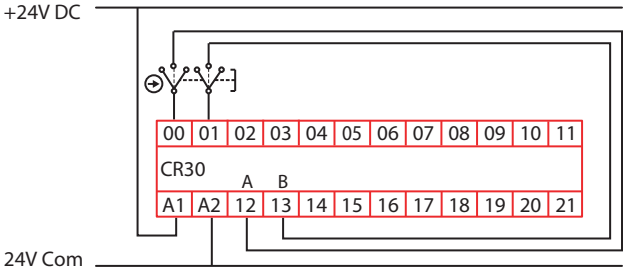


Figure 35 - Example Schematic of a Dual Channel Enabling Switch Using Test Pulses A and B



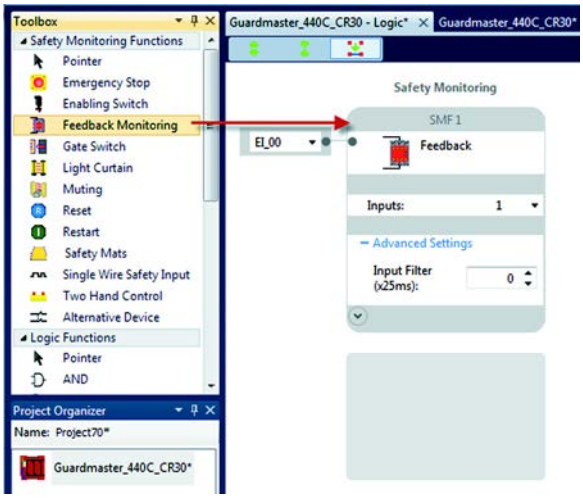
Feedback Monitoring

The Feedback function block is used in safety systems to monitor the status of output devices (like safety contactors). When the output device is off, a HI signal is fed back to the input of the CR30 to indicate that the device is indeed off. When the output device is energized, the feedback signal goes LO. If the output device remained energized, the feedback signal remains LO and the CR30 will not energize the output. The feedback contacts can be positive-guided, mechanically linked, or mirrored contacts.

The CR30 accepts 1, 2, 3, or 4 inputs into each feedback block. All inputs must be HI for the output of the block to go HI.

In the CCW, click and drag (or double-click) the block to an available Safety Monitoring Function spot.

Figure 36 - Feedback Monitoring Function Block



The available input selections for the Feedback Monitoring are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)
- P1_00...P1_03 (plug-in 1 terminals 00...03)
- P2_00...P2_03 (plug-in 2 terminals 00...03)
- SP_00...SP_15 (Modbus inputs 00...05)

You can modify the number of inputs within the range of 1...4.

You can use the default Input Filter or choose to modify this setting.

Figure 37 - Example Feedback Schematic with Two Feedback Contacts Connected in Series to One Input Terminal

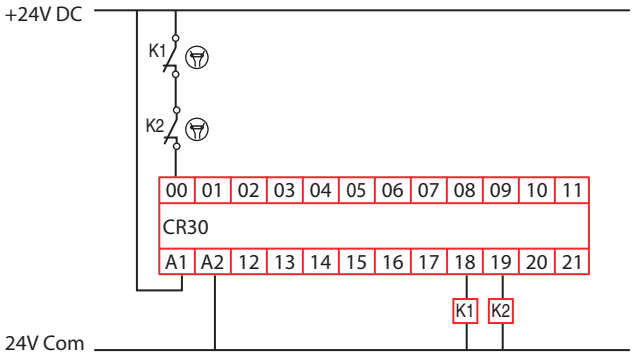
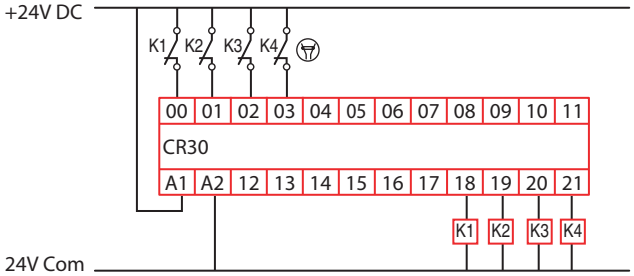


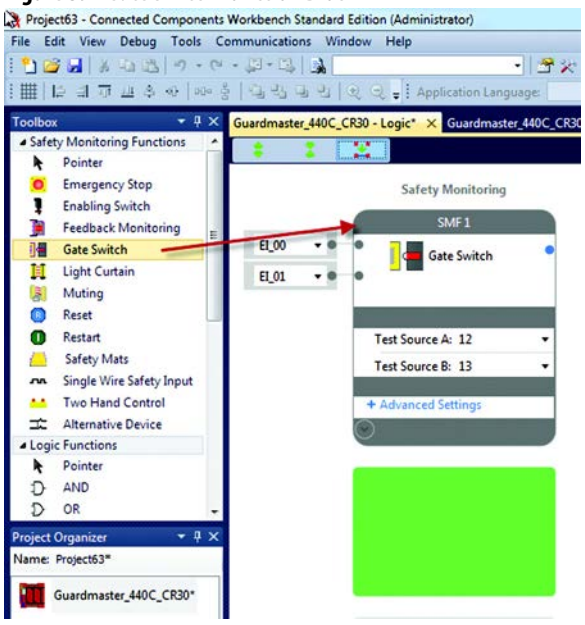
Figure 38 - Example Feedback Schematic with Four Feedback Contacts Connected Individually to Four Input Terminals



Gate Switch

The Gate Switch function block sets the parameters for typical safety gate interlock switches. In the CCW, click and drag (or double-click) the block to an available Safety Monitoring Function spot.

Figure 39 - Gate Switch Function Block



The available input selections for the Gate Switch inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1 N.C.

Pulse testing can be disabled or set to 2 Sources. When 2 Sources is selected, the next available test sources are automatically selected. You can modify the sources afterward.

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 40 - Example Schematic of a Dual Channel Safety Gate Switch Without Test Pulses

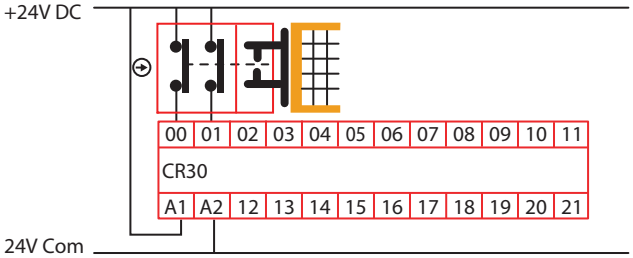


Figure 41 - Example Schematic of a Dual Channel Safety Gate Switch Using Test Pulses A and B

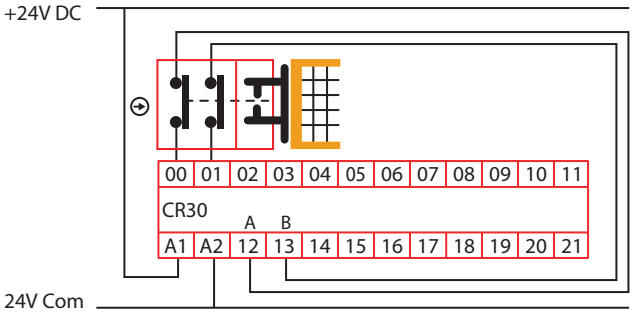
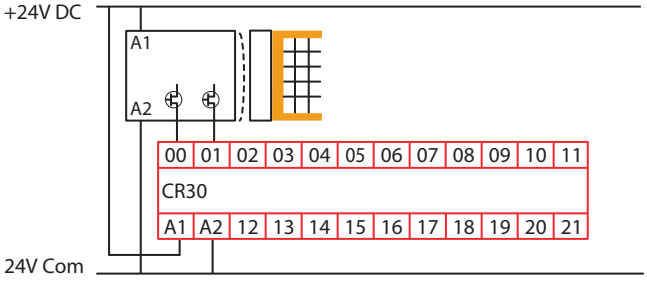


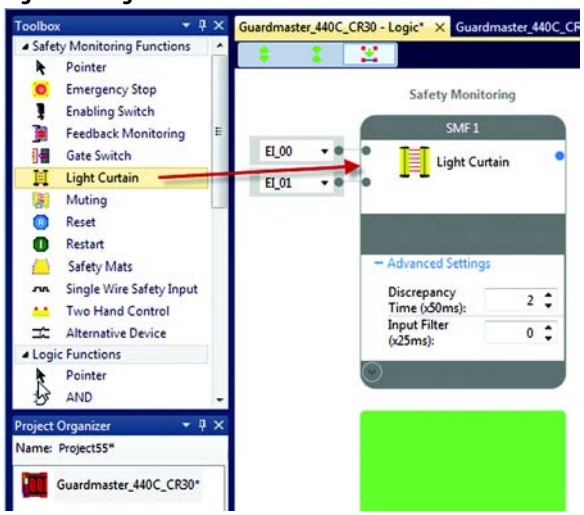
Figure 42 - Example Schematic of a Dual Channel Safety Gate Switch Using OSSD Outputs



Light Curtain

The Light Curtain function block sets the parameters for light curtains that have dual OSSD outputs. In the CCW, click and drag (or double-click) the block to an available Safety Monitoring Function spot. This block can be used for other devices, like laser scanners, with OSSD outputs.

Figure 43 - Light Curtain Function Block

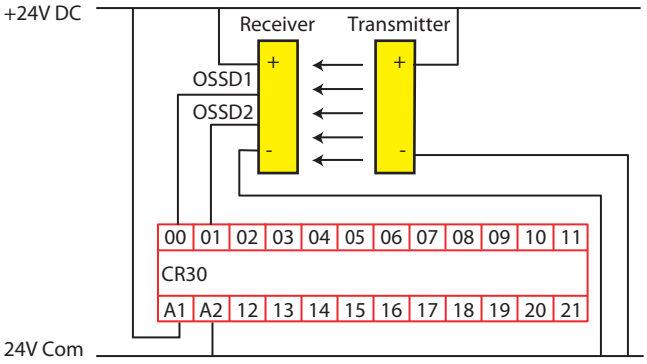


The available input selections for the Light Curtain inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

Figure 44 - Example Schematic of a Light Curtain

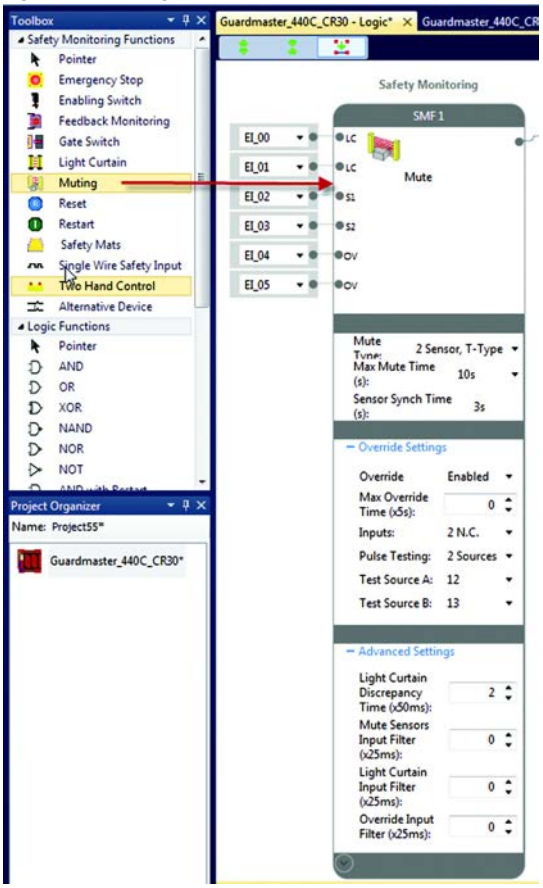


Muting

Muting is the temporary automatic suspension of the protective function of a safeguarding device like a light curtain. The muting function allows the transport of material through a light curtain without stopping a conveyor. To distinguish between material and persons, a certain sequence of events and timings are used.

Muting sensors are mounted in a certain pattern, and the material must pass by the sensors and light curtain within specified time limits. If the muting sensor sequence is incorrect or the timing parameters are violated, the conveyor is turned off. An override signal moves the material through the light curtain after a violation.

Figure 45 - Muting Function Block



The light curtain (LC) signals can use the following terminals:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

The muting (S1...S4) and override (OV) signals can use the following terminals:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)
- P1_00...P1_03 (plug-in 1 terminals 00...03)
- P2_00...P2_03 (plug-in 2 terminals 00...03)

You can use the default Discrepancy Time and Input Filters or choose to modify these settings.

The CR30 safety relay has three distinct types of muting, where the sequence and timing of signals that are monitored by the CR30 allows objects to pass through the light curtain without shutting down the machine process. The three types are:

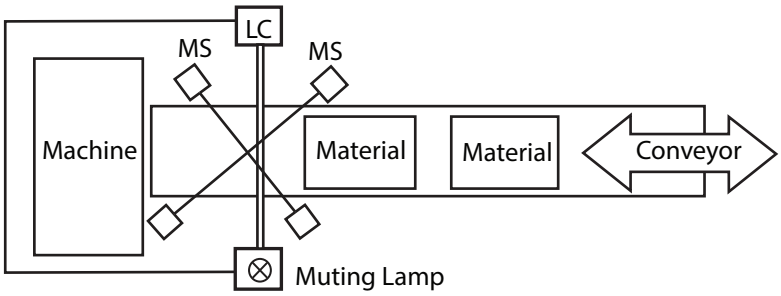
- 2-sensor T-Type
- 2-sensor L-Type
- 4-sensor

2-Sensor T-Type Muting

The sensors and light curtain form the shape of an upside down "T", when viewed from the side. The muting sensors (MS) are mounted to form an "X" sensing pattern where the sensing beams cross near the center of the light curtain (LC).

The muting sensors must be mounted asymmetrically (unequal distance from the light curtain), such that the material breaks one muting sensor and then the other muting sensor as it moves along the conveyor.

Figure 46 - 2-Sensor T-Type Muting Arrangement



The material can break either MS1 first (or MS2 first), then the other sensor, and then the light curtain. As the material clears the light curtain, it must then clear MS2 (or MS1) first and then the other sensor. The muting lamp turns on shortly after the second sensor is blocked, and the light curtain is muted

Either of these two patterns are acceptable:

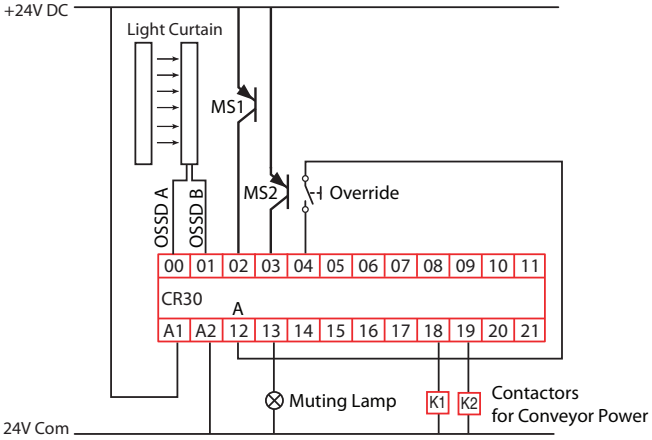
1. MS1↓ MS2↓ LC↓ LC↑ MS2↑ MS1↑
2. MS2↓ MS1↓ LC↓ LC↑ MS1↑ MS2↑

With proper arrangement of the sensors, the conveyor can move in the forward or reverse direction, while also maintaining safeguarding integrity.

In the example below, the OSSD outputs of the light curtain are connected to terminals 00 and 01. The two muting sensors are connected to terminals 02 and 03. The momentary, normally open override switch is connected between terminals 12 to 04 to take advantage of pulse testing. Contactors K1 and K2, which provide power to the conveyor (and to other hazards), are connected to terminals 18 and 19.

The muting lamp is connected to terminal 13; this terminal should be configured with no pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

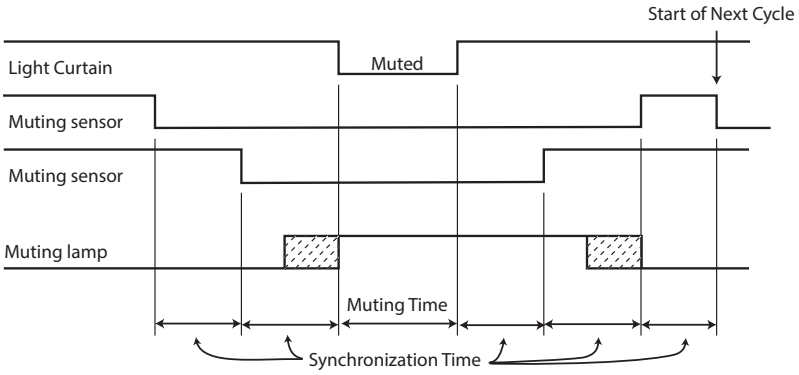
Figure 47 - Example Schematic for 2-Sensor T-Type Muting



For simplicity, the power and ground connections of the light curtain and muting sensors are not shown. The light curtain and muting sensors must have the same reference (24V Com) as the CR30 for proper operation.

For proper operation, the muting sensors are on (normally closed) when not muting, and the light curtain OSSD outputs are also on (the light curtain is clear).

Figure 48 - Muting Time for 2-Sensor T-Type Muting



For proper operation, MS1 and MS2 must be activated/deactivated within the synchronization time, and the light curtain must be clear before the muting time expires.

The minimum synchronization time is dependent on the connection of the muting sensors and is summarized in Table 4. When connected to the embedded terminals (00...11), you must maintain at least 50ms delay for reliable operation. When the muting sensors are connected to a plug-in module, the synchronization delay must be at least 150ms.

Table 4 - Minimum Synchronization Times

Muting Sensor Connection	Minimum Synchronization Time
Connected to embedded terminals 00…17	50 ms
Connected to Plug-in module terminals Px_00…Px_03	150 ms

Note: The synchronization time also depends on the input filter time settings for the muting sensor inputs.
Synchronization time (total) = 2 x Input Filter Time + Synch Time

Table 5 shows the muting and synchronization times that are selectable in the CCW. These times are linked. For example, if you select a 10 s muting time, then the synchronization time between MS1 and MS2 is 3 s. To use a synchronization time of 6 s, you must select a 60 s muting time.

Table 5 - Muting and Synchronization Timing Selections

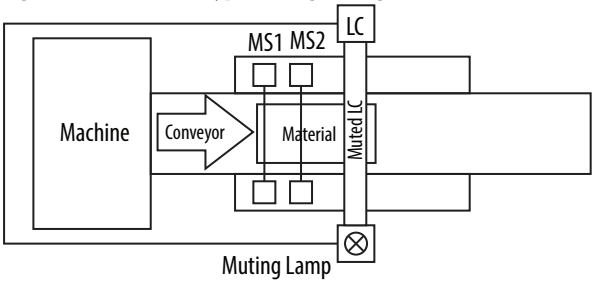
Muting Time	Synchronization Time	Muting Time	Synchronization Time
10 s	3 s	900 s (15 min)	90 s
20 s	3 s	1800 s (30 min)	180 s (3 min)
30 s	3 s	3600 s (1 hr)	180 s (3 min)
60 s (1 min)	6 s	28,800 s (8 hr)	180 s (3 min)
300 s (5 min)	30 s	Infinite	Infinite

If the synchronization time is exceeded, the FAULT indicator and muting output will flash. On the CCW, the Muting Safety Monitoring Function turns red and the Mute Lamp flashes green. If the material is backed away from the sensors, the fault is cleared and the muting lamp turns off. If the material proceeds to break the light curtain, the output of the Muting Safety Monitoring Function turns off. The FAULT indicator and Mute continue to flash. Use the muting override command to temporarily turn on the output of the Safety Monitoring Function and clear the material from the light curtain and muting sensors. The fault condition is cleared.

2-Sensor L-Type Muting

The sensors and light curtain form the shape of the letter "L", when viewed from the side. The muting sensors (MS) are mounted on one side of the light curtain (LC).

Figure 49 - 2-Sensor L-Type Muting Arrangement



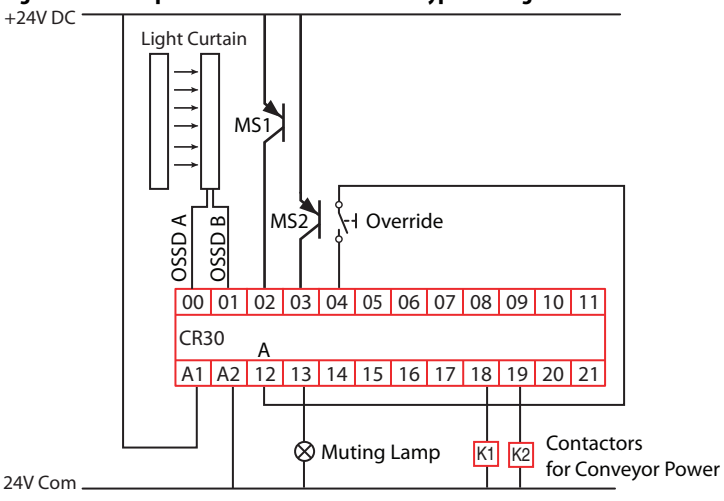
The material must first break MS1, then MS2 and then the light curtain. As the material progresses, the material must clear MS1 and then MS2. The muting lamp turns on and the light curtain is muted after MS2 is blocked. The conveyor can only move one direction.

IMPORTANT The 2-L muting arrangement must only be used for material exiting the hazard area. It must not be used for material entering the hazard area.

In the example below, the OSSD outputs of the light curtain are connected to terminals 00 and 01. The two muting sensors are connected to terminals 02 and 03. The momentary, normally open override switch is connected between terminals 12 to 04 to take advantage of pulse testing. Contactor K1 and K2, which provide power to the conveyor (and other hazards if necessary), are connected to terminals 18 and 19.

The muting lamp is connected to terminal 13; this terminal should be configured with no pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

Figure 50 - Example Schematic for 2-Sensor L-Type Muting



For simplicity, the power and ground connections of the light curtain and muting sensors are not shown. The light curtain and muting sensors must have the same reference (24V Com) as the CR30 for proper operation.

For proper operation, the muting sensors are on (normally closed) when not muting, and the light curtain OSSD outputs are also on (the light curtain is clear).

Figure 51 - Muting Time for 2-Sensor L-Type Muting

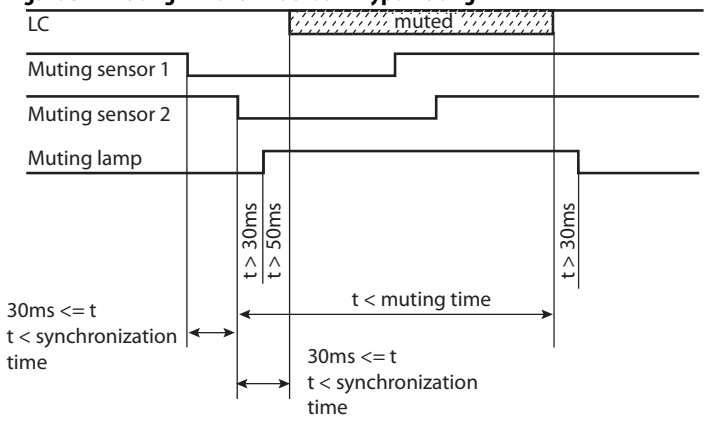


Table 6 shows the muting and synchronization times that are selectable in the CCW. These times are selected independently. For example, you can select two minute muting time, a 500 ms synchronization time between MS1 and MS2, and a 1000 ms synchronization time between MS2 and the light curtain.

> **Note:** The synchronization time also depends on the input filter time settings for the muting sensor inputs.
> Synchronization time (total) = 2 x Input Filter Time + Synch Time

Table 6 - Muting and Synchronization Times for '2L' Muting

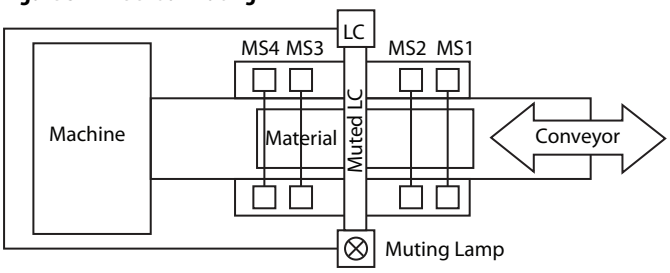
Muting Time Units	Available Values
Seconds	1…59
Minutes	1…59
Hours	1…23
Days	1…10

Synchronization Time	Available Values
MS1 to MS2	50…10,000 ms in 50 ms increments
MS2 to LC	

4-Sensor Muting

The sensors and light curtain form the shape of an upside down "T", when viewed from the side. Two muting sensors (MS) are mounted on either side of the light curtain (LC).

Figure 52 - 4-Sensor Muting

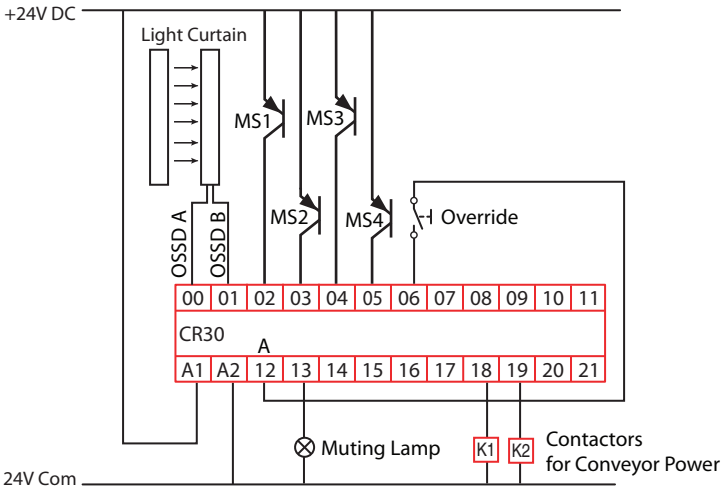


The material can travel in either direction; breaking MS1 first and MS4 last or breaking MS4 first and MS1 last. The muting lamp turns on and the light curtain is muted after the second sensor is blocked. The object must be large enough to break all four sensors.

