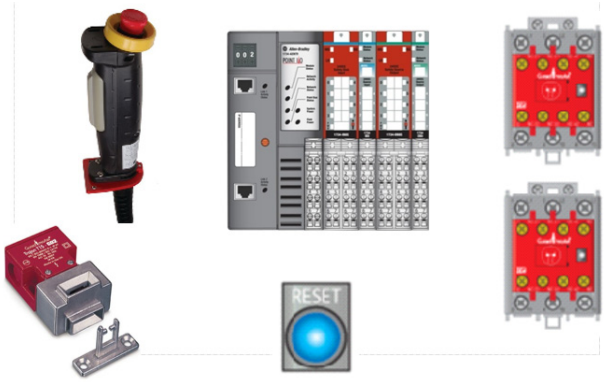
Allen-Bradley

Safety Function: Enabling Switch

Products: 440J Enabling Switch, GuardLogix Controller, POINT Guard I/O Safety Module

Safety Rating: CAT. 3, PLd to ISO 13849-1: 2008



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.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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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).

General Safety Information

IMPORTANT This application example is for advanced users and assumes that you are trained and experienced in safety system requirements.

Risk Assessments

ATTENTION: Perform a risk assessment to make sure that all task and hazard combinations have been identified and addressed. The risk assessment can require additional circuitry to reduce the risk to a tolerable level. Safety circuits must consider safety-distance calculations, which are not part of the scope of this document.

Contact Rockwell Automation to learn more about our safety-risk assessment services.

Safety Distance Calculations

ATTENTION: While safety distance or access time calculations are beyond the scope of this document, compliant safety circuits must often consider a safety distance or access time calculation.

Non-separating safeguards provide no physical barrier to prevent access to a hazard. Publications that offer guidance for calculating compliant safety distances for safety systems that use non-separating safeguards, such as light curtains, scanners, two-hand controls, or safety mats, include the following:

EN ISO 13855:2010 (Safety of Machinery – Positioning of safeguards with respect to the approach speeds of parts of the human body)

ANSI B11:19 2010 (Machines – Performance Criteria for Safeguarding)

Separating safeguards monitor a moveable, physical barrier that guards access to a hazard. Publications that offer guidance for calculating compliant access times for safety systems that use separating safeguards, such as gates with limit switches or interlocks (including SensaGuard™ switches), include the following:

EN ISO 14119:2013 (Safety of Machinery – Interlocking devices associated with guards - Principles for design and selection)

EN ISO 13855:2010 (Safety of Machinery – Positioning of safeguards with respect to the approach speeds of parts of the human body)

ANSI B11:19 2010 (Machines – Performance Criteria for Safeguarding)

In addition, consult relevant national or local safety standards to assure compliance.

Introduction

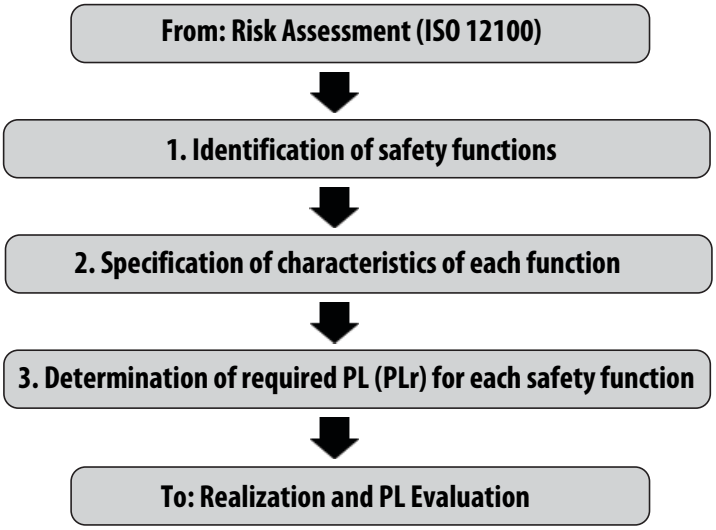
This safety function application technique explains how to wire, configure, and program a Compact GuardLogix® controller and POINT Guard I/O™ module to monitor an enabling switch. The operator squeezes the enabling switch to the middle position to bypass the primary, safety-door interlock. This action allows the GuardLogix controller to energize the final control device, in this case, a redundant pair of 100S contactors. The actual safety function that uses an enabling switch is beyond the scope of this document. The safety function may require speed monitoring, direction monitoring, force monitoring, or additional monitoring to reduce hazard to a tolerable level while using the enabling switch.

This example uses a Compact GuardLogix controller, but is applicable to any GuardLogix controller. This example uses a 440J interlock switch with an integrated jog button, but is applicable to solutions that use enabling switch technology in combination with a manual button.

The SISTEMA calculations that are shown later in this document would have to be recalculated using the actual products.

Safety Function Realization: Risk Assessment

The required performance level is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the performance level required (PLr) by the risk assessment is Category 3, Performance Level d (CAT. 3, PLd), for each safety function. A safety system that achieves CAT. 3, PLd, or higher, can be considered control reliable. Each safety product has its own rating and can be combined to create a safety function that meets or exceeds the PLr.



Enabling Switch Safety Function

This application technique includes one safety function: Removal of power from the hazard when the safety system detects that the operator does not have the enabling switch in the middle position, or the door switch is open.

Safety Function Requirements

Functional safety requires the continuous actuation of a three-position enabling switch to enable power to the motor. The handheld device provides power to the motor when squeezed to the middle position. When the operator releases or fully squeezes the switch, power to the motor is removed. Faults at the enabling switch, wiring terminals, or safety controller are detected before the next safety demand. The safety function in this example is capable of connecting and interrupting power to motors rated up to 9A, 600V AC.

The safety function in this application technique meets or exceeds the requirements for Category 3, Performance Level d (CAT. 3, PLd), per ISO 13849-1 and control reliable operation per ANSI B11.19.