In the example below, the OSSD outputs of the light curtain are connected to terminals 00 and 01. The four muting sensors are connected to terminals 02 to 05. The momentary, normally open override switch is connected between terminals 12 to 06 to take advantage of pulse testing. Contactor K1 and K2, which provide power to the conveyor (and other hazards if necessary), are connected to terminals 18 and 19.

The muting lamp is connected to terminal 13; this terminal should be configured with no pulse testing. Filament lamps will not be affected by pulse testing, but LED lamps may appear to flicker if pulse testing is enabled.

Figure 53 - Example Schematic for 4-Sensor Muting



For simplicity, the power and ground connections of the light curtain and muting sensors are not shown. The light curtain and muting sensors must have the same reference (24V Com) as the CR30 for proper operation.

For proper operation, the muting sensors are on (normally closed) when not muting, and the light curtain OSSD outputs are also on (the light curtain is clear).

Figure 54 - Muting Time for 4-Sensor Muting

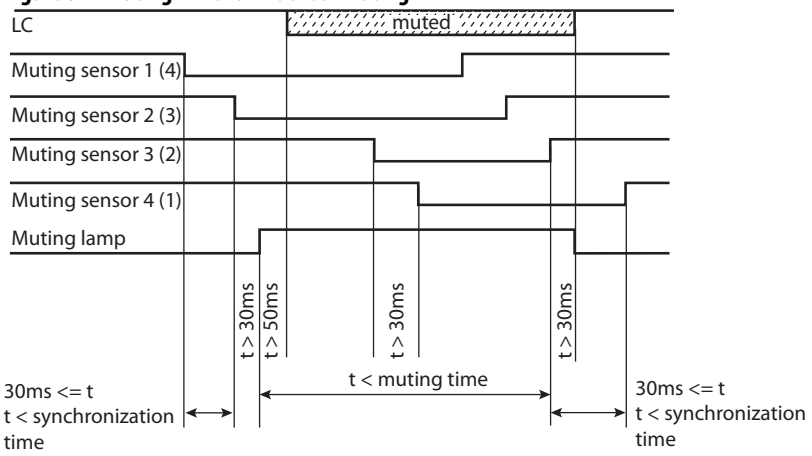


Table 7 shows the muting and synchronization times that are selectable in the CCW. These times are linked. For example, if you select a 10 s muting time, then the synchronization time between MS1 and MS2 is 3 s. To use a synchronization time of 6 s, you must select a 60 s muting time.

> **Note:** The synchronization time also depends on the input filter time settings for the muting sensor inputs.
> Synchronization time (total) = 2 x Input Filter Time + Synch Time

Table 7 - Muting and Synchronization Times for Four Sensor Muting

Muting Time	Synchronization Time
10 s	3 s
20 s	3 s
30 s	3 s
60 s (1 min)	6 s
300 s (5 min)	30 s
900 s (15 min)	90 s
1800 s (30 min)	180 s (3 min)
3600 s (1 hr)	180 s (3 min)
28800 s (8 hr)	180 s (3 min)
Infinite	Infinite

Muting Override

The muting function has an optional override input. Use the override to turn on the conveyor to clear objects through the sensors in the case of a muting sequence or timing fault.

To use the override, simply enable the feature in the safety monitoring function block. The muting override can be either a single- or dual-input and can also use input pulse testing if desired.

When the muting override input turns on, the safety outputs controlled by the muting function turn on until the override time expires or the override input turns off. The muting override can be set between 5...1275 seconds, in 5 second increments.

Muting Lamp

The muting lamp shows four states.

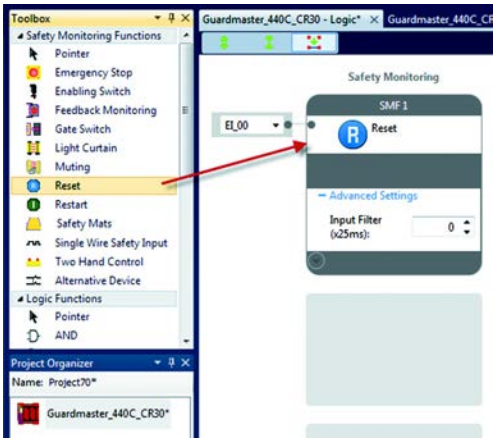
- OFF – light curtain is not muted.
- ON – light curtain is muted.
- 1 Hz blink rate – muting sequence fault.
- 3 Hz blink rate – muting is overridden (the Override input is on).

The muting lamp is not monitored. If the lamp burns out, the muting function continues to work properly.

Reset

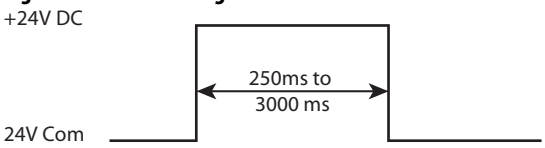
The reset block is used in safety functions that require a manual intervention to turn on the safety system.

Figure 55 - Reset Function Block



To prevent inadvertent actuation of the reset block, the reset requires a leading edge and trailing edge within a specific time frame. The pulse width must be between 250...3000 ms. If the pulse width is too short or too long, the reset function will not be executed.

Figure 56 - Reset Timing



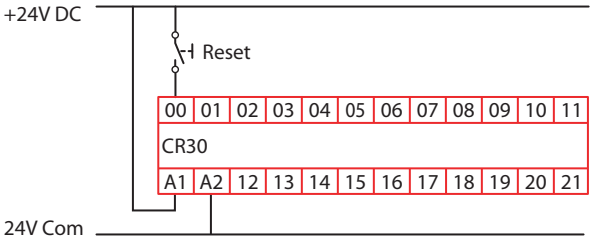
The reset block is a Safety Monitoring Function in the CCW. For a valid Reset operation, according to the requirements specified in the approved safety concept, you must use the default Reset timing and leave the input filter setting "0".

The filter setting is enabled in CCW versions previous to Rev 7. A filter time setting greater than "0" extends the Reset Timing by 2 x Filter Time.

The reset input signal can come from either one input wiring terminal or over the Modbus communication input. The available input selections are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)
- P1_00...P1_03 (plug-in 1 terminals 00...03)
- P2_00...P2_03 (plug-in 2 terminals 00...03)
- SP_00...SP_15 (Modbus inputs 00...15)

Figure 57 - Wiring Connection for a Reset Signal to Terminal 00



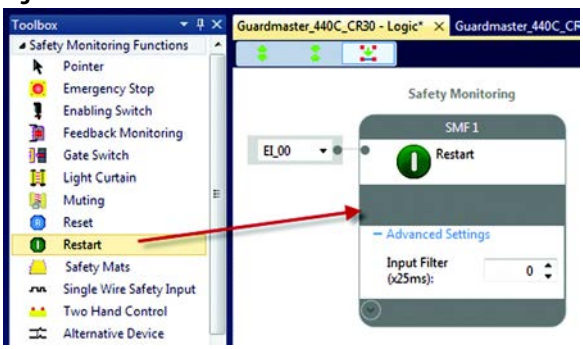
The reset block works with one or more output blocks. When an output block requires a manual reset, the CCW shows all available reset inputs that can be used.

Restart

The restart function works with an AND or OR logic block in Logic Level A and Logic Level B. When all inputs are satisfied, exercising the restart input causes the restart function go be effective. If the Restart function is already effective, the Restart input has no affect.

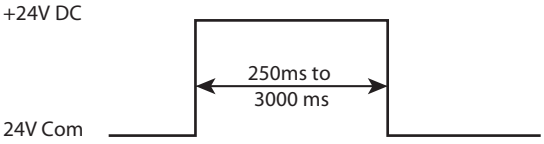
The Restart can only be used with one AND or OR logic block.

Figure 58 - Restart Function Block



The Restart Function requires a leading edge and trailing edge within a specific time frame. The pulse width must be between 250...3000 ms. If the pulse width is too short or too long, the Restart function will not be executed.

Figure 59 - Restart Timing



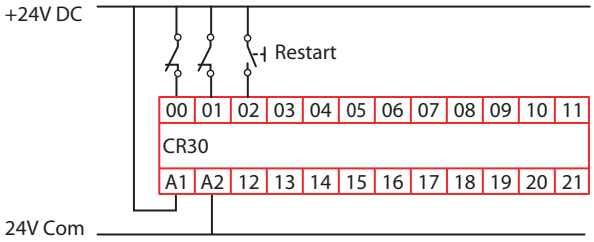
The available input selections for the Restart are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)
- P1_00...P1_03 (plug-in 1 terminals 00...03)
- P2_00...P2_03 (plug-in 2 terminals 00...03)
- SP_00...SP_15 (Modbus inputs 00...15)

For a valid Restart operation, according to the requirements specified in the approved safety concept, you must use the default Restart timing and leave the input filter setting “0”.

The filter setting is enabled in CCW versions smaller than Rev 7. A filter time setting greater than “0” extends the Reset Timing by 2 x Filter Time.

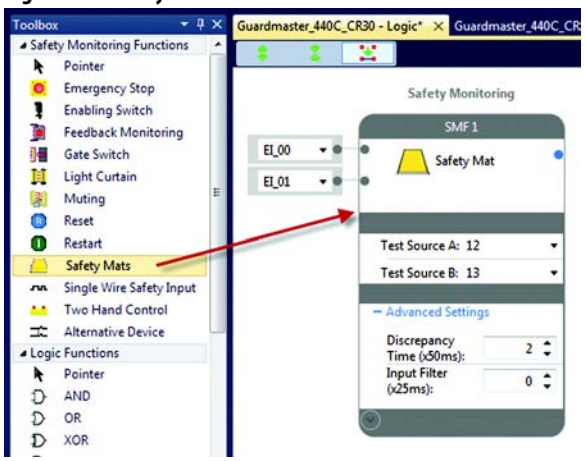
Figure 60 - Wiring Connection for a Restart Signal to Terminal 02 with Inputs on Terminals 00 and 01



Safety Mat

Four wire safety mats can be connected to the CR30. The four wires create two channels. Stepping on the safety mat creates a short circuit between channel 1 and 2. To detect the short circuit, input pulse testing is used. The mats must be connected to the input test pulses.

Figure 61 - Safety Mat Function Block



The safety mat can be connected to the following terminals:

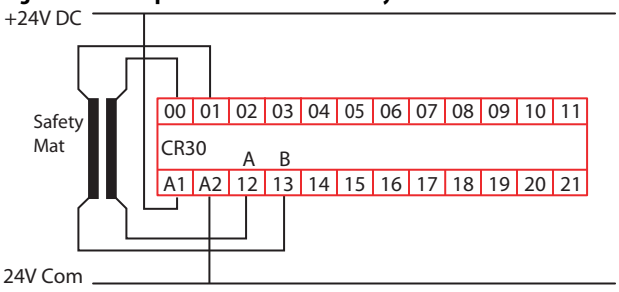
- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

For input test pulses, terminals 12...17 are available. The CCW automatically selects another test pulse pattern for each input.

An example schematic shows a safety mat that is connected to terminals 0 and 1. The mat uses test pulses that are generated at terminals 12 and 13.

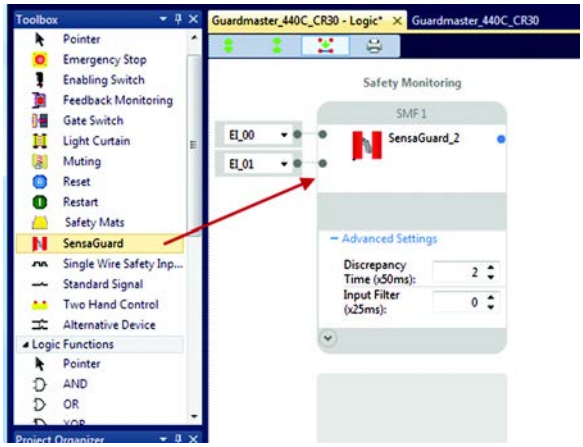
Figure 62 - Example Schematic for a Safety Mat



SensaGuard

The SensaGuard™ function block sets the parameters for interlocks having dual OSSD outputs. In the CCW, click and drag (or double-click) the block to an available Safety Monitoring Function spot. This block can be used for other devices with OSSD outputs.

Figure 63 - SensaGuard Function Block

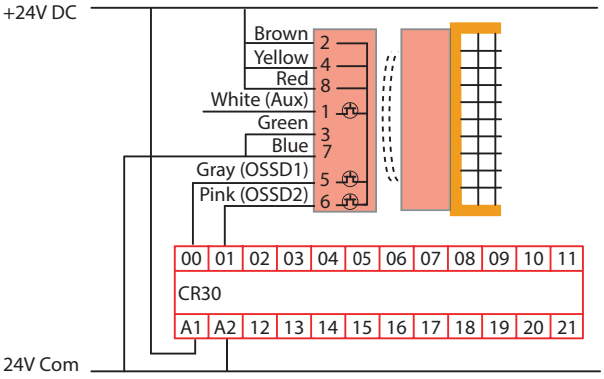


The available input selections for the SensaGuard inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can use the default Discrepancy Time (See Discrepancy Time on page 41) and Input Filter (See Input Filter on page 39) or choose to modify these settings.

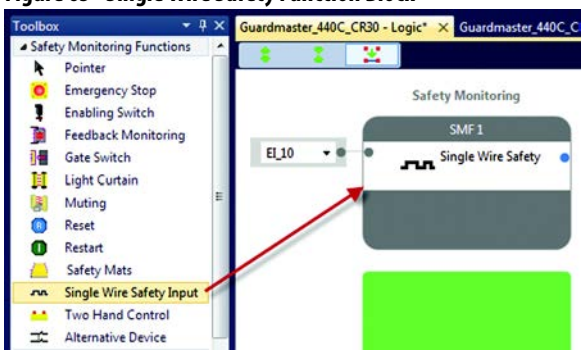
Figure 64 - Example Schematic of a SensaGuard Interlock



Single Wire Safety Input

When configured for this type of input, the CR30 expects a Single Wire Safety (SWS) input signal from a GSR relay or a safeguarding device that has an SWS output signal. The GSR relay family includes the CI, SI, DI, DIS, GLP, GLT, EM, and EMD modules. Each of these modules provides the SWS signal on terminal L11.

Figure 65 - Single Wire Safety Function Block



Only terminals 10 and 11 of the CR30 can be configured to receive the SWS signal.

- EI_10...EI_11 (embedded input terminals 10...11)

The SWS signal is a long pulse followed by a short pulse, which is repeated while the signal is active. The SWS is active when the safety outputs of a GSR safety relay are ON. When the SWS is inactive, the SWS signal is 0V. The timing and voltage characteristics of the SWS waveform are shown in Figure 66.

Figure 66 - SWS Waveform

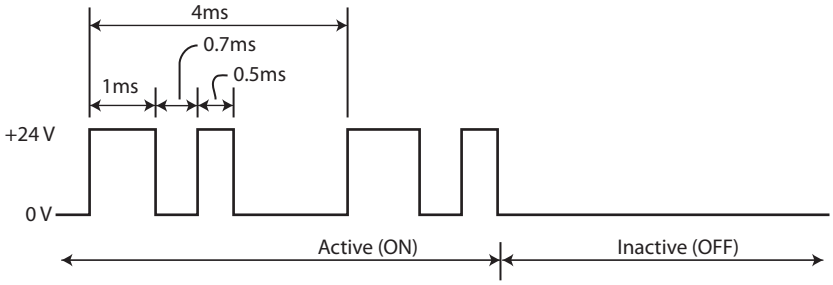
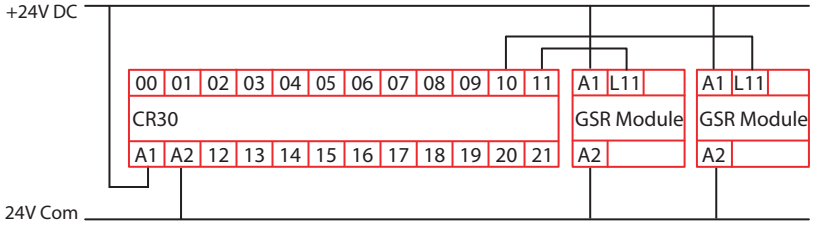


Figure 67 shows an example schematic of the connection of the SWS from other modules in the GSR family of relays. The CR30 and GSR modules must be connected to the same 24V Common.

Figure 67 - SWS Connection Schematic



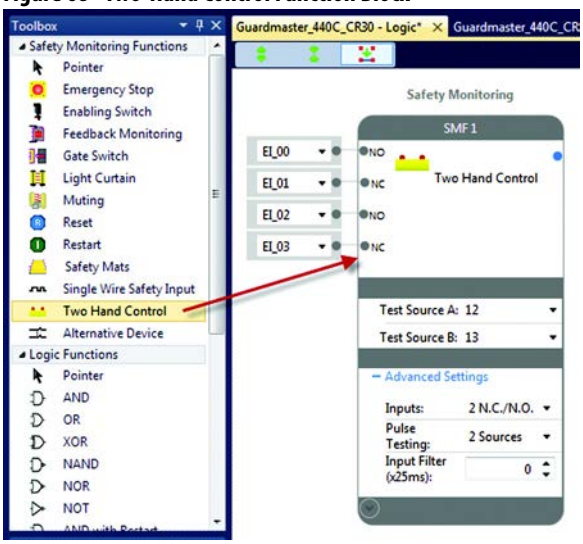
Two-Hand Control

The CR30 can be configured to operate in two different types of two-hand control, which are specified in ISO 13851. The two types are:

- Type IIIA (for low-risk safety systems)
- Type IIIC (for high-risk safety systems)

Mechanically palm-operated buttons (Bulletin 800P) or the electronic output push buttons (Bulletin 800Z Zero-Force Touch Buttons™) should be used as actuating devices for two hand control. The CR30 requires two buttons to be actuated simultaneously and maintained to turn the two-hand safety monitoring function ON. To meet the simultaneity requirement, the two buttons must be actuated within 500 ms of each other.

Figure 68 - Two-Hand Control Function Block



The two-hand controls can be connected to the following terminals.

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can use the default Input Filter or choose to modify these settings.

When test pulses are used, the CCW automatically selects another test pulse pattern for each input. The two-hand control can use input test pulses from following terminals:

- MP_12...MP_17 (multi-purpose terminals 12...17)

Type IIIA Two-hand Control

The Type IIIA uses only one normally open contact for each hand. This configuration can be set up with or without the use of test pulses. The test pulses provide short circuit fault detect between channels and between channel and 24V.

Figure 69 - Example Wiring Connection for a Type IIIA Two-hand Control without Test Pulses

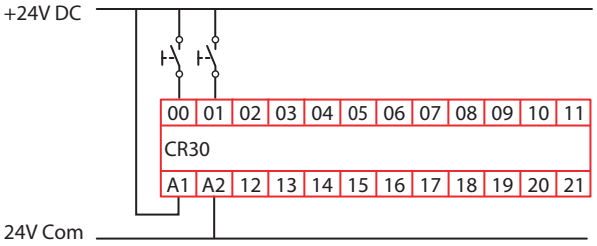
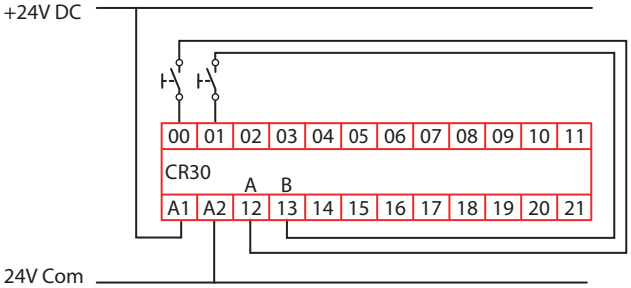


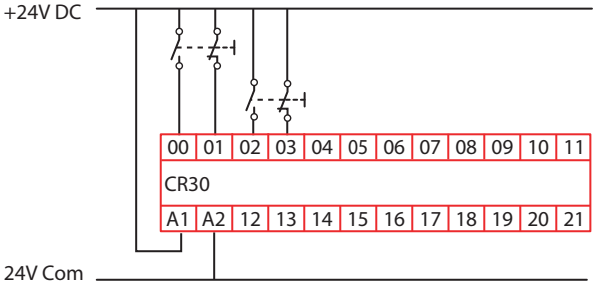
Figure 70 - Wiring Connection for a Type IIIA Two-hand Control with the Test Pulses



Type IIIC Two-Hand Control

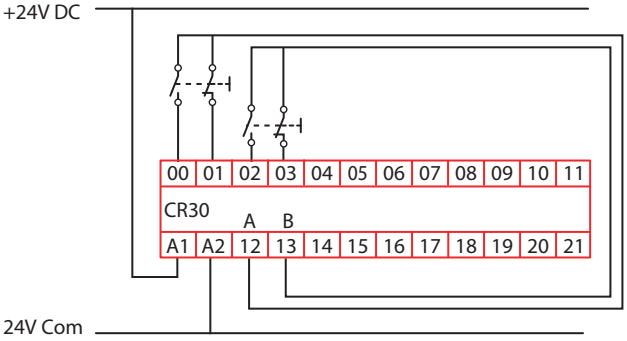
The Type IIIC uses a normally open and a normally closed contact for each hand.

Figure 71 - Example Wiring Connection for a Type IIIC Two-hand Control without Test Pulses



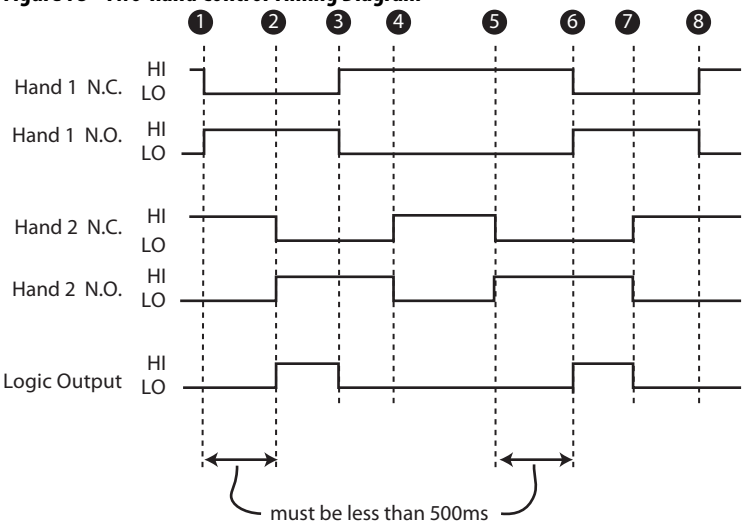
When test pulses are used, the CR30 will detect a short from Channel 1 to Channel 2 after 3.7 seconds and turn the output OFF. To clear the fault, release both buttons.

Figure 72 - Wiring Connection for a Type IIIC Two-hand Control with Test Pulses



The timing diagram for the two-hand control is shown in Figure 73. The Type IIIA uses only the N.O. contact of the button. The Type IIIC uses both the N.C. and the N.O. contacts.

Figure 73 - Two-hand Control Timing Diagram



	Description
1	Hand 1 button is pressed.
2	Hand 2 button must be pressed within 500 ms for the output logic to turn ON.
3	Releasing either hand button causes the logic output to turn off.
4	Both hand buttons must be released to start a new cycle.

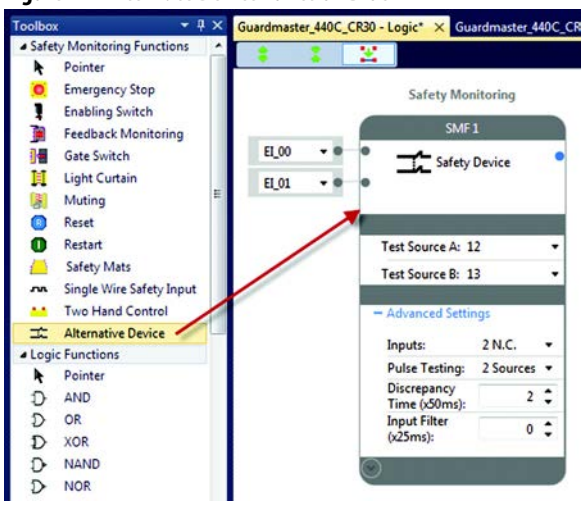
	Description
5	Hand 2 button is pressed.
6	Hand 1 button must be pressed within 500 ms for the output logic to turn ON.
7	Releasing either hand button causes the logic output to turn off.
8	Both hand buttons must be released to start a new cycle.

Alternate Device

The Alternate Device provides the flexibility to create other types of input monitoring blocks. Use this block for the following types of input functions:

- Single channel OSSD
- Single channel N.C.
- Dual channel OSSD
- Dual channel 2 N.C.
- Dual channel 1 N.C./1 N.O.
- Three channel N.C.
- Three channel OSSD

Figure 74 - Alternate Device Function Block



Single Channel

Single channel safety monitoring functions require only one connection to an input terminal. The single channel input must only be used in low-risk safety systems.

The available input terminals are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

You can use the default Input Filter or choose to modify this setting.

When test pulses are used, the CCW automatically selects the test pulse pattern. The single channel N.C. can use input test pulses from following terminals:

- MP_12...MP_17 (multi-purpose terminals 12...17)

Figure 75 - Example Schematic for Single Channel N.C. without Test Pulse

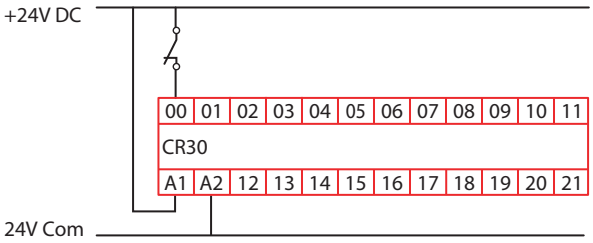


Figure 76 - Example Schematic for Single Channel N.C. with Test Pulse

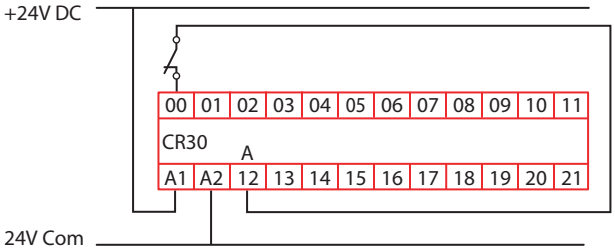
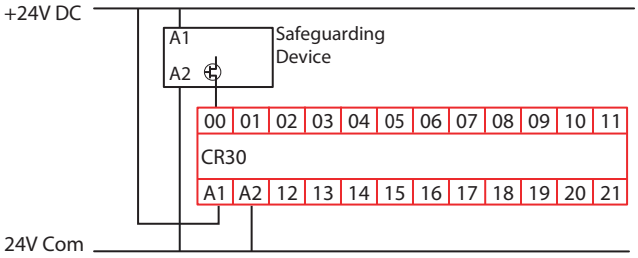


Figure 77 - Example Schematic for Single Channel OSSD



Dual Channel

Dual channel safety monitoring functions require two independent circuit connections to the CR30. Dual channel inputs are used for medium and high risk applications.