Functional Safety Description

In this example, power to the motor is enabled if the safety door is closed, or if the operator opens the door and squeezes an enabling switch to the middle position. Both the door switch and enabling switch are wired to a pair of safety inputs on a safety input module (SI1).The safety contactors (K1 and K2) are connected to a pair of safety outputs of a safety output module (SO1). The I/O module is connected via CIP Safety™ technology over an EtherNet/IP™ network to the safety controller (SC1). The safety code in SC1 monitors the status of the door and enabling switch by using pre-certified safety instructions. Dual Channel Input Stop (DCS), is used for the door and Dual Channel Input Start (DCSRT) is used for the enabling switch, as this is a safety device that starts a safety output. When all safety input interlocks are satisfied and no faults are detected, a certified function block called Configurable Redundant Output (CROUT) controls and monitors feedback for a pair of 100S redundant contactors.

Bill of Material

This application uses these products.

Cat. No.	Description	Quantity
440J-N21TNPM-NP	Enabling switch with jog button	1
440K-T11090	Trojan™ 5 standard safety interlock switch	1
800FM-G611MX10	800F Reset push button - metal, guarded, blue, R, metal latch mount, one N.O. contact, standard	1
100S-C09ZJ23C	Bulletin 100S-C - safety contactors	2
1768-ENBT	CompactLogix™ EtherNet/IP bridge	1
1768-L43S	Compact GuardLogix processor, 2.0 MB standard memory, 0.5 MB safety memory	1
1768-PA3	Power supply, 120/240V AC input, 3.5 A @ 24V DC	1
1769-ECR	Right end cap/terminator	1
1734-AENT	24V DC Ethernet adapter	1
1734-TB	Module base with removable IEC screw terminals	4
1734-IB8S	POINT Guard I/O safety input module	1
1734-OB8S	POINT Guard I/O safety output module	1
1783-US05T	Stratix 2000™ unmanaged Ethernet switch	1

Setup and Wiring

For detailed information on installing and wiring, refer to the publications listed in the Additional Resources on the back cover.

System Overview

The POINT Guard I/O safety input module monitors the contacts of both the enabling switch and the door interlock switch.

The input module can source the 24V DC for all channels to dynamically test the signal wiring for shorts to 24V DC and channel-to-channel shorts. If a fault occurs, either or all channels are set low (0), and the controller reacts by dropping out the safety contactors. Only after the fault is cleared and the faulted input device is cycled, does the function block reset.

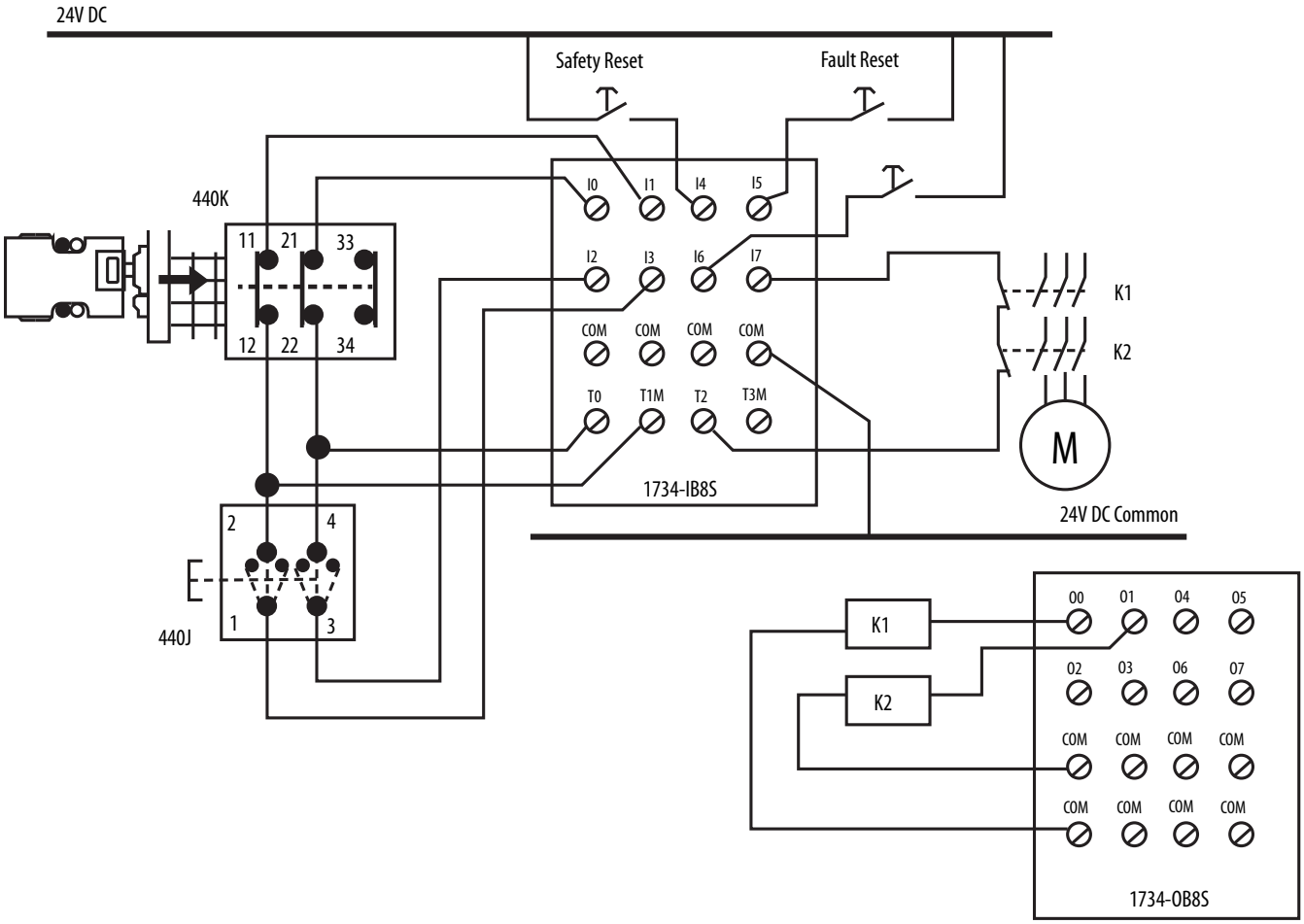
Shorts to OV DC (and wire off) are seen as an open circuit by the safety input module, and the controller reacts by dropping out the safety contactors. If the inputs remain discrepant for longer than the discrepancy time, then the function block (DCS or DCSRT) in the controller declares a fault. Only after the fault is cleared and the faulted input device is cycled, does the function block reset.