You can modify the number and types of inputs:

- 2 N.C.
- 2 OSSD
- 1N.C./1 N.O.

The available input selections for the dual-channel OSSD and two N.C. inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

The available input selections for the N.O. contact are:

- MP_12...MP_17 (multi-purpose terminals 12...17)

Pulse testing can be set to 1 Source, 2 Sources, or Disabled. When 1 or 2 Sources is selected, the next available test sources are automatically assigned by the CCW. You can modify the sources afterward.

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

The two terminals do not necessarily have to be consecutive.

Figure 78 - Example Schematic for 2 N.C. without Test Pulse

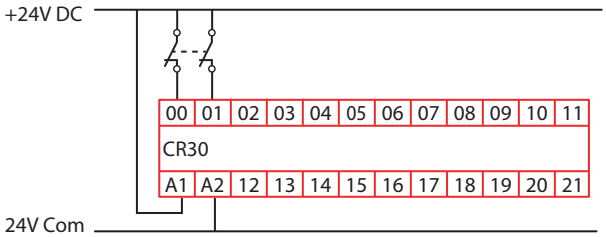
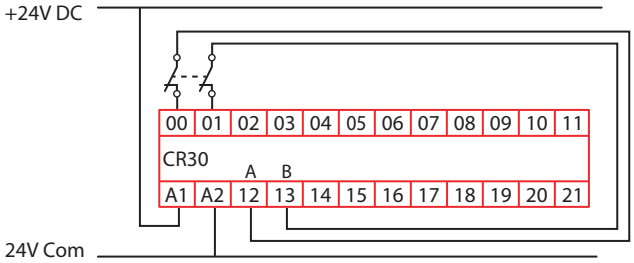


Figure 79 - Example Schematic for 2 N.C. with Two Test Pulses Sources



Dual Channel OSSD

Safeguarding devices with OSSD outputs generate their own test pulses to detect for short circuit conditions or have other methods of detecting short circuit conditions. When configured for dual channel OSSD, the CR30 ignores the test pulses.

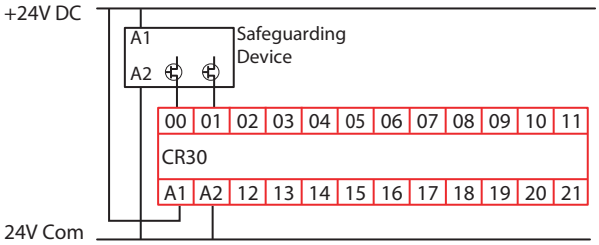
Table 8 shows examples of products that use dual channel OSSD outputs:

Table 8 - Products Using Dual Channel OSSD Outputs

Product Types	Product Name
Light Curtains	GuardShield™
Laser Scanners	SafeZone™, SafeZone Multizone
Gate Interlocks	SensaGuard™, SensaGuard with Integrated Latch
Guardlocking Interlocks	TLS-ZR, 440G-LZ

Short circuits are detected by the safeguarding device, and the safeguarding device turns off its safety outputs. Devices with OSSD outputs are capable of operating in high risk applications.

Figure 80 - Example Schematic for Two OSSD



Dual Channel N.C./N.O.

The N.C./N.O. configuration applies the diversity concepts, where one contact is open and the other contact is closed. The contact, while in an open state, cannot be welded closed. The CR30 turns off its safety outputs when either channel changes state. Both channels must change state for proper performance.

Figure 81 - Example Schematic for N.C./N.O. without Test Pulse

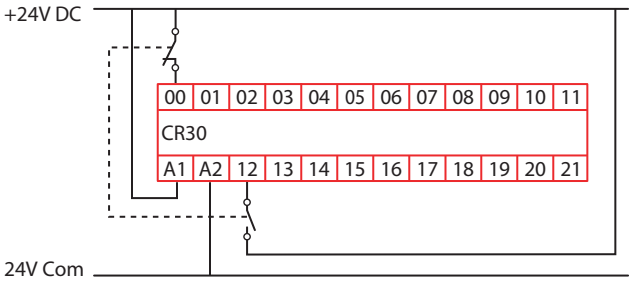


Figure 82 - Example Schematic for N.C./N.O. with One Test Pulse

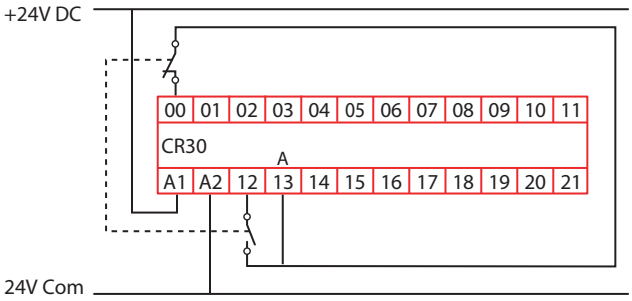
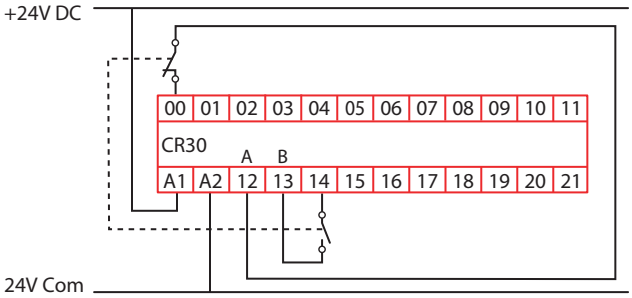


Figure 83 - Example Schematic for N.C./N.O. with Two Test Pulses



If a short circuit occurs on terminal 12 to 24V, the CR30 turns off its safety outputs within 35 ms. Remove the fault and cycle the contacts to clear the fault.

If a short circuit occurs on terminal 12 to ground, the CR30 turns off its safety outputs within 3.3 seconds. Remove the fault and cycle the contacts to clear the fault.

If a short circuit occurs from terminal 12 to terminal 13, the CR30 turns off its safety outputs within 35 ms. Remove the fault and cycle the contacts to clear the fault.

Three Channel

The CR30 can accept three channels into one safety monitoring function. All three inputs must be HI to satisfy the input. If any one of the inputs goes LO, the output of safety monitoring function goes LO and turns off its associated output devices. The three N.C. inputs can be operated without input test pulses, with one input test pulse, with only two input test pulses, or with three input test pulses.

The available input selections for the three channel inputs are:

- EI_00...EI_11 (embedded input terminals 00...11)
- MP_12...MP_17 (multi-purpose terminals 12...17)

Pulse testing can be set to 1 Source, 2 Sources, 3 Sources, or Disabled. When 1, 2, or 3 Sources is selected, the next available test sources are automatically assigned by the CCW. You can modify the sources afterward.

You can use the default Discrepancy Time and Input Filter or choose to modify these settings.

The three terminals do not necessarily have to be consecutive.

Figure 84 - Example Schematic for Three N.C. without Test Pulses

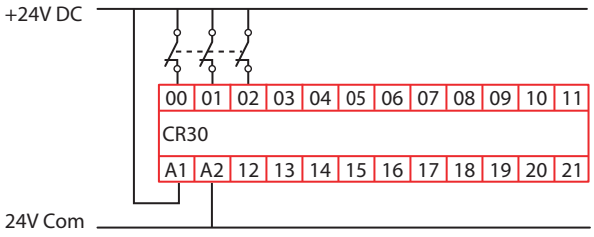


Figure 85 - Example Schematic for Three N.C. with One Test Pulse Source

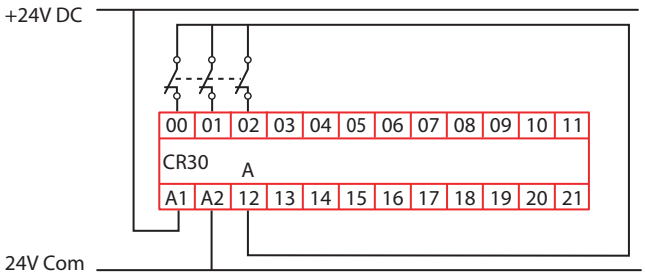


Figure 86 - Example Schematic for Three N.C. with Three Test Pulse Sources

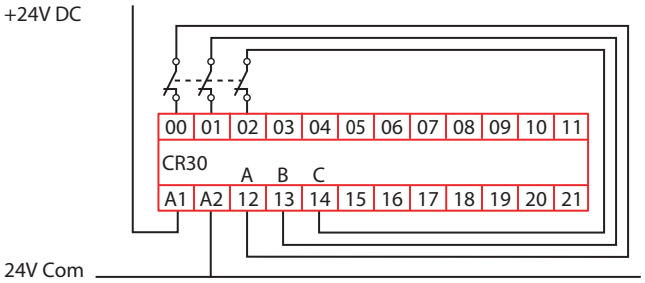
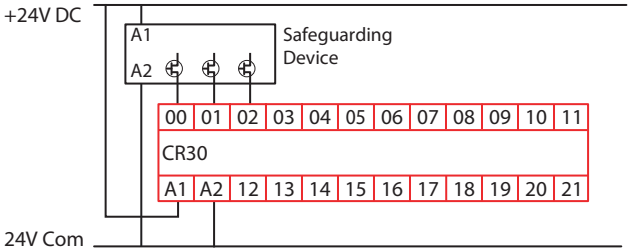


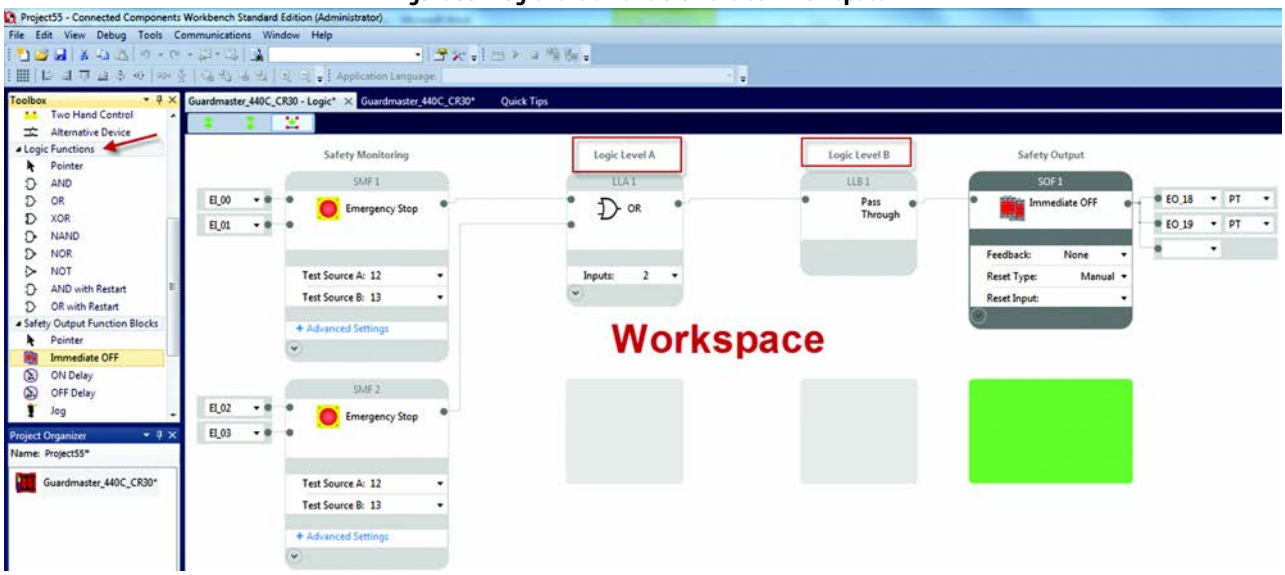
Figure 87 - Example Schematic for Three OSSD



Logic Levels A and B

The Connected Components Workbench (CCW) has two levels that allow you to apply simple logic to create more sophisticated safety systems. The logic levels are labeled A and B on the CCW workspace. The logic functions are available in the Toolbox.

Figure 88 - Logic Levels A and B on the CCW Workspace



Pass Through

When a logic level is not used, the CCW automatically creates a Pass Through block.

AND

The AND block accepts 2...24 inputs. When all inputs are HI, the output of the block is HI. If any of the inputs is LO, the output of the block is LO.

The AND block is often used when multiple E-stops must be released and multiple safety gates must be closed for the safety system to be energized.

Figure 89 - AND Logic Block

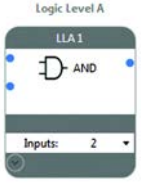


Table 9 - AND Logic Table for Two Inputs

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

OR

The OR block accepts 2...24 inputs. If any of the inputs are HI, the output of the block is HI. If all inputs go LO, the output of the block goes LO.

The OR block is often used with enabling devices.

Figure 90 - OR Logic Block

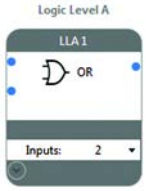


Table 10 - OR Logic Table for Two Inputs

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

XOR

The XOR block accepts 2...24 inputs. The output of the XOR block is HI when any input is HI. The output is LO when multiple inputs are HI or if all inputs are LO.

Figure 91 - XOR Logic Block

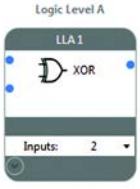


Table 11 - XOR Logic Table for Two Inputs

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

NAND

The NAND block accepts 2...24 inputs. The NAND performs the opposite of an AND block. The output of the NAND block is LO when all inputs are HI. When any input is LO, the output is HI.

Figure 92 - NAND Logic Block

Table 12 - NAND Logic Table for Two Inputs

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

NOR

The NOR block performs the opposite of the OR block. When any input is HI, the output is LO. When all inputs are LO, the output is HI.

Figure 93 - NOR Logic Block

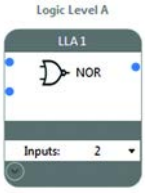


Table 13 - NOR Logic Table for Two Inputs

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

NOT

The NOT block accepts only one input. The NOT inverts the input signal. When the input is LO, the output is HI. When the input is HI, the output is LO.

Figure 94 - NOT Logic Block

Table 14 - NOT Logic Table for Two Inputs

Input	Output
0	1
1	0

AND with Restart

The AND with Restart accepts 2...24 inputs and requires a Restart input. All inputs must be HI when the Restart button is pressed.

The CCW automatically recognizes the Restart function blocks and allows you to select one. Once selected, the Restart is no longer available for other logic blocks.

Figure 95 shows an example with a gate switch and a light curtain. Both the gate must be closed and the light curtain clear. Then, the Restart input must be pressed. The output of the logic block goes HI on the trailing edge of the restart signal.

Figure 95 - Example of AND with Restart

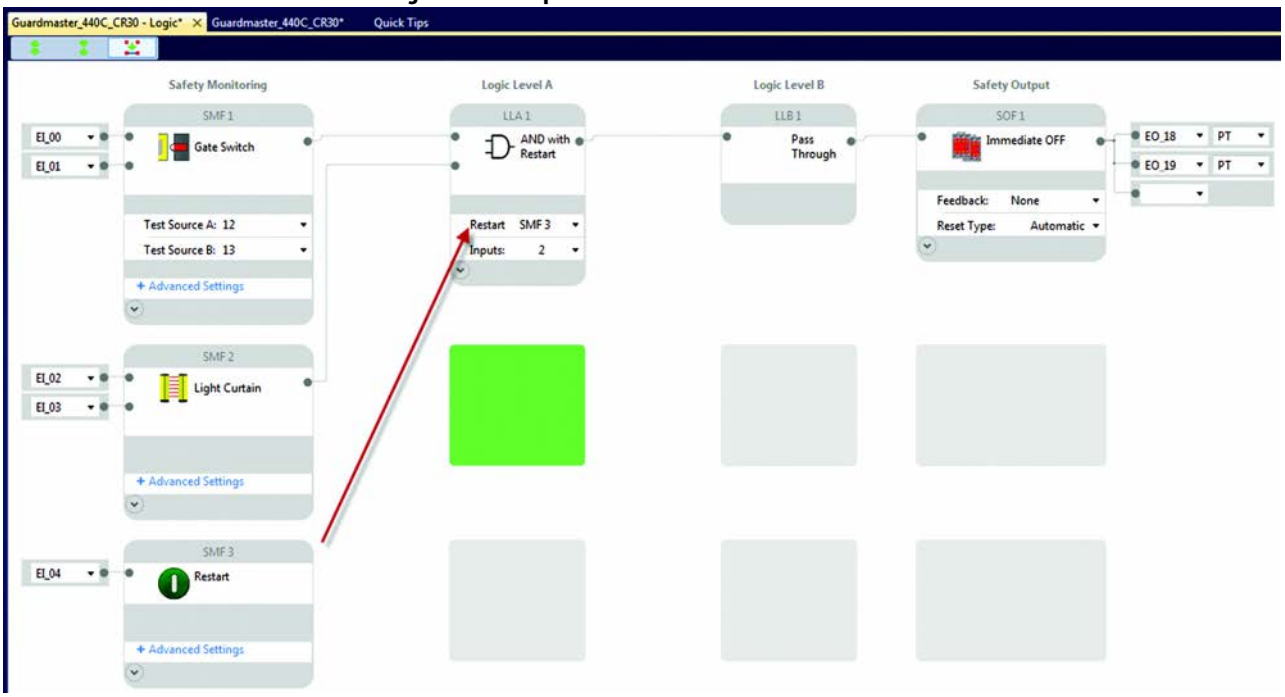
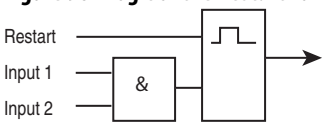
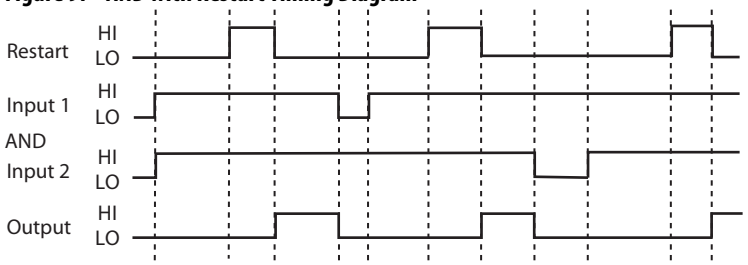


Figure 96 - Logic of the Restart Function with Two Input AND



The timing diagram shows how the output of the Logic block responds to the input signals and the Restart signal. Both inputs must be HI when the Restart signal occurs for the output to go HI. If any of the inputs go LO, the output goes LO.

Figure 97 - AND with Restart Timing Diagram



OR with Restart

The OR with Restart accepts 2...24 inputs and requires a Restart input. At least one input must be HI when the Restart button is pressed.

The CCW automatically recognizes the Restart function blocks and allows you to select one. Once selected, the Restart is no longer available for other logic blocks.

Figure 98 shows an example with a gate switch and a light curtain. Either the gate must be closed or the light curtain clear. Then, the Restart input must be pressed. The output of the logic block goes HI on the trailing edge of the restart signal.

Figure 98 - Example OR with Restart

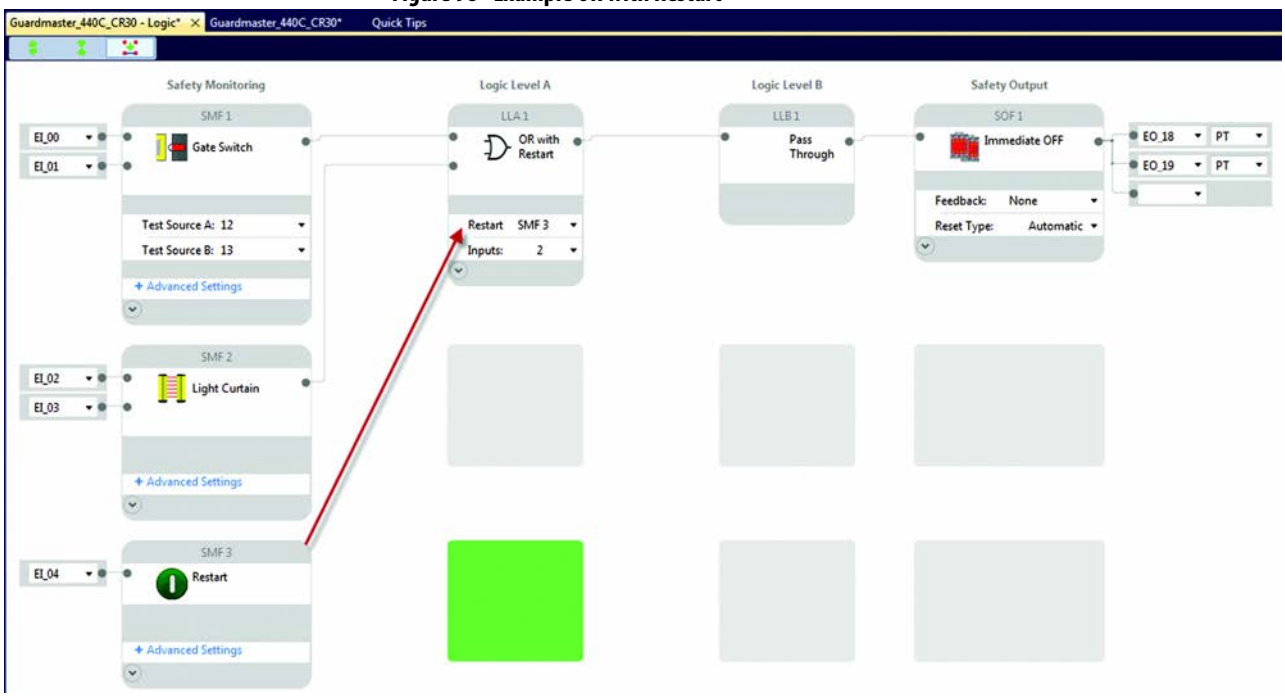
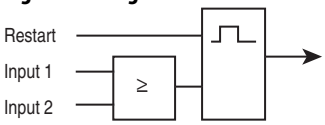
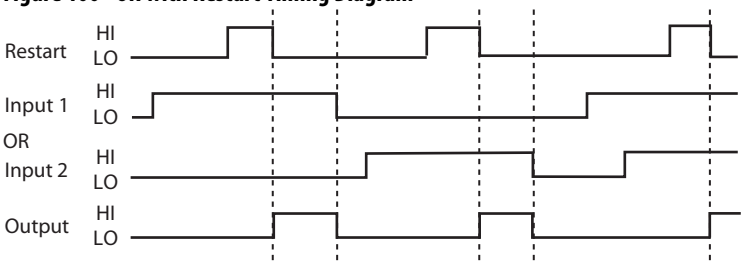


Figure 99 - Logic of the Restart Function with Two Input OR



The timing diagram shows how the output of the Logic block responds to the input signals and the Restart signal. Either or both inputs can be HI when the Restart signal occurs for the output to go HI. If all inputs go LO, the output goes LO.

Figure 100 - OR with Restart Timing Diagram



Safety Outputs

The safety output blocks are the fourth stage of the configuration. Many of the blocks have common features.

Input Connection

Each output block has one input connection. This input connection can be connected to only Logic Level B blocks.

Feedback

The Immediate OFF, ON Delay, and OFF Delay blocks have a feedback parameter. To use the feedback parameter, a feedback input block must be declared. If a feedback input block is not available, the feedback parameter is set to “None”, and can be considered to be always HI.

Reset

The reset parameter must be set to either automatic or manual.

- If set to automatic, the output turns on when the input received from the Logic Level B block is HI.
- If the reset is set to manual, a reset input block must be declared. Before the reset button is pressed, the input that is received from the Logic Level B block must be HI. Then, the output turns on if the reset button must be pressed and held for at least 0.25 s and released within 3 s.

Timing

Timing is used in the ON Delay, OFF Delay, and Jog functions.

The timing can be set between 50...300,000 ms (5 minutes) in 50 ms increments.

Output Connections

The output of the block can be connected to one or more of the following wiring terminals:

- 12...17 Multi-Purpose (MP)
- 18...21 Embedded Output (EO)
- 00...03 plug-in 1 module (not safety rated)
- 00...03 plug-in 2 module (not safety rated)

The multi-purpose outputs can be configured to operate with pulse test (PT) or without test pulses (No PT). The embedded terminals always operate with test pulses. Terminals 20 and 21 can be configured as Single Wire Safety (SWS) output.

WARNING: The plug-in outputs must only be used for nonsafety rated purposes.