The final control device in this case is a pair of 100S safety contactors, K1 and K2. The contactors are controlled by a POINT Guard I/O safety output module. The contactors are wired in a redundant-series configuration. A feedback circuit is wired through the N.O. contacts and back to an input on the safety output module to monitor the contactors for proper operation. The contactors cannot restart if the feedback circuit is not in the correct state.

The system has a reset button for resetting faults. There is a jog button on the enabling switch that the control system uses to actually start motion.

The reset button, the jog button, and the contactor feedback circuit are all wired to the safety input module in this example. This configuration is not required for functional safety. These inputs could be wired to a standard input module.

Electrical Schematic

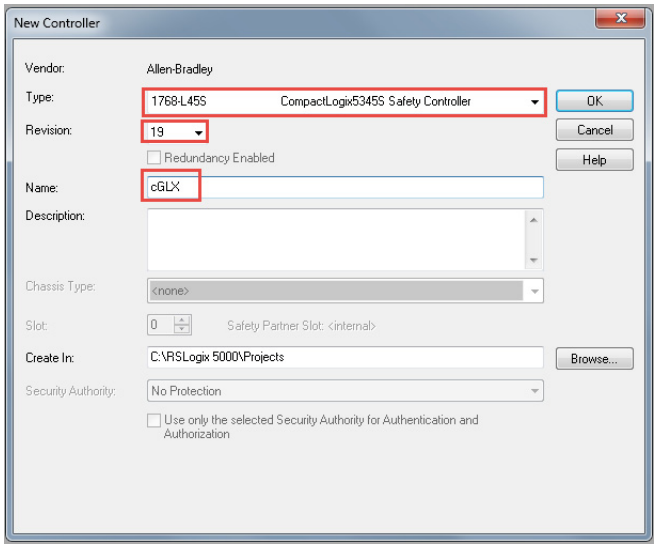


Configuration

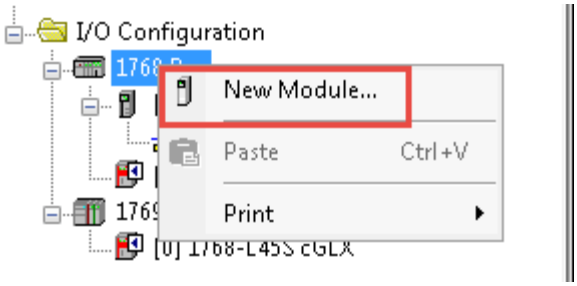
The Compact GuardLogix controller is configured using RSLogix 5000® software, version18 or later. You create a project, add the I/O modules, and then configure the I/O modules for the correct input and output type. A detailed description of each step is beyond the scope of this document. Knowledge of the RSLogix 5000 programming environment is assumed.

Configure the Controller and Add I/O Modules

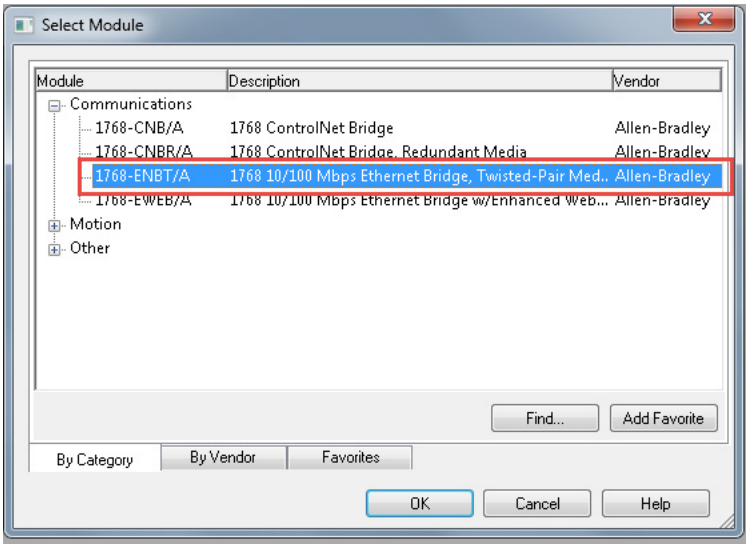
1. In RSLogix 5000 software, create a project.



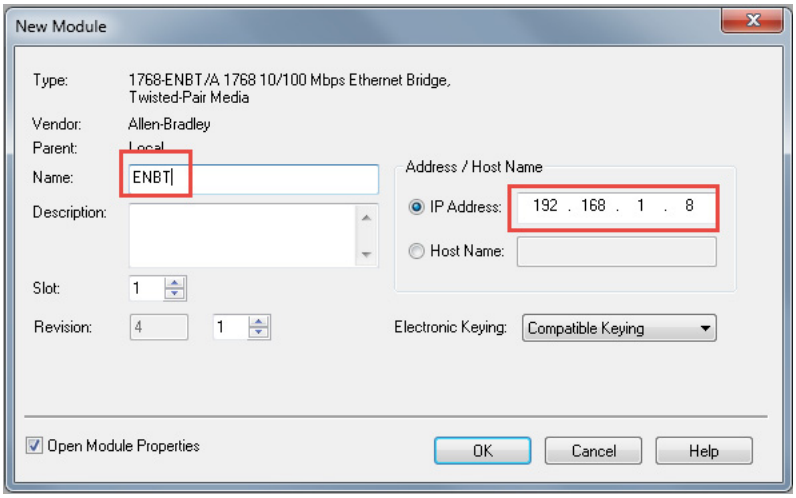
2. In the Controller Organizer, right-click the 1768 Bus and choose New Module.



3. Select the 1768-ENBT module, and click OK.

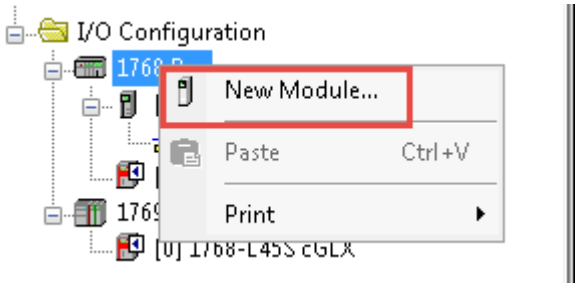


4. Name the Module module, type its IP address, and click OK.

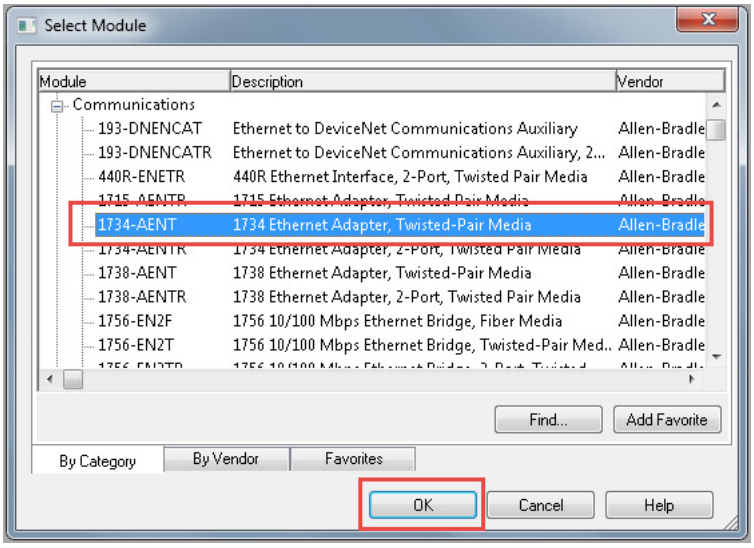


We used 192.168.1.8 for this application example. Yours can be different.

5. In the Controller Organizer, right-click the 1768-ENBT module, and choose New Module.



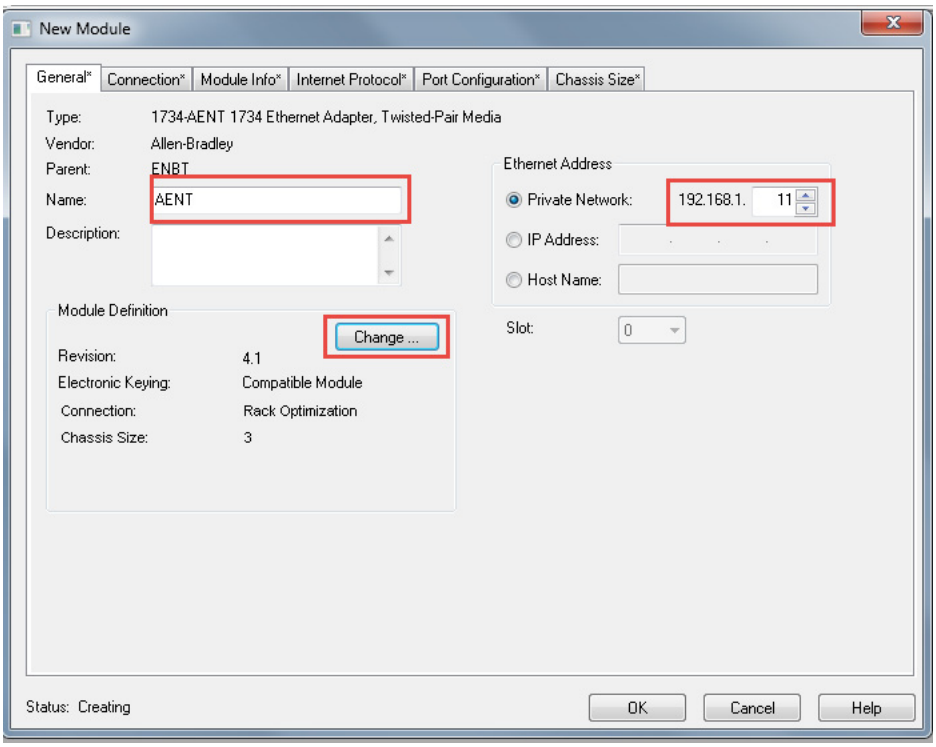
6. Select the 1734-AENT adapter, and click OK.



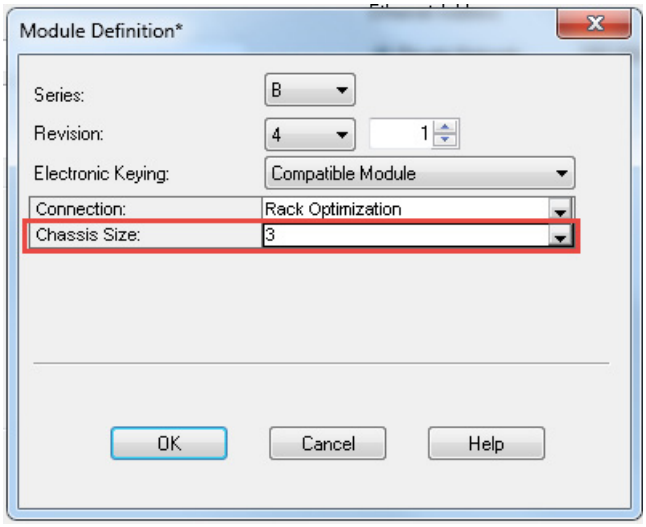
7. Name the module, type its IP address; and click OK.