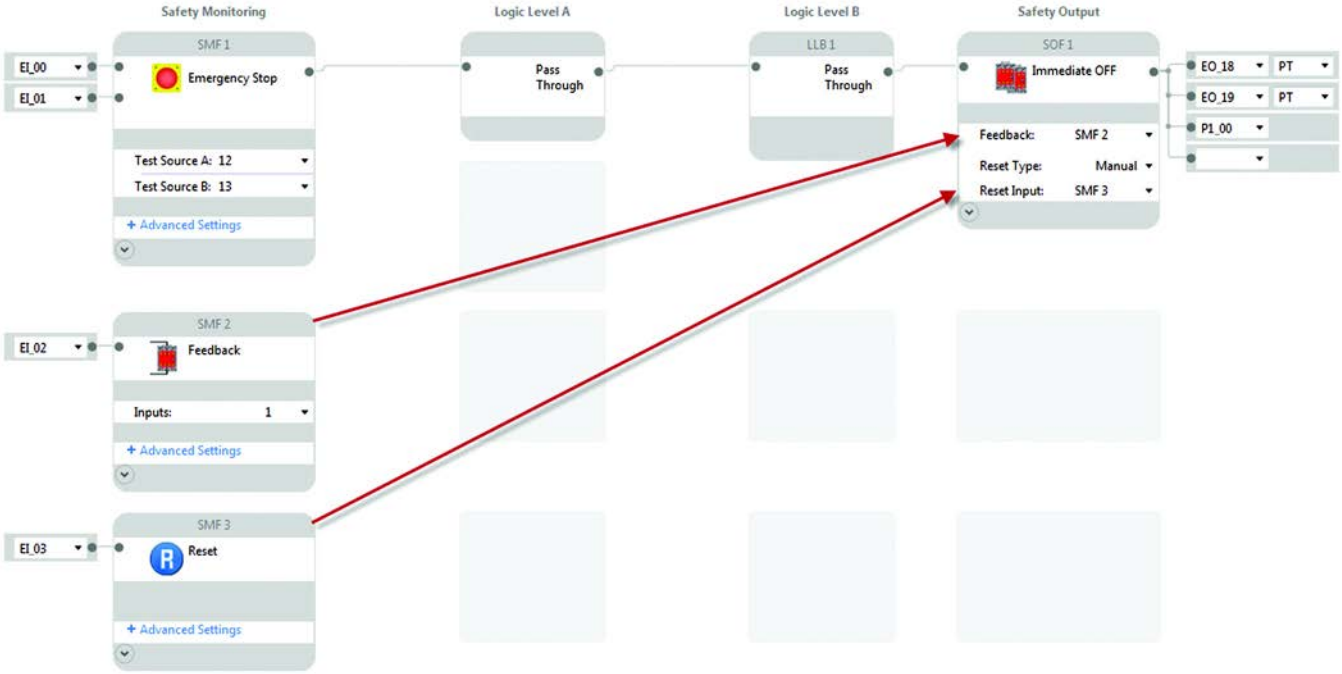
Immediate OFF

The Immediate OFF block is used to turn off output terminals immediately upon a demand that is placed on a safety function.

Figure 101 shows the Immediate OFF output block that is connected to an E-stop block through Logic Level LLB1. The feedback signal is provided by SMF2 and manual reset by SMF3. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazards.
- Plug-in 1 terminal 00 for status indication.

Figure 101 - Immediate OFF Configuration



ON Delay

The ON Delay block turns on the output after the specified time delay expires.

Figure 102 shows the ON Delay output block that is connected to an E-stop block through Logic Level LLB1. The feedback signal is provided by SMF2 and manual reset by SMF3. The time delay is set to 20. The output will turn on 1000 ms (20x50 ms) after the reset button is released. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazards.
- Terminal 20, which is configured as a Single Wire Safety (SWS) output.
- Plug-in 1 terminal 00 for status indication.

Figure 102 - ON Delay Configuration

OFF Delay

The OFF Delay block turns off the output after the specified time delay expires.

The retriggerable parameter can be set to enabled or disabled.

- When enabled, the input to the OFF Delay block can go HI again during the timing cycle, and the output remains HI.
- When disabled, the timing cycle runs to completion, regardless of changes to the input.

Figure 103 shows the OFF Delay output block that is connected to a gate switch block through Logic Level LLB1. The feedback signal is provided by SMF2 and manual reset by SMF3. The time delay is set to 30. The output will turn off 1500 ms (30x50 ms) after the gate is opened. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazards.
- Terminal 20, which is configured as a Single Wire Safety (SWS) output.
- Terminal 00 of Plug-in 2 for status reporting

Figure 103 - OFF Delay Configuration

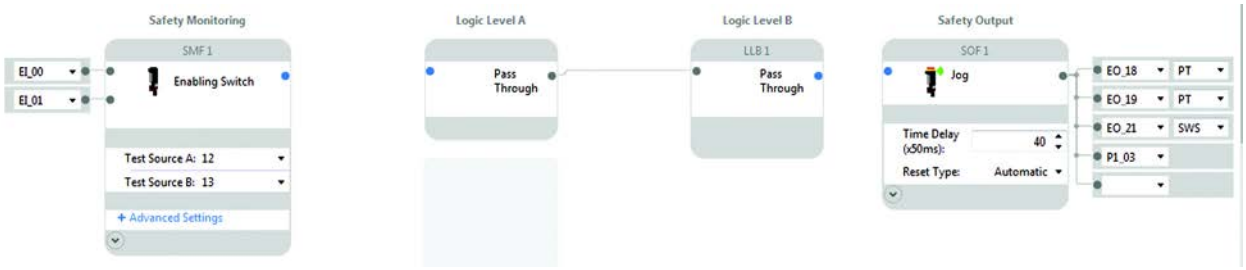
Jog

The Jog block turns on the output for a specified duration while the jog input is held HI. If the Jog input goes LO, the output immediately turns off.

Figure 104 shows the Jog output block that is connected to an enabling switch block through Logic Level LLB1. The reset is set to automatic. The time delay is set to 40. The output will turn on for a maximum of 2000 ms (40x50 ms) after the enabling switch is closed. The output is connected to:

- Terminals 18 and 19 for dual channel safety switching of the machine hazards.
- Terminal 20, which is configured as a Single Wire Safety (SWS) output.
- Plug-in 1 terminal 03 for status indication.

Figure 104 - Jog Configuration



Muting Lamp

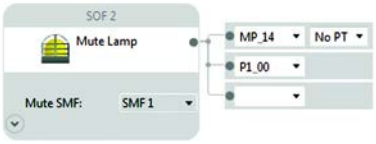
The Muting Lamp block works with the Muting safety monitoring function.

The muting lamp is not monitored. If the lamp burns out or becomes disconnected, the muting function continues to function properly.

Figure 105 shows the muting lamp output block connected to the mute function in SMF1. The output is connected to:

- Terminal 14, a multi-purpose terminal with no pulse testing (No PT).
- Plug-in 1 terminal 00 for more status indication.
- The muting lamp should be connected to terminals without pulse testing. Pulse testing does not affect filament lamps, but LED lamps can appear to flicker if pulse testing is enabled.

Figure 105 - Muting Lamp Configuration



Notes:

Plug-in Modules

The CR30 accepts up to two plug-in I/O modules. Table 15 shows which modules are available for the firmware that is installed in the CR30.

Table 15 - Plug-in Modules for the CR30

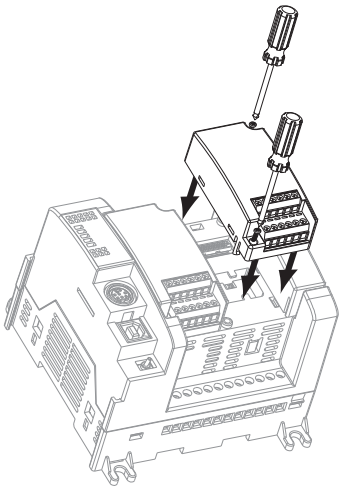
Module	Description	Firmware Release
2080-IQ4OB4	4 sinking inputs + 4 sourcing outputs	6 and later
2080-IQ4	4 sinking inputs	7 and later
2080-OB4	4 sourcing outputs	7 and later
2080-OW4I	4 electro-mechanical relay outputs	7 and later

ATTENTION: The input and output signals of these modules are not safety rated. They must only be used for standard control functions.

Insert Module into Controller

Follow the instructions to insert and secure the plug-in module to the controller.

Figure 106 - Plug-in Module



1. Position the plug-in module with the terminal block facing the front of the controller as shown.
2. Snap the module into the module bay.
3. Using a screwdriver, tighten the 10...12 mm (0.39...0.47 in.) M3 self-tapping screw to 0.2 N•m (1.48 lb•in) torque.

2080-IQ4OB4

The 2080-IQ4OB4 has four sinking inputs and four sourcing outputs. The COM connection B3 is internally connected to A3. This COM connection is for the inputs (without it, the inputs do not turn on). Terminal B4 must be connected to the +24V supply to provide power to the outputs terminals O-00...O-03.

Figure 107 - 2080-IQ4OB4 Schematic Showing Four Standard Input Signals

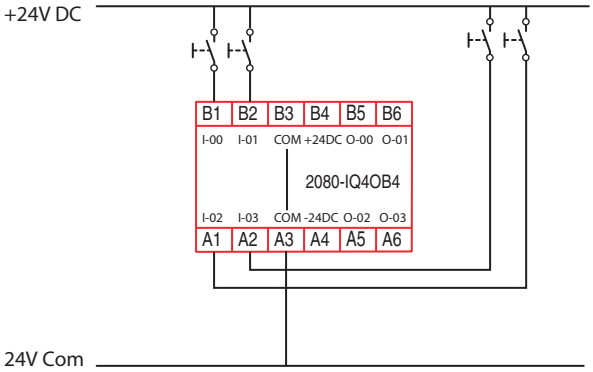
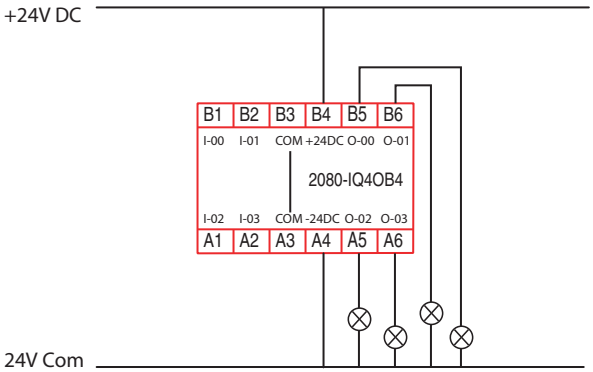


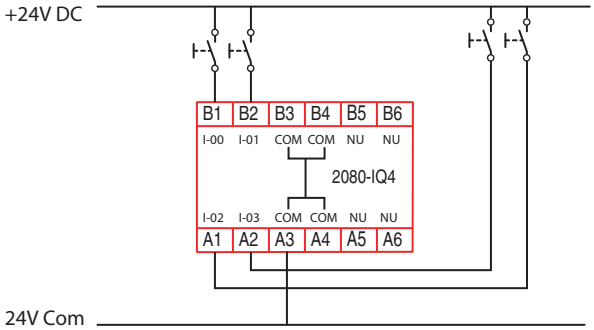
Figure 108 - 2080-IQ4OB4 Schematic Showing Four Standard Output Signals



2080-IQ4

The 2080-IQ4 has four sinking inputs. The four COM connections, A3, A4, B3, and B4 are internally connected. At least one COM connection must be connected to 24V Com (without it, the inputs do not turn on).

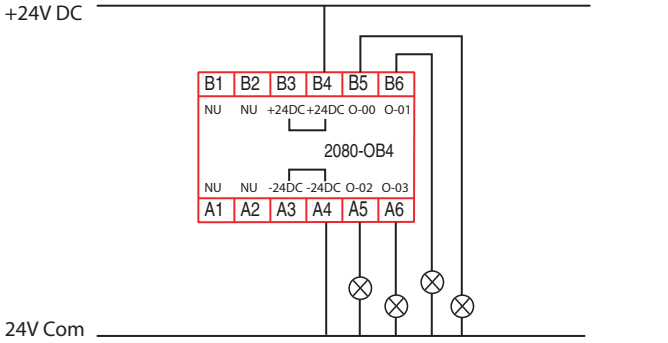
Figure 109 - 2080-IQ4 Schematic Showing Four Standard Input Signals



2080-OB4

The 2080-OB4 has four sourcing outputs. Terminals B3 and B4 are internally connected; one of these terminals must be connected to +24V DC. Terminals A3 and A4 are internally connected; one of these terminals must be connected to 24V Com.

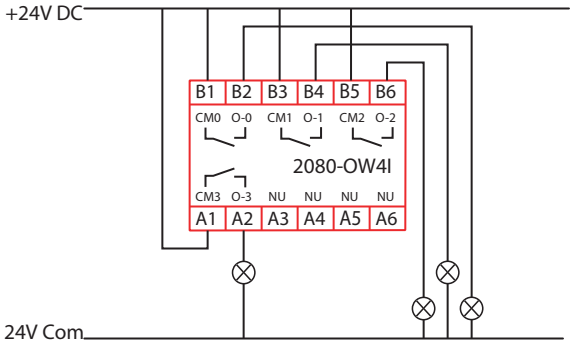
Figure 110 - 2080-OB4 Schematic Showing Four Standard Output Signals



2080-OW4I

The 2080-OW4I has four electromechanical relays with normally open (Form A) contacts.

Figure 111 - 2080-OW4I Schematic Showing Four Standard Output Signals



Install a Guardmaster 440C-ENET EtherNet/IP Plug-in Module

ATTENTION: Environment and Enclosure
This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.
This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.
This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.
In addition to this publication, see:

- *Industrial Automation Wiring and Grounding Guidelines*, for additional installation requirements, Allen-Bradley publication 1770-4.1.
- NEMA 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosures.

ATTENTION: Prevent Electrostatic Discharge
This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wrist strap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

Installation Summary

Do these steps to install the Ethernet plug-in module.

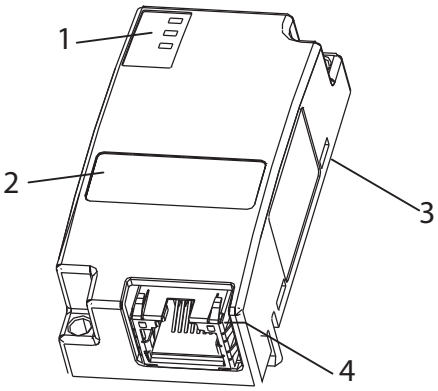
1. Mount the Guardmaster 440C CR30 safety relay on a DIN Rail or panel.
2. Install the plug-in module.

About the Module

The module provides EtherNet/IP connectivity for Guardmaster 440C-CR30 safety relays.

Use Figure 112 to identify the external features of your module.

Figure 112 - External Features



	Description		Description
1	Status indicators	3	Plug-in connector (on opposite side of circuit board)
2	MAC ID label	4	RJ45 (Ethernet) cable connector

Software Requirements

You must have one of the following versions of software.

Table 16 - Software Versions

Software	Description
Studio 5000 Logix Designer	20 or later You need to download the add-on profile from http://www.rockwellautomation.com/support/controlflah/LogixProfiler.asp
Connected Components Workbench	8 or later You need to download the software from http://www.rockwellautomation.com/rockwellautomation/support/pcdc.page

Firmware Requirements

You must have one of the following versions of firmware.

Table 17 - Firmware Versions

Module	Description
440C-CR30-22BBB	8.001 or later You need to download the firmware from http://www.rockwellautomation.com/rockwellautomation/support/pcdc.page

Install the Module

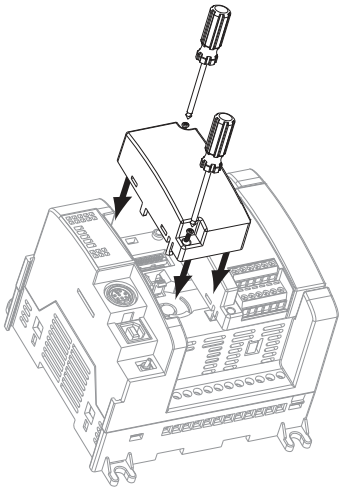
To install the module, follow this procedure.

ATTENTION:

- Do not insert or remove the plug-in module while power is applied, otherwise permanent damage to equipment may occur.
- This plug-in module is not compatible with Micro800™ controllers.

1. Position the plug-in module as shown.

Figure 113 - Plug-in Module Positioning

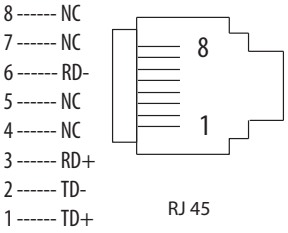


2. Snap the module into slot 1 of the module bay.
3. Using a screwdriver, tighten the 10...12 mm (0.39...0.4 in.) M3 self-tapping screw to torque specifications.

Wire the Ethernet Connector

Use an RJ45 connector to connect to the EtherNet/IP network. Wire the connector as shown.

Figure 114 - Connector Wiring



For detailed EtherNet/IP connection information, see the EtherNet/IP Media Planning and Installation Manual, available from the Open DeviceNet Vendor Association (ODVA) at http://www.odva.org.

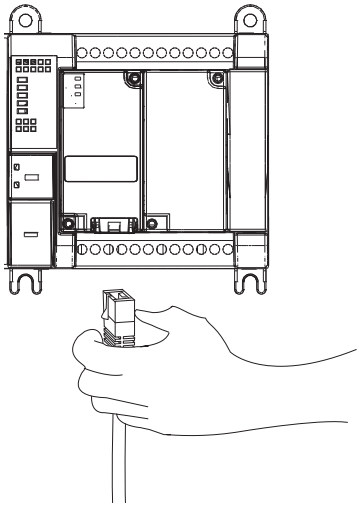
Grounding Considerations

The grounding and bonding must be of equal potential between all devices in the communication coverage area.

Connect the Module to the EtherNet/IP Network

Connect the RJ45 connector of the Ethernet cable to the Ethernet port on the bottom of the plug-in module as shown.

Figure 115 - Ethernet Cable Connection



Set the Network Address

The default settings for the 440C-CR30 safety relay is DHCP enabled for the Ethernet plug-in. You can set the network internet protocol (IP) address two ways.

- Use Dynamic Host Configuration Protocol (DHCP) server.
- Use Rockwell Automation RSLinx Classic, Studio 5000, or Connected Components Workbench software.

Use a DHCP/BOOTP Server

If you do not have a large computer that can act as a boot server, download our DHCP/BOOTP software so you can use a personal computer as a DHCP/BOOTP server.

To set the network address by using the Rockwell Automation DHCP/BOOTP server, follow these steps.

1. Access the DHCP/BOOTP utility at: http://www.software.rockwell.com/download/comms/rsnetworx/bootp-dhcp%20server%202.3.2.zip.

2. Download the version 2.3.1 DHCP/BOOTP utility.
3. Extract the zipped files to a temporary directory.
4. In the temporary directory, double-click setup.exe to install the DHCP/BOOTP utility.
5. Run the utility.
6. Refer to the following chart, which describes what happens next, depending on whether DHCP/BOOTP is enabled on the module.

If DHCP/BOOTP is	Description
Enabled	Asks for an address from a DHCP/BOOTP server. The server also assigns other Transport Control Protocol (TCP) parameters.
Not enabled	Uses the IP address (along with other TCP configurable parameters) stored in nonvolatile memory.

Use RSLinx Classic, Studio 5000, or Connected Components Workbench Software

Follow the procedures outlined in the online help that accompanies this software to set the network address.

Status Indicators

The three status indicators on the module provide diagnostic information about the module and its connections to the network.

Table 18 - Status Indicators

Indicator	Status	Description
MS	Off	The plug-in module does not have power. Check the safety relay power supply.
	Flashing green	The port is in standby mode; it does not have an IP address. Verify that the DHCP server is running.
	Green	The port is operating correctly. No action is required.
	Red	The safety relay is holding the port in reset or the safety relay has faulted. Clear the fault. If the fault will not clear, replace the plug-in.
	Flashing red/green	The module is performing its power-up self-test. No action is required.
NS	Off	The port is not initialized; it does not have an IP address. Verify that the DHCP server is running.
	Flashing green	The port has an IP address, but no CIP connections are established. If no connections are configured, no action is required. If connections are configured, check connection originator for connection error code.
	Green	The port has an IP address and CIP connections (Class 1 or Class 3) are established. No action is required.
	Red	Duplicate IP - The device has detected that its IP address is being used by another device in the network. Change the devices IP address.
	Flashing red/green	The port is performing its power-up self-test. No action is required.

Indicator	Status	Description
LNK	Off	The port is not connected to a powered Ethernet device. Therefore, the safety relay cannot communicate over an Ethernet network. Verify that all Ethernet cables are connected. Verify that Ethernet switch is powered.
	Flashing green	The port is communicating on Ethernet. No action required. The port is performing its power-up self-test. No action required.
	Green	The port is connected to a powered Ethernet device. Therefore, the safety relay can communicate over an Ethernet network. No action required.

Chapter Summary

In this chapter, you learned how to install and wire your Guardmaster 440C-ENET Ethernet plug-in module.

Automation Controller Communications

Introduction

This chapter describes and gives examples of how each type of EtherNet/IP messaging, I/O messaging, and Explicit messaging is used.

Ethernet Messaging

The Guardmaster 440C-ENET plug-in module supports two types of EtherNet/IP messaging.

- **I/O Messaging** - Used for deterministic EtherNet/IP communications with ControlLogix™, CompactLogix™, SoftLogix™, and EtherNet/IP scanners. Its primary use is to read and write I/O data for control purposes.
- **Logic Explicit Messaging** - Used for non-deterministic communications in which data is not critical for control. Logic explicit messages have a lower priority compared to I/O messages and are used to read and write non-critical data.

I/O Messaging

Studio 5000 Logix Designer software is used to configure I/O messaging between an automation controller and a Guardmaster 440C-ENET plug-in module on an EtherNet/IP network.

Logix Configuration

An Add-on Profile is available for the Guardmaster EtherNet/IP network interface and can be used with Studio 5000 Logix Designer version 20 and higher. The profile can be downloaded from:

http://support.rockwellautomation.com/controlflash/LogixProfiler.asp

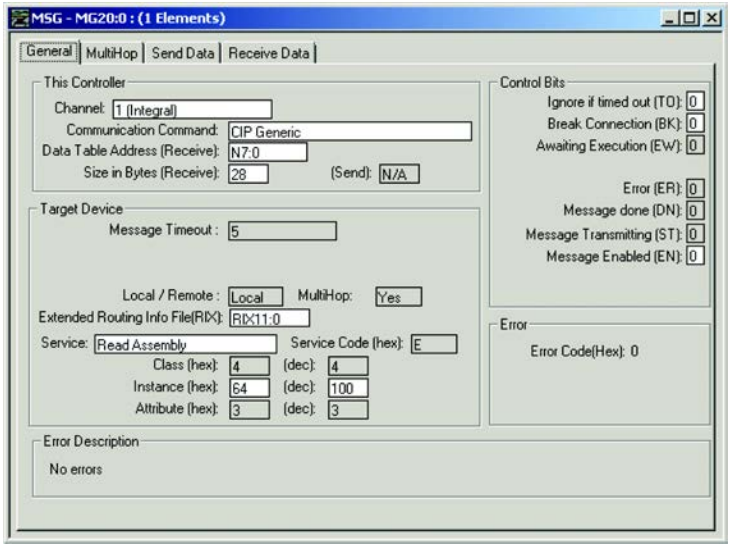
Follow the procedures outlined in the online help that accompanies the Add-on profile to configure the I/O messaging connection.

Explicit Messaging

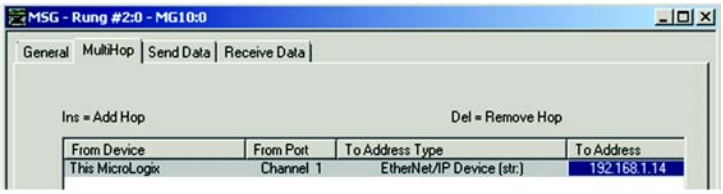
Data can be accessed from the Guardmaster 440C-CR30 safety relay with 440C-ENET plug-in by non-Logix automation controllers that support EtherNet/IP explicit messaging.

This example shows the configuration of an explicit message to read data from the Guardmaster 440C CR30 safety relay:

1. Set up the MSG instruction to read the data assembly from the Guardmaster EtherNet/IP network interface by configuring the following fields.
   - Channel: 1 (Integral) (this is the Ethernet port)
   - Communication Command: CIP Generic
   - Data Table Address (Receive): N7:0 (choose an address that supports 28 bytes)
   - Size in Bytes (Receive): 28
   - Extended Routing Info File(RIX): RIX11:0
   - Service: Read Assembly
   - Class: 04
   - Instance: 100 (64h)
   - Attribute: 03



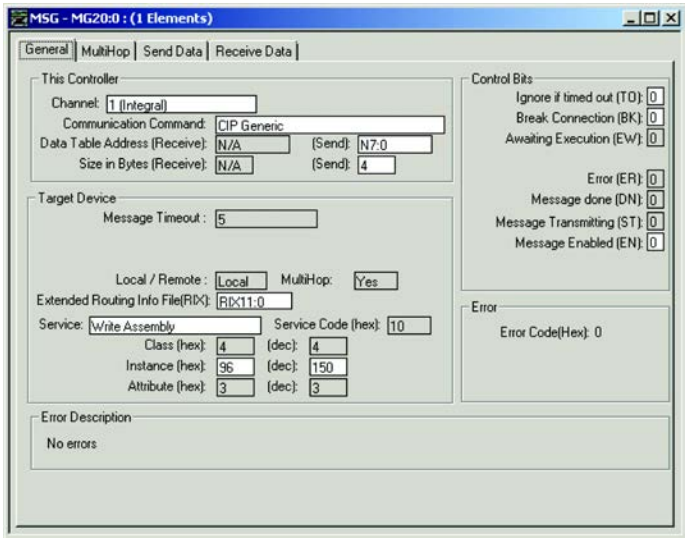
2. Set the Ethernet network address of the Guardmaster 440C-ENET plug-in module as the target of the message instruction:



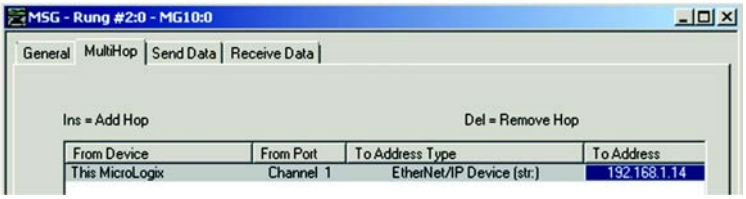
   Appendix E (page 161) describes the individual members of the data returned from the message instruction.