   We used 192.168.1.11 for this application example. Yours may be different.

8. Click Change.

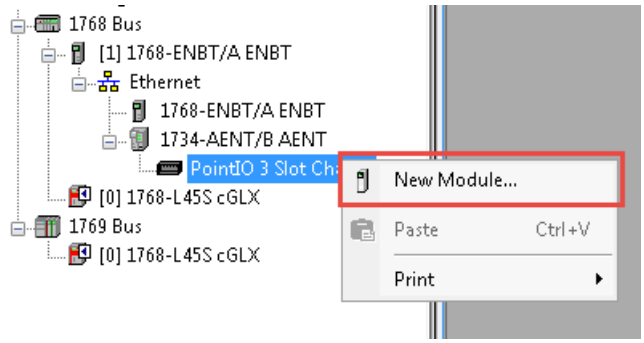


9. From the Chassis Size pull-down menu, choose 3, and click OK.

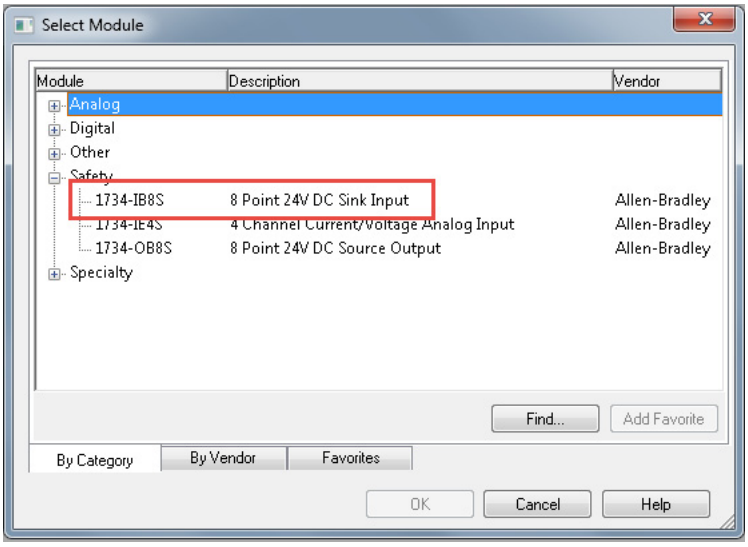


Chassis size is the number of modules that are inserted in the chassis. The 1734-AENT adapter is considered to be in slot 0, so for one input and one output module, the chassis size is 3.

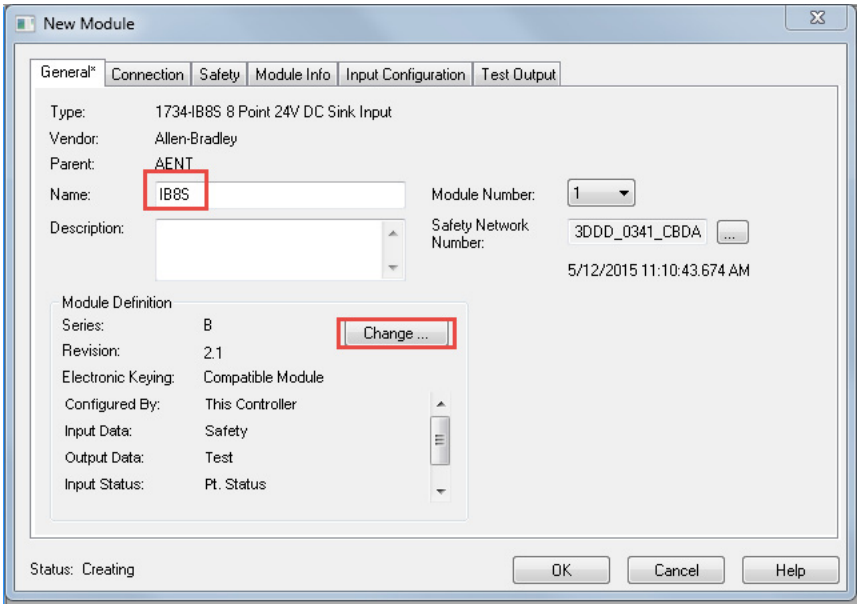
10. In the Controller Organizer, right-click the PointIO 3 Slot Chassis adapter, and choose New Module.



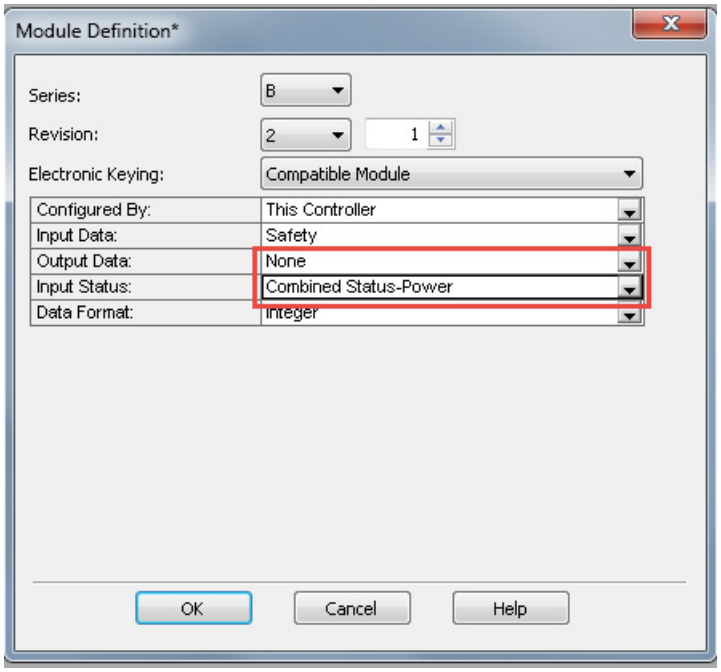
11. Expand Safety, select the 1734-IB8S module, and click OK.