This example shows the configuration of an explicit message to write data to the Guardmaster 440C CR30 safety relay:

1. Set up the MSG instruction to read the data assembly from the Guardmaster EtherNet/IP network interface by configuring the following fields.
   - Channel: 1 (Integral) (this is the Ethernet port)
   - Communication Command: CIP Generic
   - Data Table Address (Send): N7:0 (choose an address that supports 4 bytes)
   - Size in Bytes (Send): 4
   - Extended Routing Info File(RIX): RIX11:0
   - Service: Write Assembly
   - Class: 04
   - Instance: 150 (96h)
   - Attribute: 03



2. Set the Ethernet network address of the Guardmaster 440C-ENET plug-in module as the target of the message instruction:



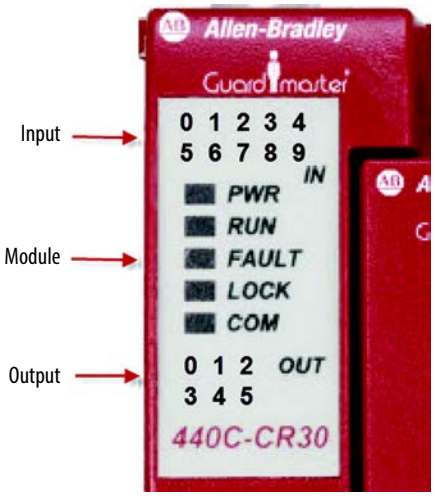
Appendix E (page 161)describes the individual members of the data returned from the message instruction.

LEDs

The CR30 has 21 LEDs on the upper left front of the module. These 21 LEDs fall into three categories:

- Input status
- Module status
- Output status

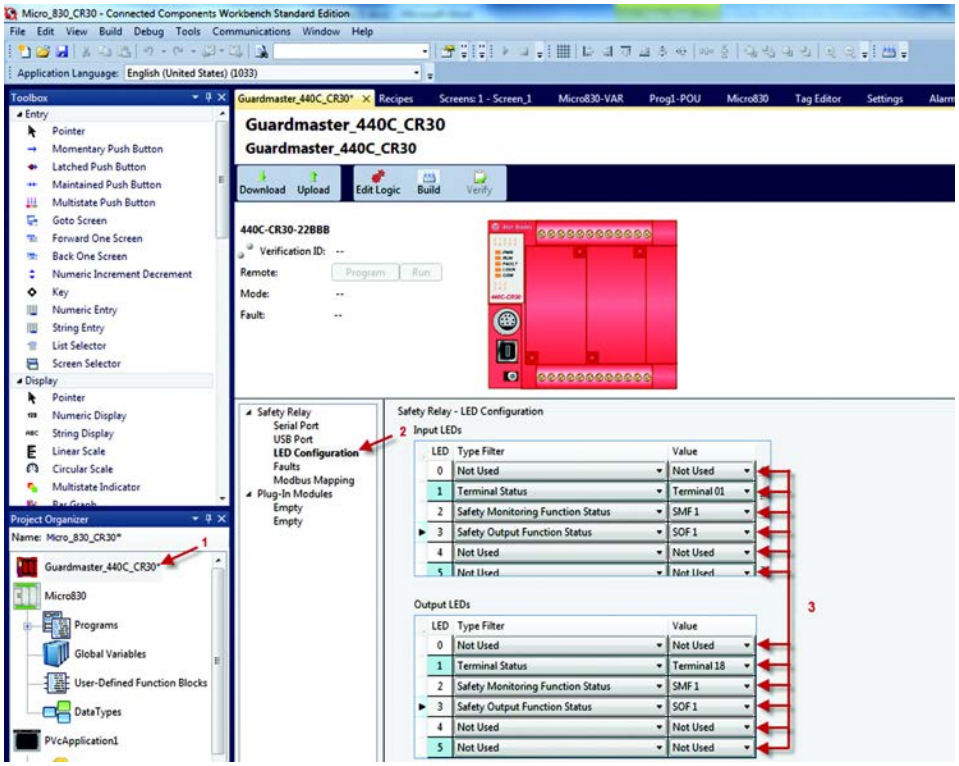
Figure 116 - LEDs



Input and Output LEDs

To access and configure the LEDs in the CCW,

1. In the Project Organizer, double-click **Guardmaster_440C-CR30***.
2. Click **LED Configuration**.
3. Configure the filter type and value for input and output LEDs.



First select one of four Filter Types for each LED:

1. Not Used
2. Terminal Status
3. Safety Monitoring Function Status
4. Safety Output Function Status

Then select the instance for each Filter Type.

Monitoring a function is advantageous when the input and output logic blocks have multiple inputs or outputs. A single LED can provide status information about multiple inputs or outputs, when it provides the status of an input or output block.

In the previous example:

a. Input LED 1 is monitoring a terminal status. In this case, it is monitoring terminal 01. When the signal to terminal 1 is HI, the LED is on. When the signal to terminal 1 is LO, the LED is off. If this were a single channel input, then the LED provides all information that we need to know about the input.

b. Input LED 2 is monitoring safety monitoring function 1. If the LED is on, then we know that all inputs are satisfied for whatever function (for example, dual channel input, muting, or two-hand control) is being monitored.

c. Output LED 3 is monitoring the status of a Safety Output Function. In this case, SOF 1 is being monitored. If SOF 1 is driving four outputs (two safety, one diagnostic, and one Modbus), we expect all four outputs to be HI when LED 3 is on.

Controller Status LEDs

The CR30 has five module status LEDs that are described in Table 19.

Table 19 - Status LEDs

LED	Color	Indicates
POWER	Off	No input power or power error condition
	Green	Power on
RUN	Off	Program mode
	Green	Run mode
	Flashing Green [2 Hz]	Application is running but not verified
FAULT	Off	No fault detected
	Red Flashing [2 Hz]	Application fault detected, recoverable
	Red	Controller hardware faulted, non-recoverable
LOCK	Off	Not used
COM	Off	No communications
	Green	Communications by serial port or USB

Notes:

Modbus Communication

The CR30 uses Modbus RTU communications to transfer status information and control signals to Micro800® controllers and human-machine interfaces like the Allen-Bradley PanelView.

The Modbus configuration of the CR30 is fixed to Modbus RTU slave at address 1.

For more information on PanelView, refer to the following documents:

- User Manual: 2711C-UM001_-EN-P
- Quick Start Guide: 440C-QS001_-EN-P

Modbus Mapping

The CR30 Modbus addresses are mapped to parameters shown in Table 20. The addresses in the range of 1...512 can be accessed as coils. The fault log can be accessed by holding register reads; each address contains 16 bits of data.

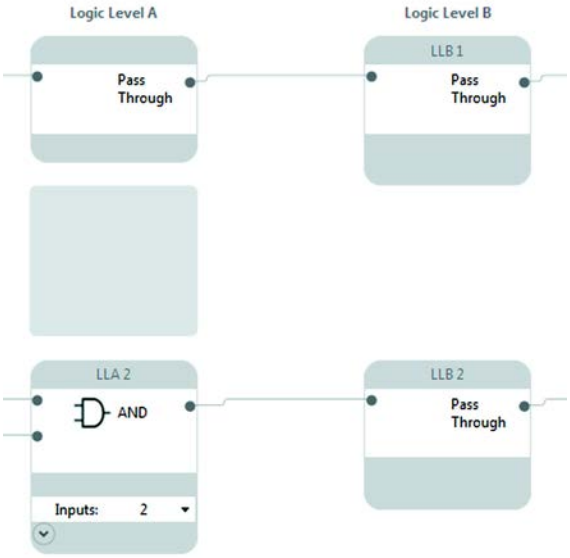
Table 20 - Modbus Addresses

Modbus Address	Parameter
000001…000016	Modbus serial input data
000025…000028	Input Data for Plug-in 1 Terminals I-00…I-03
000033…000036	Output Data for Plug-in 1 Terminals O-00…O-03
000265	Processor HW fault
000266	Safety Input HW fault
000267	Safety Output HW fault
000268	Power supply fault / Main transistor fault
000269	Communication fault
000270	Configuration fault (wrong revision, invalid configuration)
000271	Time out (Clock monitoring)
000272	Plug-in fault
000273…000294	State of Embedded Terminals 00…21
000297…000300	Input of Plug-in 2 Terminals I-00…I-03
000301…000304	Output of Plug-in 2 Terminals O-00…O-03
000305…000328	State of Safety Monitoring Function (SMF) 1…24
000329…000344	State of Logic Level A Instance (LLA) 1…16 (1)
000345…000360	State of Logic Level B Instance (LLB) 1…16
000361…000376	State of Safety Output Function (SOF) 1…16

Modbus Address	Parameter
000377…000392	Ready-to-start of SOF 1…16
000393…000416	Fault bit 0 of SMF 1…24 00: No error 01: Crossloop 10: Simultaneity fault 11: One channel open after reset
000417…000440	Fault bit 1 of SMF 1…24
000441…000464	Fault bit 2 of SMF 1…24
000465…000488	Fault bit 3 of SMF 1…24
000489…000504	Retrigger Fault SOF 1…16
000505…000512	Cross Fault of Terminals 12…17
000521…000761	Input Assembly Data (see Appendix E [page 161] for details)
000513…000520, 000762…000848	Reserved
000849…000860	Fault log

(1) When a Logic Level A block is automatically created as a Pass Through, the block does not occupy memory and cannot be read over Modbus. This can be viewed in the CCW as a block with no title. Pass Through blocks in Logic Level B can be read over Modbus.

Figure 117 - (Non-)Readable Pass-through Blocks

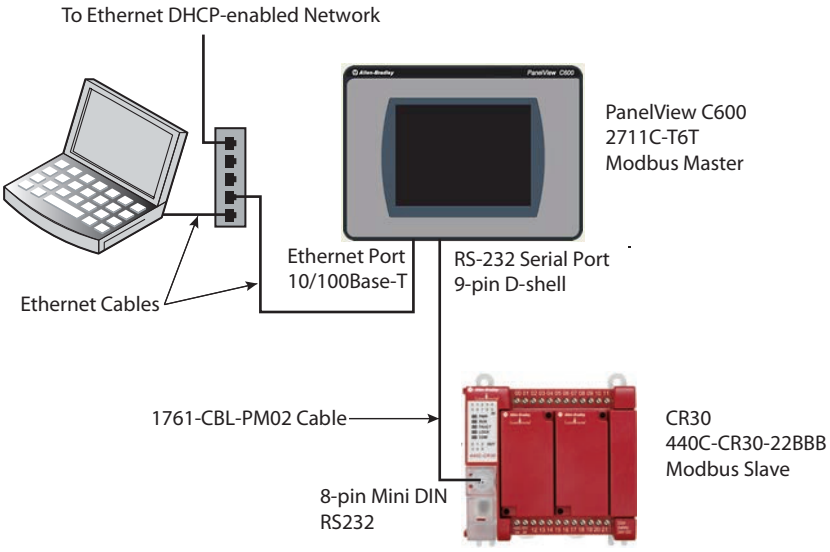


Example Architectures

Some examples of how the CR30 is used with Modbus are shown in Figure 118.

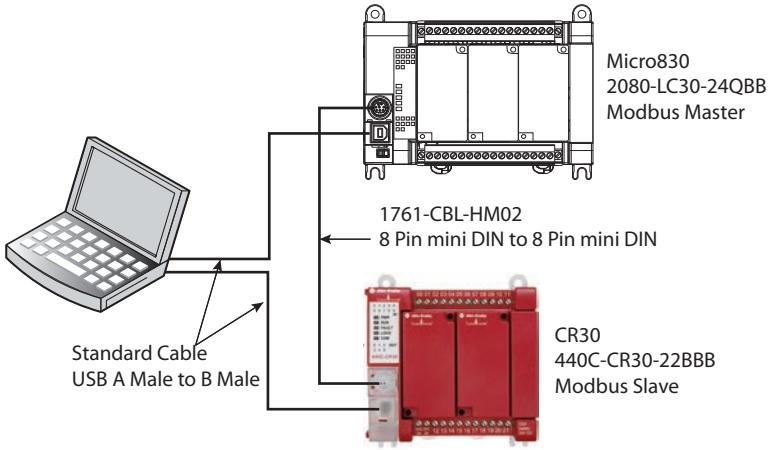
In the example below, a PanelView C600 is connected to the serial port of the CR30. The C600 is configured over its Ethernet port. The C600 can read status information from the CR30 and can send reset and restart signals to the CR30.

Figure 118 - Modbus RTU Communication — PanelView C600



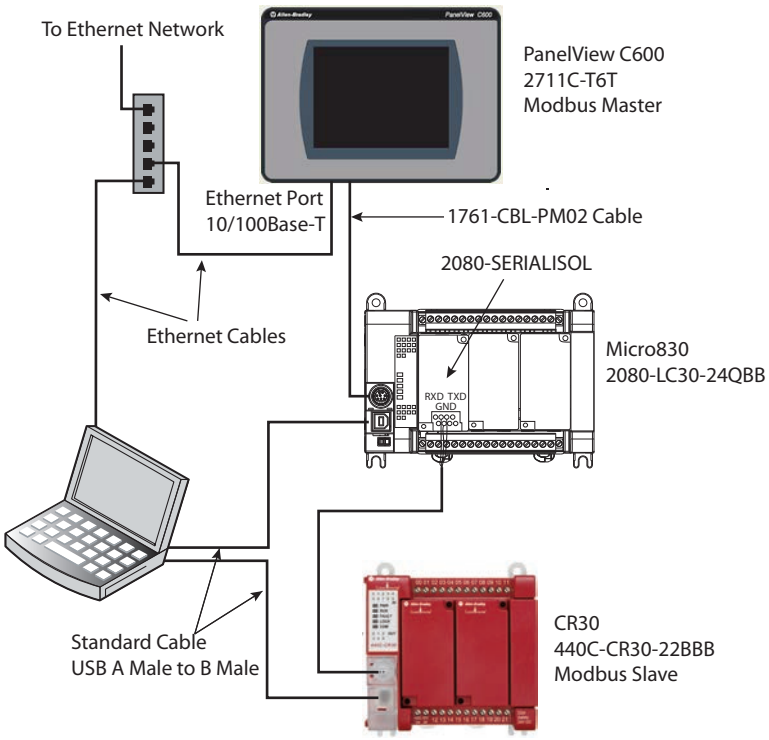
In this example, a Micro830® is connected to the CR30 by the 8-pin DIN serial port connections. The Micro830 can read/use status information from the CR30 and can send reset and restart signals to the CR30.

Figure 119 - Modbus RTU Communication — Micro830



In the example below, a PanelView C600 is connector the serial port of the Micro830 and the Micro830 is connected to the CR30 through a SERIALISOL plug-in module. The Micro830 can read/use status information from the CR30 and can send reset and restart signals to the CR30.

Figure 120 - Modbus RTU Communication — PanelView C600 & Micro830



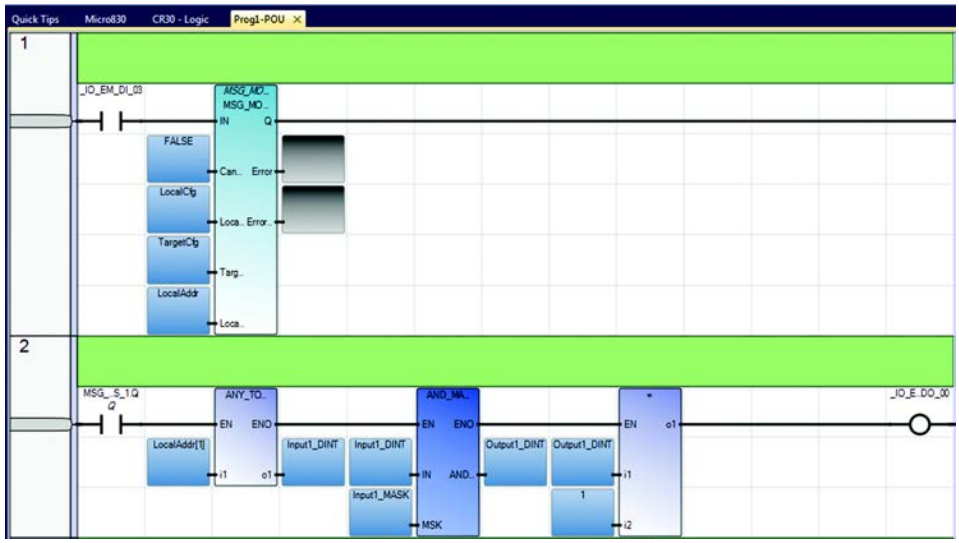
Reading CR30 Status

In the Micro800 family, the Msg_Modbus block must be used.

In the example ladder diagram below, a Micro830 reads the status of the first five input wiring terminals of the CR30.

- Rung 1: When a push button, which is connected to terminal 03 of the Micro830, is pressed, the Micro830 sends a Modbus message to the CR30
- Rung 2: The format of the data in LocalAddr is a 'WORD'. The first block ANY_TO_DINT converts the 'WORD' to a 'DINT'. The second block compares the DINT to the value of 1 with an AND_MASK. The third block checks to see if the value is 1. If the value is 1, then the output terminal _IO_EM_DO_00 goes HI.

Figure 121 - Read Ladder Diagram



You should configure local variables. In this example, they are labeled LocalCfg, TargetCfg, and LocalAddr.

- LocalCfg must be configured as a MODBUSLOCPARA data type. TargetCfg must be configured as a MODBUSTARPARA data type. LocalAddr must be configured as a MODBUSLOCADDR data type.
- TargetCfg.Addr - Select the first value from the Modbus Mapping table for the CR30. In this case, the initial value is set to 000273 (leading zeros must be included), which is mapped to terminal 00 of the CR30.
- TargetCfg.Node - Enter a value of 1. The CR30 is fixed at Node 1.
- LocalCfg.Channel - Select the serial port location. Enter a 2 if the embedded serial port is used. Enter a 5 to use the serial port in the fist plug-in slot.
- LocatCfg.TriggerType - Enter a 0 to have the block execute only once. Each time the push button that is connected to terminal _IO_EM-DI-00 is pressed, message is sent once.
- LocalCfg.Cmd - Enter a 1 to instruct the block to read a 'coil' (which is mapped to the CR30).
- LocalCfg.ElementCnt - Enter a 5 read the status if 5 inputs (starting at 000273 and ending at 000277).

- LocalAddr - The results are placed in LocalAddr. There is no need to make changes.

Figure 122 - Read Local Variables

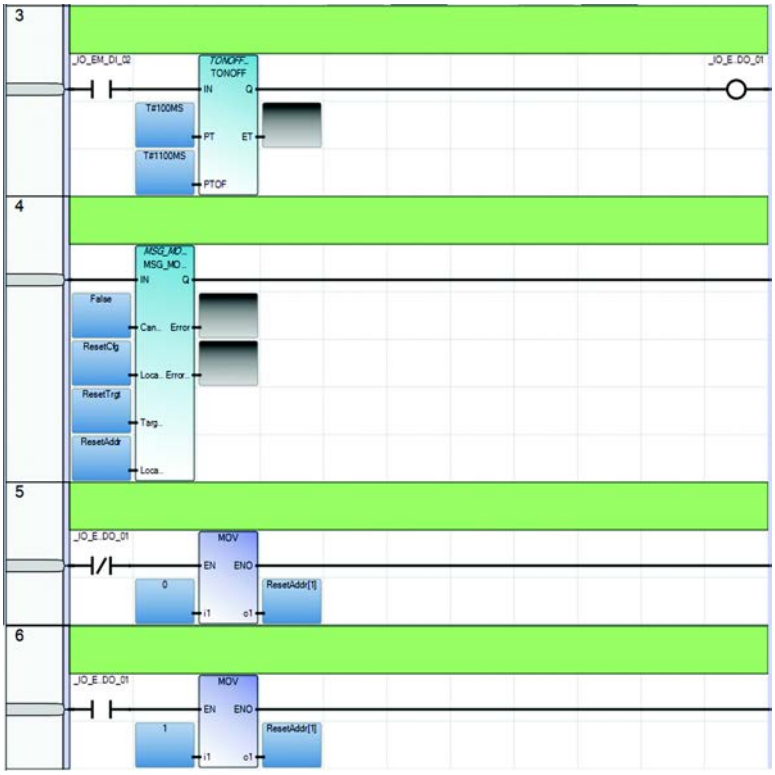
Name	Data Type	Dimension	String Size	Initial Value	Attribute
TargetCfg	MODBUSTARPARA			...	Read/Write
TargetCfg.Addr	UDINT			000273	Read/Write
TargetCfg.Node	USINT			1	Read/Write
LocalAddr	MODBUSLOCADDR			...	Read/Write
LocalCfg	MODBUSLOCPARA			...	Read/Write
LocalCfg.Channel	UINT			5	Read/Write
LocalCfg.TriggerType	USINT			0	Read/Write
LocalCfg.Cmd	USINT			1	Read/Write
LocalCfg.ElementCnt	UINT			5	Read/Write

Sending Reset to CR30

The Reset function must use a separate Modbus message block. Another constraint that must be considered is reset signal must be between 0.5...3 s long. In the example below, a momentary button is connected to embedded terminal _IO_EM_DI_02.

- Rung 3: The push button initiates a TONOFF timer. The timer is set for a 100 ms delay ON and a 1100 ms delay OFF. This provides a reset signal of 1 s.
- Rung 4: The Modbus message is sent with every scan of the ladder. The reset is executed because the reset value goes from 0 to 1 and back to 0 within the acceptable range of 0.5...3 s.
- Rung 5: When the TONOFF block goes LO, embedded output _IO_EM_DO_01 goes LO and moves the value of 0 into Reset Addr.
- Rung 6: When the TONOFF block goes HI, embedded output _IO_EM_DO_01 goes HI and moves the value of 1 into Reset Addr.

Figure 123 - Reset Ladder Diagram



You should configure a second set of local variables. In this example, they are labeled ResetCfg, ResetTrgt, and ResetAddr.

- ResetCfg must be configured as a MODBUSLOCPARA data type. ResetTrgt must be configured as a MODBUSTARPARA data type. ResetAddr must be configured as a MODBUSLOCADDR data type.
- ResetTrgt.Addr - Enter a value of 1, which is Modbus mapping of the CR30.
- ResetTrgt.Node - Enter a value of 1. The CR30 is fixed at Node 1.
- ResetCfg.Channel - Select the serial port location. Enter a 2 if the embedded serial port is used. Enter a 5 to use the serial port in the fist plug-in slot.
- ResetCfg.TriggerType - Enter a 1 to have the block execute every time that the ladder is scanned
- LocalCfg.Cmd - Enter a 5 to instruct the block to write to a 'coil' (that is, turn on an input of the CR30).
- ResetCfg.ElementCnt - Enter a 1 to write only 1 bit.
- ResetAddr - The results are placed in LocalAddr. There is no need to make changes.

Figure 124 - Reset Local Variables

ResetTrgt		MODBUSTARPARA			...	Read/Write
	ResetTrgt.Addr	UDINT			1	Read/Write
	ResetTrgt.Node	USINT			1	Read/Write
ResetCfg		MODBUSLOCPARA			...	Read/Write
	ResetCfg.Channel	UINT			5	Read/Write
	ResetCfg.TriggerType	USINT			1	Read/Write
	ResetCfg.Cmd	USINT			5	Read/Write
	ResetCfg.ElementCnt	UINT			1	Read/Write
ResetAddr		MODBUSLOCADDR			...	Read/Write

Notes:

Troubleshooting

Faults fall into two categories:

- Recoverable
- Nonrecoverable

Recoverable faults are those faults that can be corrected without having to cycle the power to the CR30. Nonrecoverable faults require power cycling to recover after the fault is corrected.

Recoverable Faults

Recoverable faults can be cleared by eliminating the cause of the fault and cycling the inputs that are associated with the fault. The output that is connected to an input with that fault is switched off. The other non-affected outputs continue to work.

Examples of recoverable faults include:

- SMF faults
- Cross loop
- Simultaneity faults
- Reset button fault
- Muting: Synchronization time exceed
- Muting time exceeded
- Sequence fault

LEDs

Faults are indicated by the fault LED. If the fault LED is flashing red, a recoverable fault has occurred. If the Fault LED is solid red, a nonrecoverable fault has occurred.

Figure 125 - Fault LED

Nonrecoverable Faults

Nonrecoverable faults and failures are malfunctions of the device itself that occur during operation. These faults are detected by internal monitoring measures helping to ensure the safety integrity of the device itself. Nonrecoverable faults require a power cycle to allow CR30 to perform all relevant internal system tests during initialization. If there are transient malfunctions, CR30 will recover after power cycle. If there is permanent damage or malfunction, the CR30 will remain in safe-state after power cycle. Permanent nonrecoverable faults are typically related to random hardware faults that cause permanent damage of components.

Potential root cause for nonrecoverable faults:

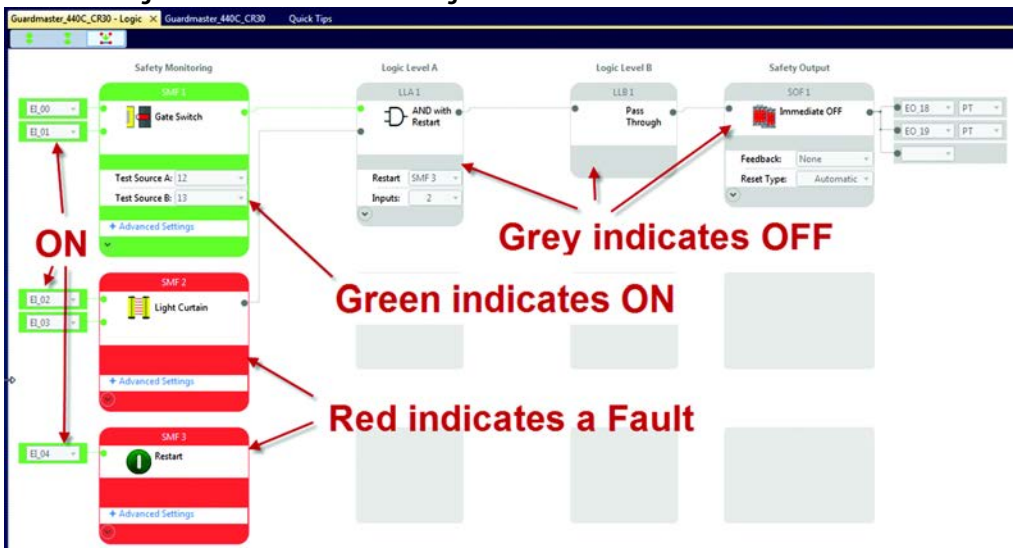
- Transient EMC disturbance causing asynchrony of the two CPU
- Environmental disturbances of high voltage or high current spikes that cause internal damage of components
- Power supply interruptions that are detected by internal voltage level monitor
- Transient overload conditions of safety outputs that trigger short circuit and overload protection or the output (for example, high inrush currents)

Troubleshooting with the CCW

When connected to the CR30 through the USB port, the CCW Logic Editor monitors and displays the status of each terminal and block.