12. In the New Module dialog box, name the device IB8S, and click Change.



13. When the Module Definition dialog box opens, change the Output Data to None, verify that the Input Status is Combined Status-Power, and click OK.



Setting the output data to None means that you cannot use the Test Outputs as standard output, which is appropriate in this example. This arrangement saves one controller connection because we are using only the input connection.

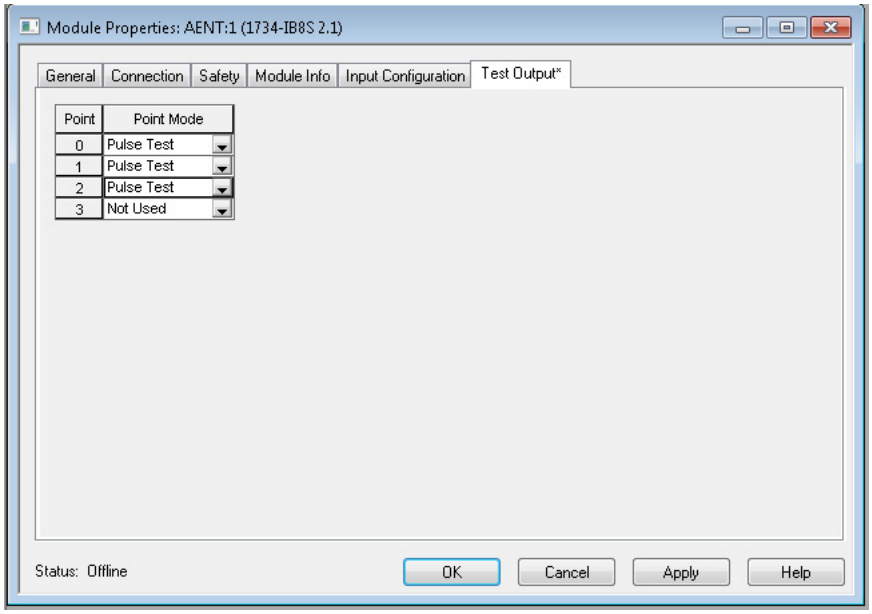
14. To close the Module configuration properties dialog box, click OK.

15. Repeat steps 10...14 to add the 1734-OB8S safety output module.
    a. Name the module OB8S.
    b. Choose slot 2.
    c. Set the Input Status to Combined Status-Readback-Power.

Configure the POINT Guard I/O Modules

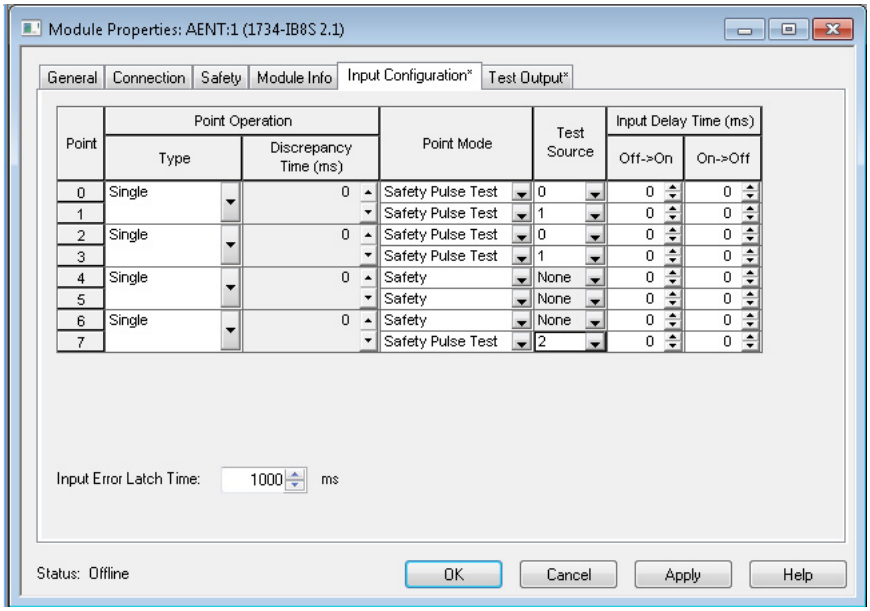
Follow these steps to configure the POINT Guard I/O modules.

1. In the Controller Organizer, right-dick the 1734-IBSS module, and choose Properties.
2. Click Test Output, and configure the module as shown.



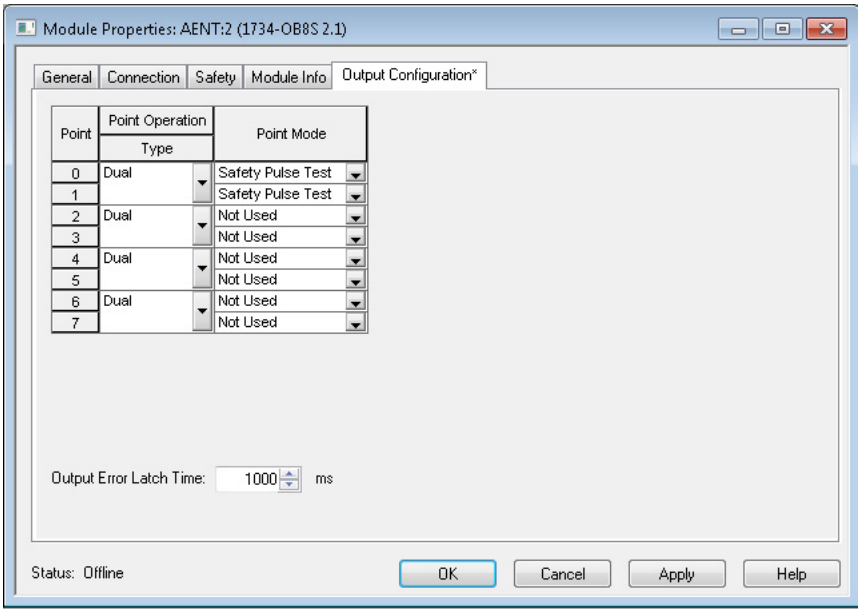
T0 and T1 are being used to pulse test both the Trojan 5 door interlock switch and the enabling switch channels. T2 is being used to pulse test the contactor feedback circuit.

3. Click Input Configuration and configure the module as shown.



Inputs 0 and 1 are the Trojan 5 door switch. Inputs 2 and 3 are the enabling switch. Test sources 0 and 1 are sourcing these devices. Inputs 4 and 5 are the reset buttons. Input 6 is the jog button that is on the enabling switch in this example. Input 7 is the contactor monitoring circuit, which is sourced from Test Output 2. I/O channel operation does not change based on whether the channel is configured as standard or safety. The configuration is used for documentation purposes, so configuring the standard reset buttons as safety is not a concern. The channels are configured for single type operation because the safety instructions within the GuardLogix system detect discrepancy faults.

4. Click Output Configuration and configure the module as shown.



The electromechanical coil on the contactor (outputs 0 and 1) can be pulse tested without reacting to the brief low (0) pulse. If you are using a contactor that does react to the pulse test, then it is advisable to disable the pulse test. This arrangement should not degrade the overall safety rating of redundancy and monitoring that are being used.

5. Click OK.

Programming

The Dual Channel Input Stop (DCS) instruction monitors dual-input safety devices whose main function is to stop a machine safely, for example, a safety gate. If the Door OK tag is sealed in around the falling edge of the Safety Reset button, then the contactors are energized.

The Dual Channel Start (DCSRT) instruction energizes its output (01) if the enable input is high (1), and both input channels are in the active (1) state. In this example, the Slow Machine Mode enable input indicates that the machine is in a mode where usage of the enabling switch is allowed. You are responsible for driving this input based on your application and risk assessment. If an enabling switch usage is allowed, and the operator squeezes the enabling switch to the idle position, then the contactors energize.

The DCS and DCSRT instructions monitor dual-input channels for consistency (Equivalent- Active High) and detect and trap faults when the inconsistency is detected for longer than the configured Discrepancy Time (ms).

The automatic restart type allows the DCS output (01) to reset automatically after a demand. The manual action typically required for safety is provided in rungs 2 and 3 to reset the safety outputs.

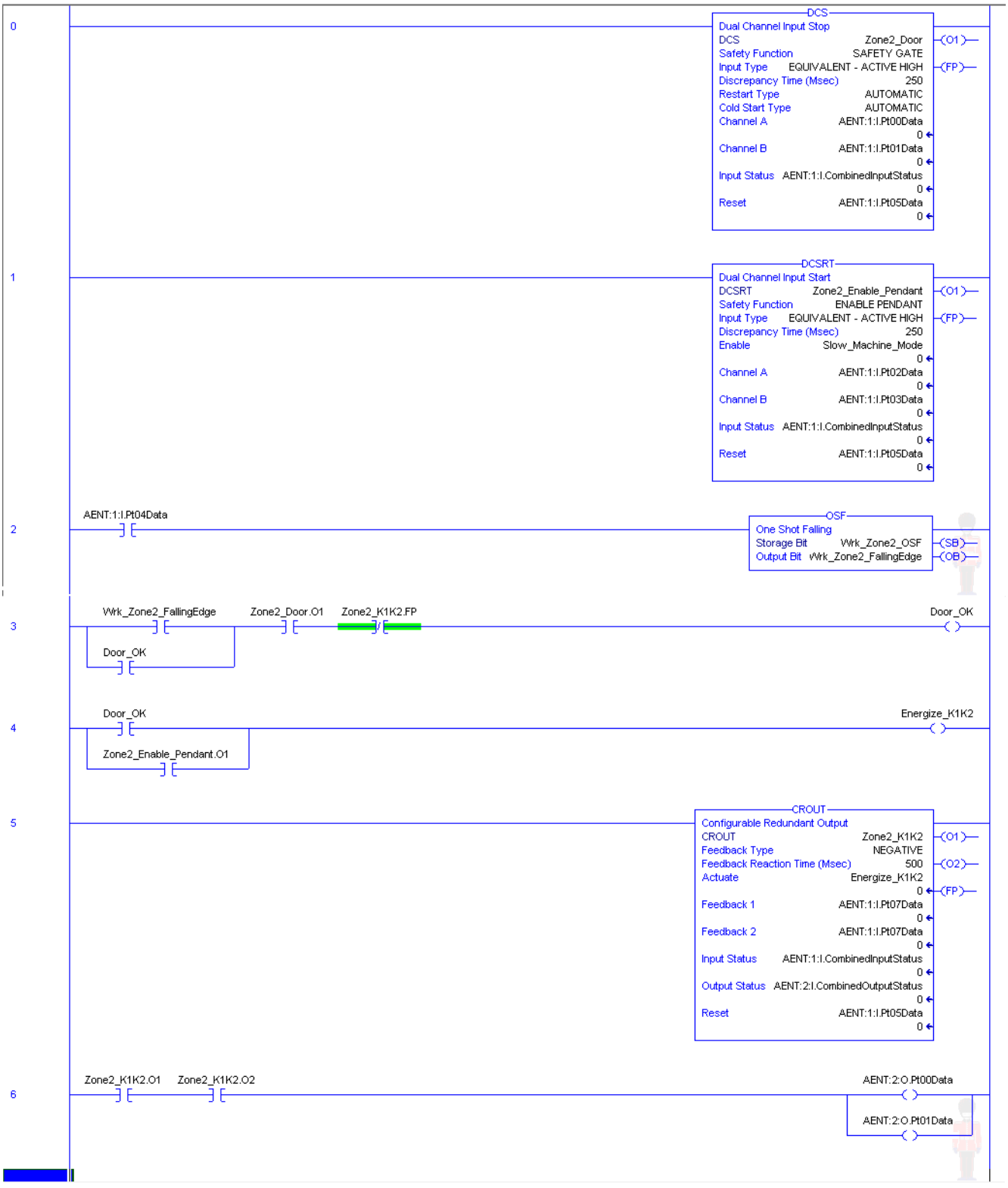
Input Status typically represents the channel status of the dual input channels. In this example, the Combined Input Status bit goes low (0) if any of the eight input channels on the 1734-IBSS module have a fault. The energize_contactors tag drives the Actuate input on the Configurable Redundant Output (CROUT) instruction. Either a closed door or the enabling switch can set this tag to high (1).