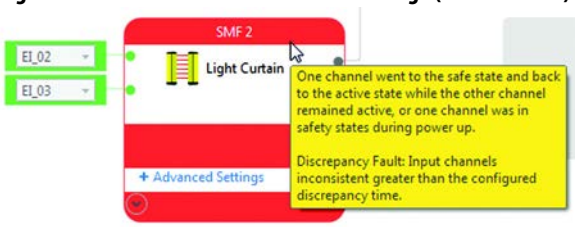
- Green shows an ON (HI) state.
- Red shows a Fault state (output is LO).
- Grey blocks are OFF (LO) state.

Figure 126 - Monitor Status with Logic Editor



Mouse over the red block, and the CCW displays an error message for 5 seconds. Move the mouse away and then back over the block to show the message again.

Figure 127 - Mouse Over to Show Error Message (in Yellow Box)



The type of fault is also shown in the top panel of the Project tab (Figure 128).

- For a recoverable fault, the Device Details view only indicates “Fault: Recoverable”. For further details, navigate to the “Logic Editor” view and mouse over the red marked function block. A user is allowed to change the operation mode to “Program Mode”
- For a nonrecoverable fault, the Device Details view provides the fault type and status. The device automatically exits “RUN” mode and switches to “Program mode”. You cannot change the operation mode. Mouse over the fault status area to get more information.

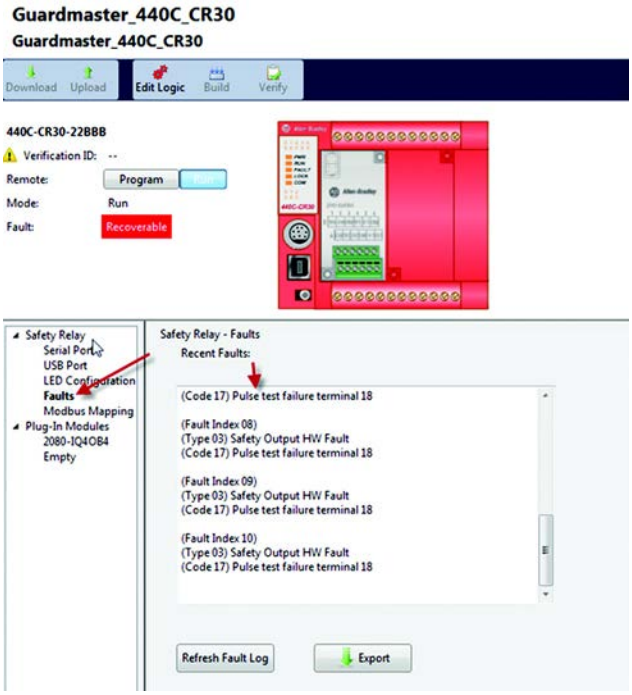
Figure 128 - Mouse Over Fault in Project Tab

To see a list of the recent faults, click Faults in the Safety Tree.

The recent faults appear in the fault pane.

Click the Export button to export the faults to a comma-separated value (.csv) file. The default path for Win7 for saving the exported fault log file is the folder at C:\Users\<user name>\documents\CCW\Fault log.

Figure 129 - Recent Fault List



Troubleshooting with Modbus

Many faults can be reported to an HMI or PLC using Modbus. Table 21 shows a list of the Modbus addresses for faults.

Table 21 - Modbus Addresses for Faults

Modbus Address	Parameter
000265	Processor HW fault
000266	Safety Input HW fault
000267	Safety Output HW fault
000268	Power supply fault / Main transistor fault
000269	Communication fault
000270	Configuration fault (wrong revision, invalid configuration)
000271	Time out (Clock monitoring)
000272	Plug-in fault
000393...000416	Fault bit 0 of SMF 0...23
000417...000440	Fault bit 1 of SMF 0...23
000441...000464	Fault bit 2 of SMF 0...23
000465...000488	Fault bit 3 of SMF 0...23
000489...000504	Retrigger Fault SOF 0...23
000505...000512	Cross Fault of Terminals 12...17
000849...000860	Fault log

Table 22 shows the 'fault bit' message for the type of functions that are selected for the Safety Monitoring Function block.

Table 22 - Fault Messages for the SMF Type

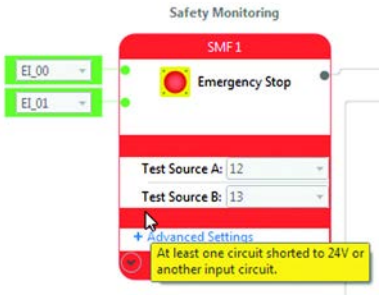
SMF Type	Fault Bit 3	Fault Bit 2	Fault Bit 1	Fault Bit 0
1 Channel	Reserved	Reserved	Reserved	Input circuit shorted to 24V.
2 Channel, Two Hand Control	Reserved	The left and right buttons have been in an inconsistent state for longer than 500 ms.	Reserved	At least one circuit shorted to 24V or another input circuit.
Safety Mat	Reserved	Discrepancy Fault: Input channels inconsistent greater than the configured discrepancy time	One channel went to the safe state and back to the active state while the other channel remained active, or One channel went to the safe state upon power up.	At least one circuit shorted to 24V or another input circuit.
3 Channel	Reserved	Reserved	One channel went to the safe state upon power up.	At least one circuit shorted to 24V.
Reset	Reserved	Reserved	Reserved	A transition of the reset input from ON (1) to OFF (0) did not occur within 3,000ms.
Override	Reserved	Reserved	Reserved	At least one circuit shorted to 24V or another input circuit.
Restart	Reserved	Reserved	Reserved	A transition of the restart input from ON (1) to OFF (0) did not occur within 3,000ms.
Mute	Reserved	Muting sensor sequence fault.	The Light Curtain was muted for longer than the configured maximum mute time.	Too much time elapsed between Sensors being blocked.
Lack of Muting L-Type	Too much time elapsed between Sensor2 and Light Curtain2 being blocked.	Muting sensor sequence fault.	The Light Curtain was muted for longer than the configured maximum mute time.	Too much time elapsed between Sensor1 and Sensor2 being blocked.

Example Fault Analysis – Crossfault

Create a crossfault from Input Test Pulse A to Input Pulse Test B with the safety output ON.

- The Modbus address 000505 goes HI immediately, showing that the fault was detected.
- About 4 seconds later, the fault is acted upon.
- Modbus address 000393 (Bit 0 of SMF1) goes HI.
- The Safety Output goes off.
- On the CCW Logic tab, the E-stop and gate inputs go off, and both logic blocks show red color.
- The CCW Project tab shows “Recoverable Fault”.

Figure 130 - Mouse Over E-stop Block



Remove the fault

- The Modbus address 000505 goes LO immediately, showing that the fault was removed.
- Modbus address 000393 (Bit 0 of SMF1) remains HI.
- On the CCW Logic tab, both the E-stop and gate logic blocks continue to show red color.
- The safety output remains off.

Cycle the E-stop.

- Modbus address 000393 (Bit 0 of SMF1) goes LO.
- On the CCW Logic tab, the E-stop block turns green, and the gate block remains red,

Cycle the gate.

- On the CCW Logic tab, the gate block turns green.

The safety system is back to an operating state and waiting for the reset button to be pressed.

Security and Password

Guardmaster 440C safety relay security has two components:

- Exclusive access that prevents simultaneous configuration of the safety relay by two users.
- Password protection that secures the intellectual property that is contained within the safety relay and prevents unauthorized access.

Exclusive Access

Exclusive access is enforced on the Guardmaster 440C safety relay regardless of whether the safety relay is password-protected or not. This means that only one Connected Components Workbench (CCW) session is authorized at one time and only an authorized client has exclusive access to the safety relay application. This helps ensure that only one software session has exclusive access to the Guardmaster 440C application-specific configuration.

Exclusive access is enforced on Guardmaster 440C firmware version 7 and later. When a CCW user connects to a Guardmaster 440C safety relay, the software is given exclusive access to that safety relay.

Password Protection

By setting a password on the safety relay, you effectively restrict access to the configuration software connections to the safety relay to software sessions that can supply the correct password. Essentially, CCW operations such as upload, download, and connect are prevented if the safety relay is secured with a password and the correct password is not provided.

Guardmaster 440C safety relays with firmware version 7 and later are shipped with no password. A password can be set through the CCW software (version 7 or later).

The safety relay password is also backed up to the memory backup module (Cat. No. 2080-MEMBAK-RTC).

Compatibility

The Safety Relay Password feature is supported on:

- Connected Components Workbench version7 and later
- Guardmaster 440C safety relays with revision 7 or later firmware

Users with earlier versions of the software and/or hardware are advised to upgrade the software and firmware. See Upgrade the Firmware on page 153 for instruction on firmware upgrades.

Work with a Locked Safety Relay

The following workflows are supported on compatible Guardmaster 440C safety relays (firmware revision 7 or later) and CCW version 7 or later.

Upload from a Password-Protected Safety Relay

1. Launch the CCW software project with your Guardmaster 440C safety relay configuration.
2. Double-click the **Guardmaster 440C safety relay** in the Project Organizer to open the Safety Relay workspace.
3. Select **Upload** from the pull-down menu in the safety relay header.
4. Select the target safety relay in the Connection Browser.
5. When requested, provide the safety relay password.

Connect to a Password-Protected Safety Relay

1. Launch the CCW software project with your Guardmaster 440C safety relay configuration.
2. Double-click the **Guardmaster 440C safety relay** in the Project Organizer to open the Safety Relay workspace.
3. Select **Connect** from the pull-down menu in the safety relay header.
4. Select the target safety relay in the Connection Browser.
5. When requested, provide the safety relay password.

Download to a Password-Protected Safety Relay

1. Launch the CCW software project with your Guardmaster 440C safety relay configuration.
2. Double-click the **Guardmaster 440C safety relay** in the Project Organizer to open the Safety Relay workspace.
3. Select **Download** from the pull-down menu in the safety relay header.
4. Select the target safety relay in the Connection Browser.
5. When requested, provide the safety relay password.

Configure Password

Set, change, and clear the password on a target safety relay through the Connected Components Workbench software.

IMPORTANT The following instructions are supported on Connected Components Workbench version 7 and Guardmaster 440C safety relays with firmware revision 7.

Set Safety Relay Password

In the following instructions:

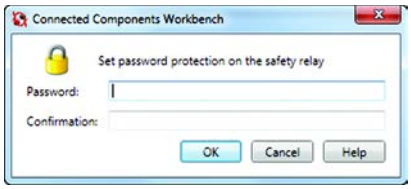
- The Connected Components Workbench software is connected to the Guardmaster 440C safety relay.
- The relay is loaded with a viable configuration.
- The configuration does not necessarily have to be verified.
- The CR30 can be in either program or run mode.

1. On the Connected Components Workbench software, open the project for the target safety relay by double-clicking the safety relay in the Project Organizer.
2. On the Device Details toolbar, mouse over the **Secure** button. The tooltip message "Set, Change, or Clear Safety Relay Password Protection" is displayed.

3. Click the **Secure** button. Select **Set Password**.
4. Provide password. Confirm the password by providing it again in the Confirm field.

TIP Passwords must have at least eight characters to be valid.

5. Click **OK**.
   Once a password is created, any new session that tries to connect to the safety relay has to supply the password to gain exclusive access to the target safety relay.



IMPORTANT If you have to flash the safety relay, the project in the relay is lost. A new project must be downloaded.

6. Click **OK**.

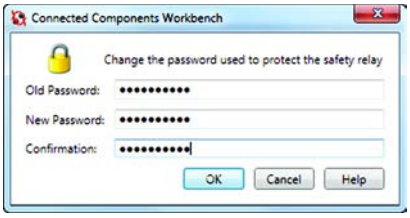
Change Password

With an authorized session, you can change the password on a target safety relay through the Connected Components Workbench software. The target safety relay must be in Connected status.

1. On the Device Details toolbar, click the **Secure** button. Select C**hange Password**.

The Change Safety Relay dialog appears.

2. Enter the Old Password, New Password and confirm the new password.



3. Click **OK**.
   The safety relay requires the new password to grant access to any new session.

IMPORTANT	Keep the password carefully. If lost, you have to flash the safety relay to reset the password. The project in the safety relay is lost but a new project can be downloaded.

Clear Password

With an authorized session, you can clear the password on a target safety relay through the Connected Components Workbench software.

1. On the Device Details toolbar, click the **Secure** button. Select **Clear Password**.

   The Clear Password dialog appears.

2. Enter Password.
3. Click **OK** to clear the password.
   The safety relay will require no password on any new session.

Lost Password

If the safety relay is secured with a password and the password has been lost, then it becomes impossible to access the safety relay using the Connected Components Workbench software.

To recover, use ControlFLASH™ to refresh the safety relay firmware, which also clears the safety relay memory and clears the password

ATTENTION: The project in the safety relay is lost but a new project can be downloaded.

Using the Memory Module

Overview

Guardmaster 440C safety relays support the Cat. No. 2080-MEMBAK-RTC memory modules for the following purposes:

- Project backup and restore
- Firmware and project backup and restore

ATTENTION: Removal and Insertion Under Power (RIUP) is not supported on the Cat. No. 2080-MEMBAK-RTC memory module when used with a Guardmaster® 440C safety relay.

ATTENTION: The Cat. No. 2080-MEMBAK-RTC module can only be installed in Slot 1 (the leftmost plug-in slot) on the Guardmaster 440C safety relay.

IMPORTANT Do not remove the Cat. No. 2080-MEMBAK-RTC or power down while operations such as backup and restore are ongoing to prevent data loss. A blinking status indicator on the memory module indicates that these operations are ongoing.

IMPORTANT Backup can only occur when the safety relay is in the Safety Verified state. To learn about safety verification, see Verification on page 30.

IMPORTANT Using the Cat. No. 2080-MEMBAK-RTC with the CR30 is only supported with firmware revision 7 or later.

Project Backup and Restore

Project backup and restore on Guardmaster 440C safety relays are supported through the Cat. No. 2080-MEMBAK-RTC memory module. Both backup and restore can be initiated through the Connected Components Workbench™ (CCW) software and using buttons physically present on the Guardmaster 440C safety relay and the Cat. No. 2080-MEMBAK-RTC module.

A backup of both the Guardmaster 440C safety relay firmware and project can only occur through the CCW software.

Backup and restore can only occur when the Cat. No. 2080-MEMBAK-RTC module is present in plug-in Slot 1 (the leftmost slot) of the Guardmaster 440C safety relay. On safety relay power-up, the safety relay enters a fault state where the application logic is not executing. Backup and restore commands can be issued in this fault state.

The Cat. No. 2080-MEMBAK-RTC memory module stores the safety relay password, if present, in encrypted format. When the password is mismatched, the contents of the Cat. No. 2080-MEMBAK-RTC memory module is not restored on the safety relay.

Back-up Project

You can back up a Guardmaster 440C safety relay project to a Cat. No. 2080-MEMBAK-RTC memory module using the button on the memory module.

1. Power down the Guardmaster 440C safety relay.
2. Remove the dustcover or plug-in module that is currently located in slot 1, the leftmost slot, of the safety relay module bay.
3. Snap the Cat. No. 2080-MEMBAK-RTC module into slot 1 of the module bay.
4. Power on the Guardmaster 440C safety relay.
   The safety relay detects the presence of the Cat. No. 2080-MEMBAK-RTC memory module and enters a fault state

The LEDs are as follows:
PWR - solid green
RUN - off (not executing)
FAULT - solid red
LOCK - solid green
COM - off

The behavior of the IN and OUT LEDs depends on whether the configuration is verified:

- **Verified** - the IN and OUT LEDs continuously cycle through the verification number.
- **Not Verified** - the IN 0 and the OUT 1, 2, 3 and 4 are solid green. The backup cannot take place since the configuration is not verified.

5. Using a small flathead screwdriver press the Backup button on the Cat. No. 2080-MEMBAK-RTC memory module. Hold the button until the Status LED on the Cat. No. 2080-MEMBAK-RTC module begins flashing indicating the backup process has begun.
   When the backup operation is complete the Status LED on the Cat. No. 2080-MEMBAK-RTC stops flashing.

   TIP If the Status LED does not blink and turns on after 15 seconds, the program is not verified and backup cannot take place.

6. Confirm the Verification ID displayed on the safety relay match the expected Verification ID of the application to be backed up.
7. Power down the Guardmaster 440C safety relay.
8. Remove the Cat. No. 2080-MEMBAK-RTC memory module from slot 1 of the safety relay module bay.
9. Snap the dustcover or previous plug-in module into slot 1 of the module bay.
10. Power on the Guardmaster 440C safety relay to resume normal operation.

Restore Project

You can restore a Guardmaster 440C safety relay project from a Cat. No. 2080-MEMBAK-RTC memory module using the buttons on the memory module and safety relay.

1. Power down the Guardmaster 440C safety relay.
2. Remove the dustcover or plug-in module that is currently located in slot 1, the leftmost slot, of the safety relay module bay.
3. Snap the Cat. No. 2080-MEMBAK-RTC module into slot 1 of the module bay.
4. Power on the Guardmaster 440C safety relay.
   The safety relay detects the presence of the Cat. No. 2080-MEMBAK-RTC memory module and enters a fault state. The Fault LED is solid Red and the application logic is not executed.

The LEDs are as follows:
PWR - solid green
RUN - off (not executing)
FAULT - solid red
LOCK - solid green
COM - off

The behavior of the IN and OUT LEDs depends on whether the configuration is verified:

- **Verified** - the IN and OUT LEDs continuously cycle through the verification number of the configuration currently running in the CR30.
- **Not Verified** - the IN 0 and the OUT 1, 2, 3 and 4 are solid green. The restore can take place since the configuration being downloaded is verified.

5. Press and hold the MEM/ID button that is located on the Guardmaster 440C safety relay just below the USB port.
6. While holding the MEM/ID button, using a small flathead screwdriver press the Backup button on the Cat. No. 2080-MEMBAK-RTC memory module. Hold both buttons until the Status LED on the Cat. No. 2080-MEMBAK-RTC module begins flashing (approximately 5 seconds) which indicates the restore process has begun.

   TIP You do not have to hold the Backup button down until the flashing stops.

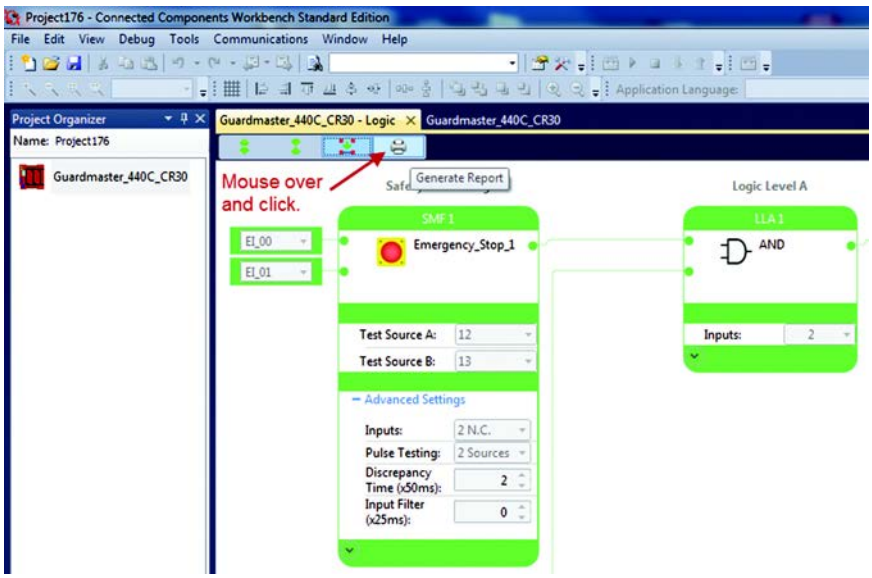
   When the restore operation is complete, the Status LED on the Cat. No. 2080-MEMBAK-RTC stops flashing and the LEDs on the Guardmaster 440C safety relay begin to cycle through each of the verification digits of the application that is restored to the safety relay from the memory module.
7. Confirm the Verification ID displayed on the safety relay match the expected Verification ID of the application to be restored from the memory module.
8. Power down the Guardmaster 440C safety relay.
9. Remove the Cat. No. 2080-MEMBAK-RTC memory module from slot 1of the safety relay module bay.
10. Snap the dust cover or previous plug-in module into slot 1 of the module bay.
11. Power on the Guardmaster 440C safety relay to resume normal operation.

Reports

The Connected Components Workbench™ (CCW) allows you to generate a report using Microsoft Word automatically. The report is editable, which allows you to add more information or combine the report with other documents for the safety technical file.

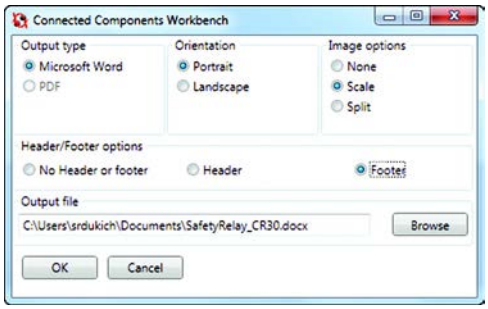
The report generator button is at the top of the logic editor. Mouse over the icon that looks like a printer and click.

Figure 131 - Report Icon at Top of Logic Editor



The report generator takes a snapshot of the logic editor as viewed by the operator. If the editor is actively monitoring the configuration, the report generator captures the colors reflected the block status. You can expand or collapse the blocks as desired to show or hide the advanced setting of each block.

Figure 132 - Report Output Settings



Select the desired output type, orientation, image options, header/footer options, and output file location and name. If a report with the same name already exits, the user is prompted to overwrite it.

An example of a report is shown in the following two figures.

Figure 133 - Example Report - Page 1

Project 440C_CR30
This is the body of a section for project. It should contain some general introduction of the project and its properties.

Configuration General
(* *)
Vendor Name: Allen-Bradley
Catalog ID: 440C-CR30-22BBB
Safety Relay Project Version: 7.000
Name: Guardmaster_440C_CR30
Description:
Verification ID: 5264

Configuration Serial Port
(* Common Settings *)
Driver: Modbus RTU
Baud Rate: 19200
Parity: None
Modbus Role: Slave
ModbusUnit Address: 1

(* Protocol Control *)
Media: RS232 no handshake
Data Bits: 8
Stop Bits: 1

Configuration LED
(* Input LEDs *)

LED	Type Filter	Value
0	Safety Monitoring Function Status	SMF 1
1	Safety Monitoring Function Status	SMF 2
2	Safety Monitoring Function Status	SMF 3
3	Safety Monitoring Function Status	SMF 4
4	Not Used	Not Used
5	Not Used	Not Used
6	Not Used	Not Used
7	Not Used	Not Used
8	Not Used	Not Used
9	Not Used	Not Used

(* Output LEDs *)

LED	Type Filter	Value
0	Safety Output Function Status	SOF 1
1	Safety Output Function Status	SOF 2
2	Not Used	Not Used
3	Not Used	Not Used
4	Not Used	Not Used
5	Not Used	Not Used

Plug-in Module Slot 0
(* *)
Vendor Name: Allen-Bradley
Catalog ID: 2080-IQ4OB4
Firmware Version: 1.004

Plug-in Module Slot 1
(* *)
Vendor Name: Allen-Bradley
Catalog ID: 2080-OW4I
Firmware Version: 1.004

2014-09-27 Page 1

Figure 134 - Example Report - Page 2

440C_CR30.Logic
Image of CR30 Logic

2014-09-27 Page 2

Specifications

SIL Rating

The CR30 meets the requirements of SIL CL 3 in accordance with IEC/EN 61508.

Table 23 - SIL Rating

Safety Integrity Level Claim Limit	3
PFD	1,76 10-3 (whole safety function)
PFH	1 10-8
Mode of Operation	High-demand mode
Safety Related Subsystems	Type B (use of programmable / complex components)
Hardware Fault Tolerance	HFT = 1 (two channel system)
Safe Failure Fraction	90…99%

Performance Level/Category

The performance Level of the safety function is dependent on the structure of all devices that comprise the safety function.

The CR30 is capable of being used in safety systems meeting up to Category 4 and Performance Level PLe in accordance with ISO 13849-1.

Table 24 - Performance Level/Category

Category	Up to 4
Performance Level	Up to e

General

Number of I/O	22
Dimensions	90 x 100 x 80 mm (3.54 x 3.94 x 3.15 in.)
Shipping Weight, approx.	0.423 kg (0.933 lb)
Wire Size	0.2…2.5 mm^2 (24…12 AWG) solid copper wire or 0.2…2.5 mm^2 (24…12 AWG) stranded copper wire rated @ 90 °C (194 °F) insulation max
Wiring Category	2 – on signal ports 2 – on power ports Use this Conductor Category information for planning conductor routing. See *Industrial Automation Wiring and Grounding Guidelines*, publication 1770-4.1.
Insulation Stripping Length	7 mm (0.28 in.)
Terminal Screw Torque	0.6 N•m (4.4 lb•in) max (Using a 2.5 mm (0.10 in.) flat-blade screwdriver)
Input Circuit Type	24V DC source
Output Circuit Type	24V DC source
Power Supply Voltage Range	24V DC +10% -15% ❶
Fuse Specification	6 A
Power Consumption	5.28 W
I/O Rating	Input 24V DC, 4 mA Output 24V DC, Class 2, 0.5 A per point
Enclosure Type Rating	IP20

❶ Power has to be supplied by a power supply that complies with IEC / EN 60204 and IEC / EN 61558-1. Such a power supply meets the electrical safety requirements and maintain the minimum power of 18V DC during 20 ms even in the event of voltage dips.

Environmental

Temperature, Operating	-5…+55 °C (23…131 °F)
Relative Humidity	90%
Vibration	10…55 Hz, 0.35mm
Shock	10 g, 16 ms
Pollution Level	2

Inputs

Number of Inputs	Up to 18 embedded 12 dedicated inputs 6 configurable as Inputs
Operating Voltage Range	20.4…26.V DC
Off-state Voltage, max	5V DC
Off-state Current, max	2.91 mA (independent of supply)
On-state Voltage, max	26.4V DC
On-state Voltage, min	11.0V DC
On-state Current, min	3.14 mA at 20.4V DC
On-state Current, nominal	3.2 mA at 24V DC
On-state Current, max	3.25 mA at 26.4V DC
Off Pulse Accepted for OSSD Setting without Declaring the Input as OFF	Min = 0 µs Max = 700 µs
Reverse Voltage Protection	No
Input Capacitance	10 nF
Galvanic Isolation: I/O from Logic	No

Outputs

Number of Outputs	Up to 10
Output Signals	Standard, OSSD and Single Wire Safety
Continuous Output Current	0.5 A (Terminals 12…19) 0.3 A (Terminals 20…21)
Aggregate Current of Outputs per Device (Max)	3 A
Surge Output Current	1 A
Surge Output Current Duration	5 ms
Residual Voltage (Drop from Power Supply), max	0.2V DC
Max Load Capacitance	200 nF / 20 mA load 100 nF / 10 mA load 22 nF without load
Off-state Leakage Current, max	< 0.1 mA
Short Circuit Detection	Yes
Short Circuit Protection	Yes
Galvanic Isolation: I/O from Logic	No
Pulse Test Duration	≤700 µs
Pulse Test Period	≤13000 ms (less than 15 s)

Reaction Times

Safety Input	Automatic reset < 100 ms Manual monitored reset < 500 ms
Single Wire Safety Input	
Safety Mats	

Recovery Times

To trigger Inputs again	Response time as demand + reaction time + 100 ms

Response Times

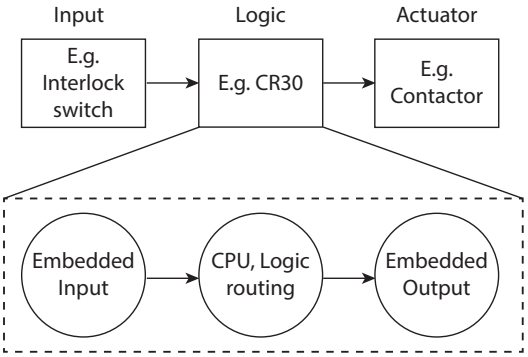
Safety Input	45 ms + Input Filter time
Single Wire Safety Input	<45 ms
Safety Mats	<70 ms
Single Wire Safety Output	<60 ms

System Response Time Calculation

The safety response time is the time that is required to establish the safe state of the safety output function considering the demand of the safety monitoring function and/or occurrence of faults and failures in the safety chain. The overall response time of the safety function considers the whole safety chain, including the safety input device, logic device, and actuator. The safety response time is used to calculate the safety distance, distance between a safeguarding device, and the hazardous area.

The following paths have to be considered:

Figure 135 - System Response Time



Response Time - Demand of the Safety Function

The safety response time of CR30 is the screw-to-screw response time to turn off a safety output at demand of the safety function by the safety input device. The safety response has to be calculated for each safety monitoring function. Table 25 shows the possible safety chain with all considerable response times.

Table 25 - Safety Chain Response Times

	Description	Where to find:	Value
Safety Sensors	Safety response time of sensor device	Sensor operating manual	
SMF	Specific Processing time of safety monitoring function configured in CCW	Below table of specific SMF processing times	
Input Filter	Configured Input Filter time	From SMF configuration “advanced settings” (2)	
Logic	Internal execution time to process input signal, routing and output processing (1)	From technical specification	45 ms
SOF	Configured Off-Delay time	From SOF configuration	
Actuator	Safety switching device controlling the load	Actuator operating manual	
		Total	

(1) The internal execution time is static and independent of the number of function blocks that are configured for the safety function.

(2) The maximum input filter time shall not be greater than 250 ms.

Table 26 shows the additional processing time of dedicated SMF

Table 26 - Processing Time

SMF	Description	SMF response time
Emergency Stop	SMF inputs deactivated	0 ms
Enabling Switch		
Gate Switch		
Light Curtain		
Alternative Device		
Muting	N/A	0 ms
Light Curtain	Light interrupted, not muted	0 ms
Override	Deactivate Override when light curtain is interrupted	0 ms
Safety Mats	Step on Mat, cross loop between safety mat inputs	25 ms
Single Wire Safety	Deactivated SWS signal	15 ms
Two Hand Control	Release of at least 1 Hand actuator	0 ms

Figure 136 - Example

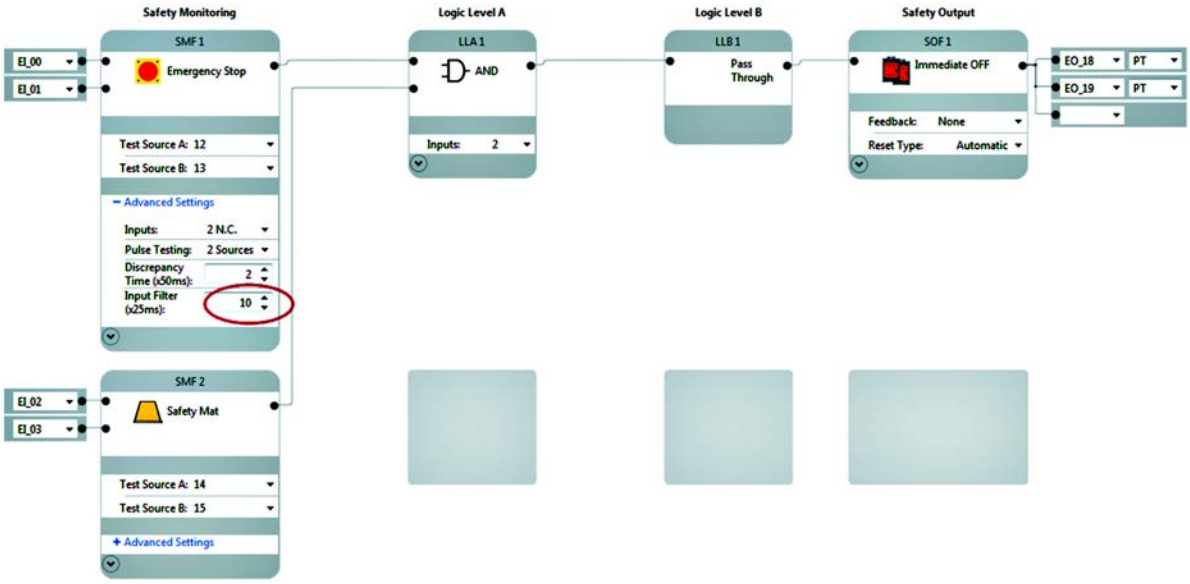


Table 27 - For SMF1 - E-stop:

	Comment	Value
Safety Sensors	Safety response time of sensor device - considered as 0 ms since mechanical device only	0 ms
SMF	An E-stop SMF does not require extra processing time	0 ms
Input Filter	Advanced Settings: Input Filter: 10 x 25 ms = 250 ms	250 ms
Logic	Internal execution time to process input signal, routing, and output processing	45 ms
SOF	Configured Off-Delay time - immediate OFF	0 ms
Actuator	Assuming a contactor with a response time of 30 ms	30 ms
	Total	325 ms

A demand of the E-stop will force a safe state after 325 ms.

Table 28 - For SMF2 - Safety Mat

	Comment	Value
Safety Sensors	Safety response time of sensor device - considered as 0 ms since mechanical device only	0 ms
SMF	Safety mat processing time	25 ms
Input Filter	Advanced Settings: Input Filter: 0 ms	0 ms
Logic	Internal execution time to process input signal, routing, and output processing	45 ms
SOF	Configured Off-Delay time - immediate OFF	0 ms
Actuator	Same contactor is controlled by the safety mat SMF as by the E-stop	30 ms
	Total	100 ms

A demand of the Safety Mat will force a safe state after 100 ms.

Monitoring Time - Occurrence of Recoverable Faults and Failures

Recoverable faults as defined earlier (Chapter 16 - Troubleshooting) are faults and failures within the connected periphery of the CR30. The ability to detect faults depends on the wiring, the type of sensor, and the signal evaluation function that is applied to the circuit. The monitoring time is the amount of time to evaluate the fault or failure after detection and to initiate appropriate system response. Recoverable faults can be recovered by removing the fault and cycling the appropriate input circuit.

The detection of a recoverable fault does not lead to the loss of the safety function. When the safety function is demanded during the monitoring time, after the occurrence of a recoverable fault, the system will respond within the safety response time according to the response time considerations of this safety function (See System Response Time Calculation on page 134).

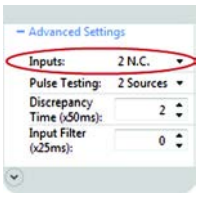
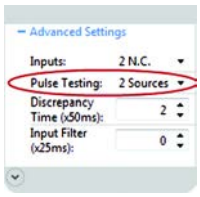
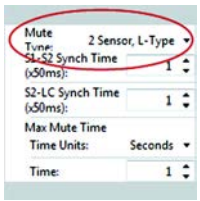
> **Note:** Monitoring measures that are provided by CR30 to the periphery define the diagnostic coverage of the application and thus the safety rating. Internal monitoring measures related to a fail-safe design of CR30 are only related to the safety integrity of the CR30 itself, see “nonrecoverable” faults.

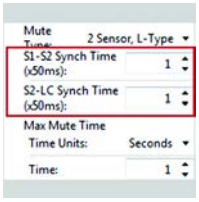
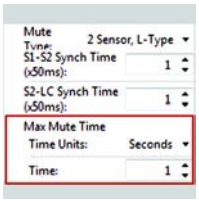
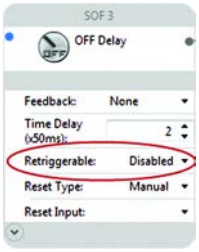
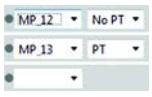
Examples of recoverable faults include:

- Cross loop and shorts to 24V and COM faults
- Input discrepancy
- Muting: Synchronization times exceed
- Muting time exceeded
- Muting sequence fault
- Two-hand discrepancy fault
- Reset/Restart timing fault

The evaluation method of the input or output signal depends on the configuration of the SMF and SOF in CCW and the wiring of the sensor. Table 29 shows typical evaluation functions and required settings to be enabled.

Table 29 - Evaluation Method

Evaluation Method	Configuration	Applicable for
Multi-channel signal evaluation	Inputs: 2 N.C., 2 OSSD, 3 N.C. (1) or 3 OSSD(1) 	SMF: Emergency Stop Enabling Switch Gate Switch Light Curtain Two Hand Control Alternative Device Muting: Light Curtain settings Muting: Override settings
Test pulse evaluation	Test Pulses: 1 or 2 sources, or 3 sources (1): >0 	SMF: Emergency Stop Enabling Switch Gate Switch Two Hand Control Alternative Device Muting: Override settings
Input Discrepancy Time	Discrepancy Time (2): >0 Range: 0.05…3 s 	SMF: Emergency Stop Enabling Switch Gate Switch Light Curtain Two Hand Control Alternative Device Muting: Light Curtain settings Muting: Override settings
Two Hand Discrepancy Monitoring	Default: 0.5 s The maximum amount of time between activation of Hand 1 and Hand 2 to enable SMF	SMF Two Hand Control
Muting Sequence	Muting Type: 2 Sensor T-Type, 2 Sensor L-Type, 4 Sensor Defines the type of muting application and thus the valid sequence of clearing or blocking the muting sensors and protective device. 	SMF Muting

Evaluation Method	Configuration	Applicable for
Muting: Synchronization time	Synch Time: 0.05…10 s The maximum amount of time that is allowed between clearing or blocking of the muting sensor inputs before generating a fault. 	SMF Muting
Muting time	Max. Mute Time: 1 s…10 days Maximum amount of time during which the instruction lets the protective function of the light curtain be disabled before generating a fault. 	SMF Muting
Input pulse monitoring	Input Pulse of 250 ms…3 s Monitors the operation of a valid reset or restart actuation.	SMF Reset Restart
Retrigger Time Delay	If retrigger function is disabled, once the Time Delay has begun timing, it cannot be reset. When SOF input signal transitions from the Safe state back to the Active state, when timing has started, the time will completely lapse but the SOF indicates a fault 	SOF Off Delay
Integral test pulses	Integral test pulses are enabled for safety outputs controlled by an SOF When using the multi-purpose terminals 13…17 as outputs, the integral test pulses can be disabled. 	SOF Immediate OFF OFF Delay ON Delay Jog

(1) For Alternative SMF only

(2) A Discrepancy time of 0 disables discrepancy monitoring. The time between opening or closing the channels is infinite.

Test Pulse Evaluation

Integral test pulses are applied to the input circuit of safety sensor with electromechanical outputs. The test pulse output signal becomes input signal of a safety input through the contacts of the safety sensor. Sensors with electronic OSSDe (output safety switching device electronic) semiconductor outputs have their own test pulses and do not require a test pulse evaluation that is sourced by the logic device.

> **Note:** In case multiple input circuits are sourced by the same test pulse output, a fault affects all inputs that are connected to this output.

Multi-Channel Signal Evaluation and Discrepancy Monitoring

Independent of the test pulse evaluation or sensor type, components can be wired in a single, dual channel, or even three channel structure. In a dual or three channel structure, all channels must be active to enable the SMF. Disabling at least one of the channels will demand the safety function. These channels can be monitored against discrepancy.

The discrepancy time is the amount of time that input channels of an SMF are allowed to be in an inconsistent state before an instruction fault is generated. The discrepancy time cannot be set in Single Channel Mode.

Sequence and Timing Faults

Typically applied to specialty safety functions such as Muting or Two-hand control. It monitors the sequence of events to evaluate the validity of input signals to enable the SMF.

Integral Test Pulses of Safety Outputs

Test pulses are applied to safety outputs to detect faults within the connected periphery such as short circuits to 24V of 0V or cross-loop faults between two output sources. Integral pulses on safety outputs are also used to help ensure the safety integrity of the output itself, such as ability to switch off. An output fault, internal or external, always requires a power cycle to test if the fault is recoverable or not.

> **Note:** To help ensure the ability to switch off actuator devices in case of short circuits to 24V DC within the control line of one actuator, it is recommended to use a pair of safety outputs controlling two redundant switching actuators. Once the fault is detected, a second channel is able to switch off the load. Fault exclusions of potential short circuits between two conductors are also possible when following the requirements for fault exclusions according to EN ISO 13849-2 Table D.3 and D.4, among others protection (for example, cable conduit) and separated wiring of safety signals.

The overall monitoring time to evaluate a fault and initiate a system response, after the occurrence of a recoverable fault must consider any specific-fault processing times depending on the I/O evaluation method and configured input filter times. Table 30 shows the response time for specific recoverable faults, if the safety function is not demanded, and the required settings of SMF and SOF to enable the proper fault evaluation method.

Table 30 - Processing Time of Recoverable Faults and Required Settings

Recoverable Fault	Detection Enabled by	Processing Time
Cross loop fault	Inputs: 2 N.C. Pulse Testing: 2 Sources	3 s
Short circuit fault	Inputs: 1 N.C., or 2 N.C. Pulse Testing: 1 Source, 2 Sources	3 s
Input discrepancy fault	Inputs: 2 N.C., 2 OSSD Discrepancy Time: >0…3 s	Discrepancy time + Input Filter time
Reset/restart timing fault	Default: 0.25…3 s	0 s (1)
Non-retriggerable timer fault	Retriggerable: Disabled	Configured time delay (2)
Muting: Synchronization time exceeded	Synch Time: 0.05…10 s Muting Sensors Input Filter: 0…3 s	Max. Synch Time (3) + 2 x Input Filter Time
Muting time exceeded	Max. Mute Time: 1 s…10 days	Configured Max. Mute Time
Muting sequence fault	Muting Type: 2 Sensor T-Type, 2 Sensor L-Type, 4 Sensor	Input Filter Time

(1) A Reset/Restart Timing Fault can only occur when safety outputs are OFF, so there is no impact on the safety response time

(2) The maximum of the configured delay must be considered. The remaining time at occurrence of fault will lapse.

(3) The synchronization time between the Muting Sensors, and between Muting Sensor can be set individually. The longest synchronization must be considered.

Table 31 - Response time of the Safety Chain at Occurrence of Recoverable Faults without a Demand of the Safety Function

	Description	Where to find:	Value
SMF	Fault processing	Above table, according to configured input evaluation of the SMF	
Logic	Internal execution time to process input signal, routing and output processing (1)	From technical specification	45 ms (fix)
SOF	Fault processing time and configured time delay	From SOF configuration	
Actuator	Safety switching device controlling the load	Actuator Operating manual	
		Total	

(1) The internal execution time is static and independent of the number of function blocks that are configured for the safety function.

Figure 137 - Example

Table 32 - Consideration for Recoverable Faults of E-stop Safety Function

	Description	Value
SMF	Cross loop fault: 3 s according to above table	3 s
Logic	Internal execution time to process input signal, routing, and output processing	45 ms
SOF	No off delay configured	0 s
Actuator	Assuming a contactor with a response time of 30 ms	30 ms
	Total	3.075 s

Response Time - Occurrence of Nonrecoverable Faults and Failures

Nonrecoverable faults are detected by internal monitoring measures applied to monitor the safety integrity of the system. These faults are independent of the logic configuration. Once detected the CR30 forces the safe state within the internal process cycle time of 45 ms.

Reaction Time

The reaction time is the time to enable the safety output function when activating the safety input devices and performing a valid reset operation. The overall reaction time of the safety function considers the whole safety chain, including the safety input device, logic device, and actuator. The reaction time must be calculated for each safety function.

Table 33 shows the possible chain with all considerable reaction times for a safety function.

Table 33 - Safety Function Reaction Times

	Description	Where to find:	Value
Feedback	Feedback Input Filter time	From SMF configuration "advanced settings" (3)	
Safety Sensors	Reaction time of sensor device	Sensor operating manual	
SMF	Configured Input Filter time	From SMF configuration "advanced settings" (3)	
Reset/Restart	Reset/Restart Pulse Time + 2 x Filter Time (1)	Reset Pulse: max 3s Input Filter Time from SMF configuration	3s + 2 x Input Filter
Logic	Internal execution time to process input signal, routing, and output processing (2)	From technical specification	100 ms
SOF	Configured On-Delay time	From SOF configuration	
Actuator	Safety switching device controlling the load	Actuator Operating manual	
		Total	

(1) If input filter time settings are not disabled, the recommended setting is "0". Values greater "0" must be considered for the reaction time.

(2) The internal execution time is static and independent of the number of function blocks that are configured for the safety function.

(3) The maximum input filter time must not be greater than 250 ms.

Figure 138 - Example 1:

Table 34 - For SMF1 - E-stop:

	Comment	Value
Feedback	Disabled for SOF	0 ms
Safety Sensors	Reaction time of sensor device - considered as 0 ms since mechanical device only	0 ms
SMF	Configured Input Filter time 10x25 ms = 250 ms	250 ms
Reset/Restart	SOF configured for Automatic	0 s
Logic	Internal execution time to process input signal, routing, and output processing 2)	100 ms
SOF	No On delay configured for SOF	0 s
Actuator	Assuming a contactor with a response time of 10ms	10 ms
	Total	360 ms

It takes 360 ms to enable the outputs when the E-stop is active (closed contacts).

Table 35 - For SMF2 – Safety Mat:

	Comment	Value
Feedback	Disabled for SOF	0 ms
Safety Sensors	Reaction time of sensor device - considered as 0 ms since mechanical device only	0 ms
SMF	Input Filter Disabled	0 ms
Reset/Restart	SOF configured for Automatic	0 ms
Logic	Internal execution time to process input signal, routing and output processing 2)	100 ms
SOF	No On delay configured for SOF	0 s
Actuator	Assuming a contactor with a response time of 10 ms	10 ms
	Total	110 ms

It takes 110 ms to enable the outputs when the Safety Mat is released.

Figure 139 - Example 2: Same as Figure 138 on page 143 but with manual monitored reset and feedback monitoring

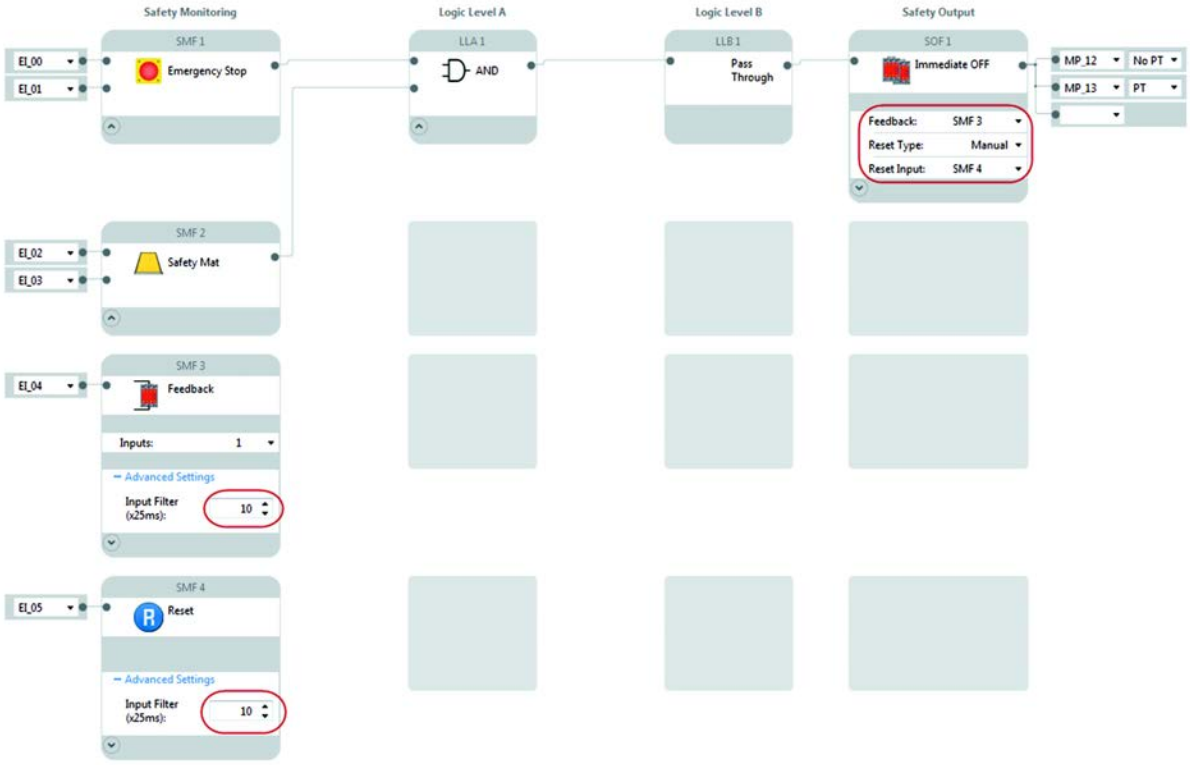


Table 36 - For SMF1 - E-stop:

	Comment	Value
Feedback	Configured Input Filter time 10x25 ms = 250 ms	250 ms
Safety Sensors	Reaction time of sensor device - considered as 0 ms since mechanical device only	0 ms
SMF	Configured Input Filter time 10x25 ms = 250 ms	250 ms
Reset/Restart	Min: 2 x Input Filter Time + 250 ms = 500ms + 250 ms = 0.75 s Max: 2 x Input Filter Time + 3 s = 0.5 + 3 s = 3.5 s	Min: 0.75 s Max: 3.5 s
Logic	Internal execution time to process input signal, routing, and output processing 2)	100 ms
SOF	No On delay configured for SOF	0 s
Actuator	Assuming a contactor with a response time of 10 ms	10 ms
	Total	Min: 1.36 s Max: 4.11 s

It takes a minimum of 1.36 s, after a valid Reset operation of at least 250 ms to enable the outputs when the E-stop is active (closed contacts).

Table 37 - For SMF2 - Safety Mat:

	Comment	Value
Feedback	Configured Input Filter time 10x25 ms = 250 ms	250 ms
Safety Sensors	Reaction time of sensor device - considered as 0 ms since mechanical device only	0 ms
SMF	Input Filter Disabled	0 ms
Reset/Restart	Min: 2 x Input Filter Time + 250 ms = 500ms + 250 ms = 0.75 s Max: 2 x Input Filter Time + 3 s = 0.5 + 3 s = 3.5 s	Min: 0.75 s Max: 3.5 s
Logic	Internal execution time to process input signal, routing, and output processing 2)	45 ms
SOF	No On delay configured for SOF	0 s
Actuator	Assuming a contactor with a response time of 10 ms	10 ms
	Total	Min: 1.055 s Max: 3.3 s

It takes a minimum of 1055 s, after a valid Reset operation of at least 250 ms to enable the outputs when the E-stop is active (closed contacts).

440C-ENET Module Specifications

The following are specifications for the Guardmaster 440C-ENET Ethernet plug-in module.

Table 38 - Technical Specifications

Specification	Description
Module location	Slot 1 module bay only.
Backplane current (mA) at 24V DC	42 mA
Isolation voltage	50V DC, Reinforced Insulation Type, Ethernet to system Type tested at 1500V AC for 60 s
Power consumption, max	1 W
Thermal dissipation	3.41 BTU/hr @ 65 °C
Wire size	Ethernet connections: RJ45 connector according to IEC 60603-7, 2 or 4 pair Category 5e minimum cable according to TIA 568-B.1 or Category 5 cable according to ISO/IEC 24702.
Wiring category	1 - on communication port(1)
Enclosure type rating	None (open-style)

(1) Use this Conductor Category information for planning conductor routing. Refer to *Industrial Automation Wiring and Grounding Guidelines*, publication 1770-4.1.

Table 39 - Environmental Specifications

Specification	Description
Temperature, operating • IEC 60068-2-1 (Test Ad, Operating Cold) • IEC 60068-2-2 (Test Bd, Operating Dry Heat) • IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	-20…+65 ºC (-4…+149 ºF)
Temperature, nonoperating • IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold) • IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat) • IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…+85 ºC (-40…+185 ºF)
Relative humidity, operating • IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…85% noncondensing
Relative humidity, nonoperating • IEC 60068-2-30 (Test Db, Unpackaged Damp Heat)	5…95% noncondensing
Vibration • IEC 60068-2-6 (Test Ea, Unpackaged Shock)	2 g @ 10…500 Hz
Shock, operating • IEC 60068-2-27 (Test Ea, Unpackaged Shock)	25 g (DIN Rail or panel mount)
Shock, nonoperating • IEC 60068-2-27 (Test Ea, Unpackaged Shock)	25 g (DIN Rail mount) 35 g (panel mount)
Emissions • CISPR 11	Group 1, Class A
Immunity, ESD • IEC 6100-4-2	6 kV contact discharges 8 kV air discharges
Immunity, radiated RF • IEC 61000-4-3	10V/m with 1 kHz sine-wave 80%AM from 80…2700 MHz 10V/m with 200 Hz 50% Pulse 100%AM at 900 MHz 10V/m with 200 Hz 50% Pulse 100%AM at 1890 MHz
Immunity, EFT/B • IEC 61000-4-4	±1 kV at 5 kHz on Ethernet port
Immunity, surge transient • IEC 61000-4-5	±1 kV line-earth(CM) on Ethernet port
Immunity, conducted RF • IEC 61000-4-6	10V rms with 1 kHz sine-wave 80%AM from 150 kHz…80 MHz

Table 40 - Certifications

Certification	Description
cULus	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E361015.
CE	European Union 2004/108/EC EMC Directive, compliant with: • EN 61326-1; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 60947-1; Auxiliary Devices
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions
EtherNet/IP	ODVA conformance tested to EtherNet/IP specifications

Note: When product is marked. See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details

Regulatory Approvals

Agency Certifications

- UL Listed Industrial Control Equipment (certified for US and Canada)
- CE marked for all applicable directives
- C-Tick marked for all applicable acts
- CCC Mark
- S-Mark

Compliance to European Union Directives

This product has the CE mark and is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

Machine Safety Directive

This product is designed and tested to meet the European Council Directive 2006/42/EC on machinery and the following standards.

- IEC/EN 61508 - Functional safety of electrical/electronic/programmable electronic safety-related systems
- IEC/EN 62061 - Safety of machinery - Functional safety of safety-related electrical, electronic, and programmable electronic control systems
- EN ISO 13849-1 - Safety of machinery -- Safety-related parts of control systems -- Part 1: General principles for design

This product is intended for use in an industrial environment.

EMC Directive

This product is designed and tested to meet the European Council Directive 2004/108/EC on Electromagnetic Compatibility (EMC) and the following standards:

- EN 61000-6-4: Generic Standards - Emission Standard for Industrial Environments
- EN 61000-6-2: Generic Standards - Immunity for Industrial Environments

This product is intended for use in an industrial environment.

Notes:

Configuration Reference Document

The Configuration Reference Document must be stored together with technical documentation of the machine. It includes information about the validity of a configuration that is created for the machine. This document must be updated anytime changes to the configuration have been made, validated, and verified.

Any new configuration or changes to an existing configuration require a validation and verification before putting it into service. An unverified application will stop operating after 24 hr after power-up.

With your signature you confirm that:

- you have conducted validation and verification of the safety configuration, identified the above mentioned details AND
- the configuration and installation meets all specified operational and environmental requirements of the machine to which CR30 is to be fitted AND
- you have read and understood the "Important User Information"

Important User Information

Read the documents that are listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be conducted by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner that is not specified by the manufacturer, the protection that is provided by the equipment can be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

Resource	Description
Guardmaster® 440C-CR30 Software-Configurable Safety Relay User Manual, publication 440C-UM001 -EN-P.	A detailed description of module functionality, configuration, installation procedure, and information on how to use the Guardmaster Software-Configurable Safety Relay (440C-CR30).
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.

Configuration Reference Document

Device Information:

Device Name: From Name Field, General View	
Description: From Description Field, General View	
Vendor:	Allen-Bradley
Catalog ID:	440C-CR30-22BBB
Safety Relay Firmware Version: Found in the Device Details Window of CCW	

Project Information:

Project Name: As stored in the configuration tool	
Project File Name: From file name	
Software revision: From Help -> About CCW	
Verification ID: Generated in verification window	

Approval:

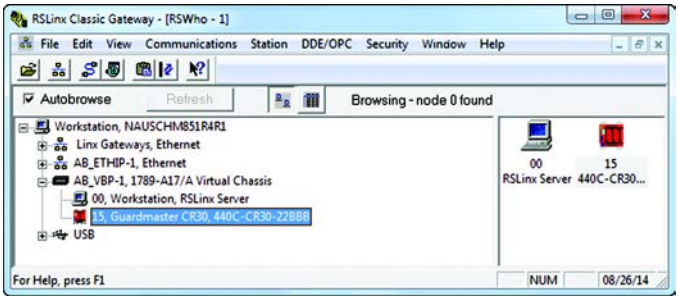
Project Developer Name:	
Date:	
Signature	

ControlFLASH Firmware Upgrade

Upgrade the Firmware

This appendix shows how to flash update the firmware in a Guardmaster CR30 safety relay using ControlFLASH™. To download the latest Guardmaster CR30 safety relay firmware revision, go to http://www.rockwellautomation.com/support/pcdc.page and select your desired revision.

1. Through USB connection: Verify successful RSLinx Classic communications with you Guardmaster CR30 safety relay by USB using RSWho. The Guardmaster CR30 uses the AB_VBP-x driver.



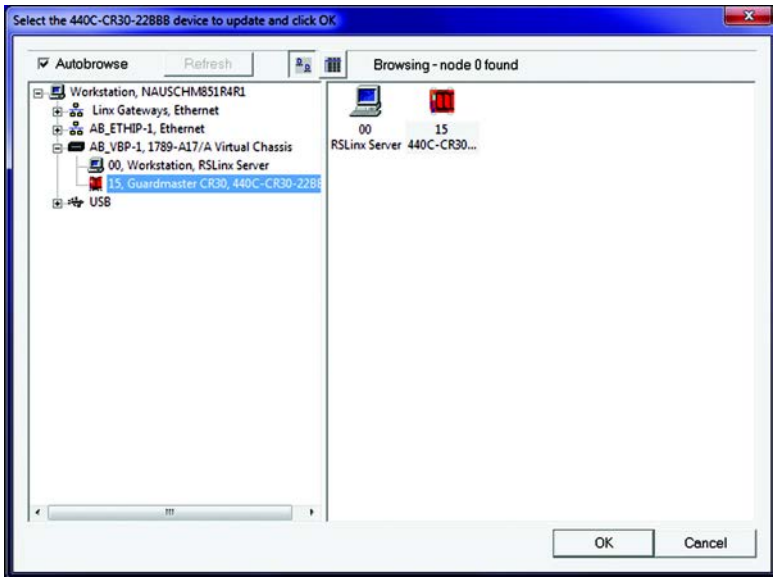
2. Start ControlFLASH
   Click **Start** > **All Programs** > **FLASH Programming Tools** > **ControlFLASH**.

3. Select **Local** and click **OK**.

4. Click **Next**

5. Select the catalog number of the Guardmaster CR30 safety relay (440C-CR30-22BBB) that you are updating and click **Next**.

6. Expand the AB_VBP-1, 1789-A17/A Virtual Chassis by clicking the +.
7. Select the safety relay in the browse window and click **OK**.
   If the device comes up unrecognized, the EDS file has not been loaded.

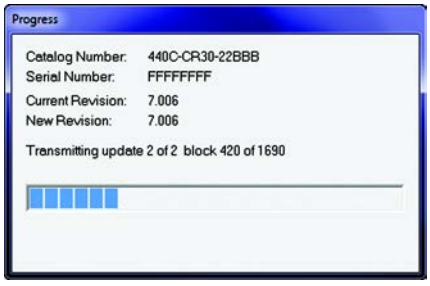


8. Verify the revision, and click **Next** to continue.

9. Click **Finish**.

10. Click **Yes** to initiate the update.

The next screen shows the download progress.



11. When the flash update is complete, you see a status screen similar to the following. Click **OK** to complete the update.

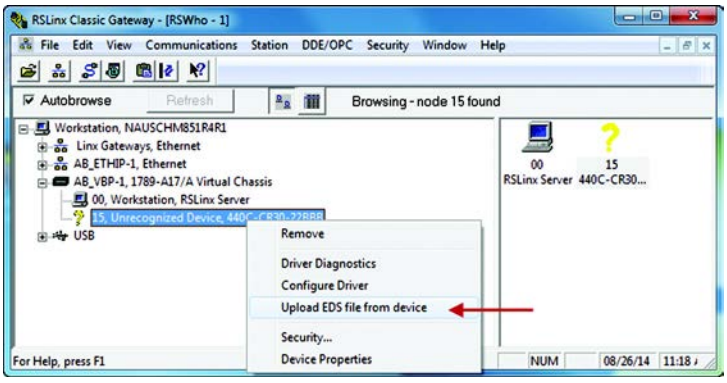
12. The "Welcome to ControlFlash" window appears again. Click **Cancel**.

13. Click **Yes** to end the session.

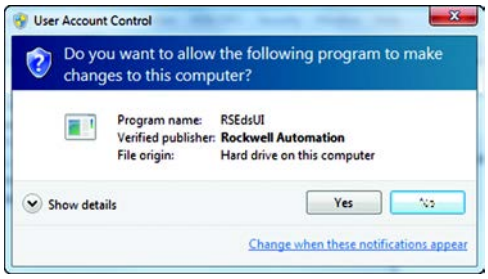
Unrecognized Device

If the device comes up as Unrecognized, the EDS file must be uploaded.

1. Right-click the device and select **Upload EDS file from device**.

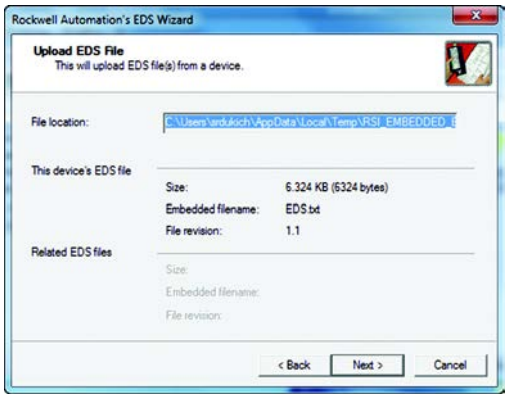


2. Click **Yes**.

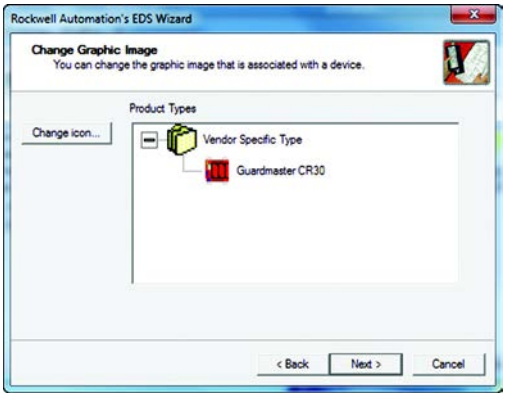


3. Click **Next**.

4. Click **Next**.



5. Click **Next**.



6. Click **Next**.

7. Click **Finish**.

Notes:

EtherNet/IP I/O Assemblies

Input Assemblies

The following are input assemblies available over EtherNet/IP for the Guardmaster 440C CR30 safety relay.

Table 41 - 440C-CR30 Input Assemblies

Instance Decimal (hex)	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
100 (64h)	0	Reserved				Minor Fault	Major Fault	Connection Faulted	Run Mode
	1	Reserved							
		High Byte				**Low Byte**			
	2, 3	Verification ID							
	4, 5	Major Fault Type (1)				Major Fault Code (1)			
	6, 7	Minor Fault Type (1)				Minor Fault Instance (1)			
	8, 9	Minor Fault Code (1)							
	Byte	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	10	Pt 07 Data	Pt 06 Data	Pt 05 Data	Pt 04 Data	Pt 03 Data	Pt 02 Data	Pt 01 Data	Pt 00 Data
	11	Pt 15 Data	Pt 14 Data	Pt 13 Data	Pt 12 Data	Pt 11 Data	Pt 10 Data	Pt 09 Data	Pt 08 Data
	12	Reserved		Pt 21 Data	Pt 20 Data	Pt 19 Data	Pt 18 Data	Pt 17 Data	Pt 16 Data
	13	Plug-in 2 Pt 07 Data	Plug-in 2 Pt 06 Data	Plug-in 2 Pt 05 Data	Plug-in 2 Pt 04 Data	Plug-in 2 Pt 03 Data	Plug-in 2 Pt 02 Data	Plug-in 2 Pt 01 Data	Plug-in 2 Pt 00 Data
	14	SMF 8 Data	SMF 7 Data	SMF 6 Data	SMF 5 Data	SMF 4 Data	SMF 3 Data	SMF 2 Data	SMF 1 Data
	15	SMF 16 Data	SMF 15 Data	SMF 14 Data	SMF 13 Data	SMF 12 Data	SMF 11 Data	SMF 10 Data	SMF 9 Data
	16	SMF 24 Data	SMF 23 Data	SMF 22 Data	SMF 21 Data	SMF 20 Data	SMF 19 Data	SMF 18 Data	SMF 17 Data
	17	LLA 8 Data	LLA 7 Data	LLA 6 Data	LLA 5 Data	LLA 4 Data	LLA 3 Data	LLA 2 Data	LLA 1 Data
	18	LLA 16 Data	LLA 15 Data	LLA 14 Data	LLA 13 Data	LLA 12 Data	LLA 11 Data	LLA 10 Data	LLA 9 Data
	19	LLB 8 Data	LLB 7 Data	LLB 6 Data	LLB 5 Data	LLB 4 Data	LLB 3 Data	LLB 2 Data	LLB 1 Data
	20	LLB 16 Data	LLB 15 Data	LLB 14 Data	LLB 13 Data	LLB 12 Data	LLB 11 Data	LLB 10 Data	LLB 9 Data
	21	SOF 8 Data	SOF 7 Data	SOF 6 Data	SOF 5 Data	SOF 4 Data	SOF 3 Data	SOF 2 Data	SOF 1 Data
	22	SOF 16 Data	SOF 15 Data	SOF 14 Data	SOF 13 Data	SOF 12 Data	SOF 11 Data	SOF 10 Data	SOF 9 Data
	23	SOF 8 Reset Required	SOF 7 Reset Required	SOF 6 Reset Required	SOF 5 Reset Required	SOF 4 Reset Required	SOF 3 Reset Required	SOF 2 Reset Required	SOF 1 Reset Required
	24	SOF 16 Reset Required	SOF 15 Reset Required	SOF 14 Reset Required	SOF 13 Reset Required	SOF 12 Reset Required	SOF 11 Reset Required	SOF 10 Reset Required	SOF 9 Reset Required
	25	Reserved							
	26	Reserved							
	27	Reserved							

Where:
- Pt = Value of the I/O point
- SMF = Safety Monitoring Function (SMF) block status in the 440C-CR30 editor
- LLA = Logic Level A (LLA) Function block status in the 440C-CR30 editor
- LLB = Logic Level B (LLB) Function block status in the 440C-CR30 editor
- SOF = Safety Output Function (SOF) block status in the 440C-CR30 editor

(1) See Appendix F (page 163) for details on Faults.

Output Assemblies

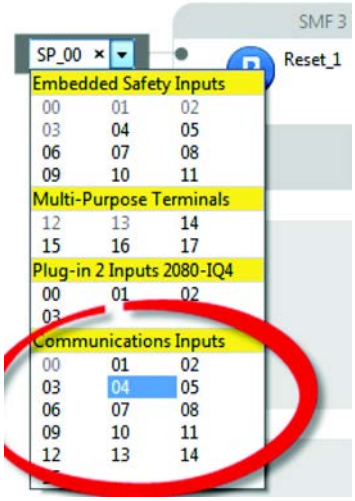
The following are output assemblies available over EtherNet/IP for the Guardmaster 440C CR30 safety relay.

Table 42 - 440C-CR30 Output Assemblies

Instance Decimal (hex)	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
150 (96h)	0	PNB 07	PNB 06	PNB 05	PNB 04	PNB 03	PNB 02	PNB 01	PNB 00
	1	PNB 15	PNB 14	PNB 13	PNB 12	PNB 11	PNB 10	PNB 09	PNB 08
	2, 3	Reserved							

Where:

- PNB = Produced Network Bit, writes to the Communications Inputs selections in the 440C-CR30 editor.



Tag Definitions

Table 43 - 440C-CR30 Input Tags

Name	Data Type	Tag Definition
RunMode	BOOL	**Run Mode** - Indicates the operating mode of the safety relay. 0 = Idle/Program Mode 1 = Run Mode
ConnectionFaulted	BOOL	**Connection Faulted** - Indicates the state of the communication connection between the safety relay and the controller. 0 = Connection 1 = Connection faulted
MajorFault	BOOL	**Major Fault Status** - Indicates whether the safety relay is major (non-recoverable) faulted. 0 = No Fault 1 = Fault
MinorFault	BOOL	**Minor Fault Status** - Indicates whether the safety relay is minor (recoverable) faulted. 0 = No Fault 1 = Fault
VerificationID	INT	**Verification ID** - Indicates the unique verification ID of the safety relay when the configuration has been verified by the user. Valid verification ID values - 0001. . . 9999. 0000 = Configuration is not verified
PtxxData	BOOL	**Data** - Off/On status for input/output point echoed back from the safety relay. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
Plugin2InPtxxData (1)	BOOL	**Data** - Off/On status for input/output point echoed back from the safety relay slot 2 plug-in module. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
Plugin2OutPtxxData (1)	BOOL	**Data** - Off/On status for input/output point echoed back from the safety relay slot 2 plug-in module. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
MajorFaultType	SINT	**Major Fault Type** - Indicates the major fault type of the safety relay. 01H = Hardware Fault 02H = Safety Input Fault 04H = Safety Output Fault 08H = Power Fault 10H = Communication Fault 20H = Configuration Fault 40H = Time Monitoring Fault 80H = Plug-in Fault

Name	Data Type	Tag Definition
MajorFaultCode	SINT	**Major Fault Code** - Indicates the specific major fault code for the corresponding major fault type. See Table 45 for additional details
MinorFaultType	SINT	**Minor Fault Type** - Indicates the type of function block that is faulted. 10H = Safety Monitoring Function minor fault 40H = Safety Output Function minor fault
MinorFaultInstance	SINT	**Minor Fault Instance** - Indicates the instance of the function block that is faulted. Valid values: 01…24
MinorFaultCode	INT	**Minor Fault Code** - Indicates the specific minor fault code for the corresponding minor fault type and instance. See Table 46 for additional details.
SMFxx (1)	BOOL	**Data** - Off/On status for Safety Monitoring Function echoed back from the safety relay. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
LLAxx (1)	BOOL	**Data** - Off/On status for Logic Level A Function echoed back from the safety relay. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
LLBxx (1)	BOOL	**Data** - Off/On status for Logic Level A Function echoed back from the safety relay. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
SOFxx (1)	BOOL	**Data** - Off/On status for Safety Output Function echoed back from the safety relay. This is used to verify proper communication only. No field side verification is done. 0 = Off 1 = On
SOFxxResetRequired (1)	BOOL	**Safety Output Function Reset Required** - Indicates whether a safety output function is awaiting a reset command before initiating its output. 0 = No reset required 1 = Reset required

(1) xx corresponds to 01…16 for bits 00…15 of the integer.

Table 44 - 440C-CR30 Output Tags

Name	Data Type	Tag Definition
LogicDefinedDataxx (1)	BOOL	**Logic Defined Data** - These 16 bits write to the Communications Inputs in the 440C-CR30 safety relay editor.

(1) xx corresponds to 00…15.

Table 45 - Major Faults

Type	Code	Cause	Recovery Method
01H	01	RAM test failure	Do one of the following: • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	02	ROM test failure	
	03	Stack overflow or underflow	
	04	Watchdog expired	
	05	Memory error	
	06	Register failure	
	07	Flow control/switch default	
	08	EEPROM fault	
	11	Host detected incorrect safety firmware version	Do one of the following: • Power cycle the safety relay. • Update the firmware in the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	12	Host detected incorrect safety firmware CRC A	
	13	Host detected incorrect safety firmware CRC B	
	15	Host software error	
02H	01…18	Safety input pulse test failure. Code corresponds to specific terminal that is faulted +1	Do one of the following: • Check wiring for shorts to 24V or other channels. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	19	Cross loop inputs of input shift register	Do one of the following: • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	20…21	Input data transfer fault	
04H	01…10	Safety output plausibility failure (short of failure on power up). Code 01…10 corresponds to terminals 12…21, respectively.	Do one of the following: • Check wiring for shorts to 24V or other channels. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	11…20	Safety output pulse test failure. Code 11…20 corresponds to terminals 12…21, respectively.	

Type	Code	Cause	Recovery Method
08H	01	Over/under voltage detected or pulse test failure of main internal transistor	Do one of the following: • Validate the electrical installation and appropriate supply voltage is provided. • Power cycle the safety relay. • Reconfigure the safety relay. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	02	Pulse test fault of voltage monitoring/main transistor	
	03	Under voltage reset	
10H	01	Compare UART data during operation	
	02	Communication timeout between safety processors	Do one of the following: • Power cycle the safety relay. • Reattempt download of the safety relay configuration. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	17	Host processor detected safety processors are unresponsive	
	18	Host processor detected safety processors lost communication	
20H	01	CRC Error in the configuration file	
	02	CRC of configuration file different from EEPROM	
	03	Mismatch between I/O µC A and I/O µC B in configuration files	
	04	Invalid ID numbers for configuration files	
	05	Mismatch between configured plug-in and plug-in detected on slot 2	Do one of the following: • Verify plug-in physically present in the slot matches the configuration. • Reattempt download of the safety relay configuration. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	21	Mismatch between configured plug-in and plug-in detected on slot 1	
40H	01…03	Timing fault	Do one of the following: • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
80H	20	Memory module restore failed	Do one of the following: • Verify Memory Module is properly seated in slot 1 • Power cycle the safety relay. • Initiate backup or restore If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	21	Memory module backup failed	
	41	Plug-in slot 1: Parity failure	Do one of the following: • Verify plug-in physically present in the slot matches the configuration. • Reattempt download of the safety relay configuration. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	42	Plug-in slot 1: Communication error	
	43	Plug-in slot 1: Plug-in Type not supported	
	81	Plug-in slot 2: Parity failure	
	82	Plug-in slot 2: Communication error	
	83	Plug-in slot 2: Plug-in type not supported.	

Table 46 - Minor Faults

Type	Code	Cause	Recovery Method
10H	01H	Pulse Test Failure Channel shorted to 24V or another channel.	Do one of the following: • Check wiring for shorts to 24V or other channels. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	02H	Reset Held On A transition of the reset input from ON (1) to OFF (0) did not occur within 3 seconds.	
	04H	Light Curtain Mute Time Exceeded. The Light Curtain was muted for longer than the maximum configured mute time.	Do one of the following: • Verify there is no obstruction of the mute sensor or Light Curtain. • Verify the application times are appropriate • Check wiring for shorts to 24V or other channels. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	08H	Contact bounce One channel went to the safe state and back to the active state after a reset.	Do one of the following: • Check wiring and mechanical integrity of the field device. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	10H	Mute Time Exceeded. Too much time elapsed between mute sensors being blocked.	Do one of the following: • Verify there is no obstruction of the mute sensor. • Verify the application times are appropriate • Check wiring for shorts to 24V or other channels. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	14H	Combination of faults detected	See all of the following fault codes: • 04H • 10H
	20H	Discrepancy Fault. The configured amount of time that the inputs are allowed to be in an inconsistent state expired.	Do one of the following: • Check wiring for shorts to 24V or other channels. • If appropriate, adjust the Discrepancy Time for the Safety Monitoring Function. • Power cycle the safety relay. • Reconfigure the safety relay. • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support

Type	Code	Cause	Recovery Method
10H	40H	Muting Sequence Fault. An illegal input pattern, the pattern of sensors being blocked and cleared, for the mute sensors was detected.	Do one of the following: • Check the sensor • Check wiring • Power cycle the safety relay • Reconfigure the safety relay • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	44H	Combination of faults detected	See all of the following fault codes: • 04H • 40H
	50H	Combination of faults detected	See all of the following fault codes: • 10H • 40H
	54H	Combination of faults detected	See all of the following fault codes: • 4H • 10H • 40H
	90H	Combination of faults detected	See all of the following fault codes: • 10H • 80H
	94H	Combination of faults detected	See all of the following fault codes: • 4H • 10H • 80H
	120H	Combination of faults detected	See all of the following fault codes: • 40H • 80H
	124H	Combination of faults detected	See all of the following fault codes: • 4H • 40H • 80H
	130H	Combination of faults detected	See all of the following fault codes: • 10H • 40H • 80H
	134H	Combination of faults detected	See all of the following fault codes: • 4H • 10H • 40H • 80H
	80H	Light Curtain Sequence Fault. An illegal input pattern, the pattern of sensors and light curtain being blocked and cleared, was detected.	Do one of the following: • Check the sensor • Check wiring for shorts to 24V or other channels • Power cycle the safety relay • Reconfigure the safety relay • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support

Type	Code	Cause	Recovery Method
10H	FFFFH	Unregistered fault	Contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
40H	01H	Retrigger Fault. Enabled input transitioned from OFF (0) to ON (1) while the output delay time was in progress.	Do one of the following: • Verify application logic and wiring is appropriate • Power cycle the safety relay • Reconfigure the safety relay • Validate the electrical installation and appropriate measures to reduce noise and suppress surges are taken. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support
	FFFFH	Unregistered fault	Contact your local Rockwell Automation technical support representative. For contact information, see: http://rockwellautomation.com/support

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

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Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

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