The CROUT instruction controls and monitors redundant outputs. Essentially, this instruction verifies that feedback follows the safety outputs appropriately. For the negative feedback used in this example, if the outputs are high (1), the feedback should be low (0) and vice versa. ln this example, the feedback has 500 ms to change to the proper state. Because only one feedback circuit is being used, the feedback tag is used for both Feedback 1 and 2.

The two output tags from the CROUT instruction are used to drive the contactor outputs on the 1734-0B8S module.

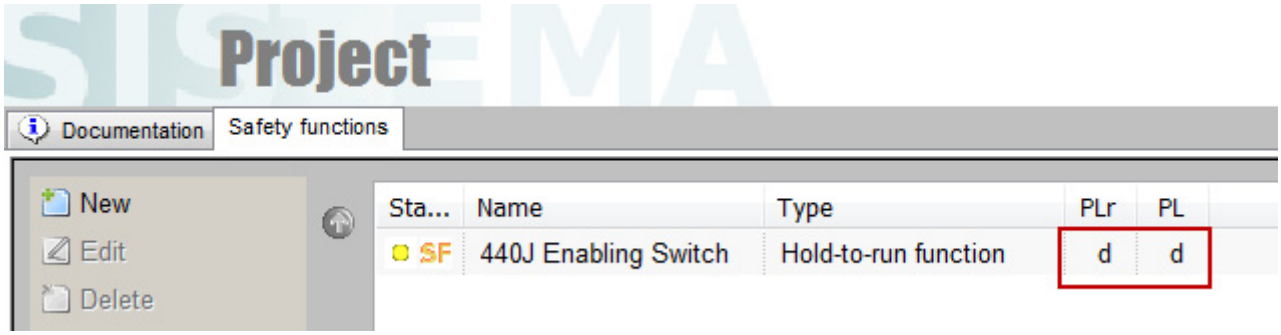
The final two rungs make sure that when the switch is being used, a rising edge of the jog button must be seen before the motion jog signal is sent to the control system. If the jog button is released, the safety contactors are not dropped out and simply pressing the jog button again resends the motion jog signal.

If the switch is squeezed too much, or released, then the contactors drop out. To recover, the jog button must be released, the enabling switch squeezed to the middle position (energizing the contactors), and then the jog button must be pressed again to resend the motion jog signal.

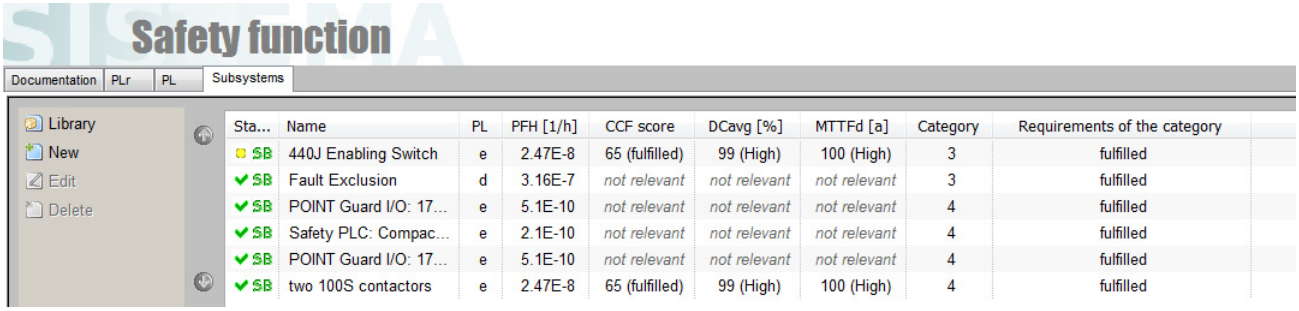

0
DCS
Dual Channel Input Stop
DCS Zone2_Door
Safety Function SAFETY GATE
Input Type EQUIVALENT - ACTIVE HIGH
Discrepancy Time (Msec) 250
Restart Type AUTOMATIC
Cold Start Type AUTOMATIC
Channel A AENT:1:I.Pt00Data
0
Channel B AENT:1:I.Pt01Data
0
Input Status AENT:1:I.CombinedInputStatus
0
Reset AENT:1:I.Pt05Data
0
O1
FP
1
DCSRT
Dual Channel Input Start
DCSRT Zone2_Enable_Pendant
Safety Function ENABLE PENDANT
Input Type EQUIVALENT - ACTIVE HIGH
Discrepancy Time (Msec) 250
Enable Slow_Machine_Mode
0
Channel A AENT:1:I.Pt02Data
0
Channel B AENT:1:I.Pt03Data
0
Input Status AENT:1:I.CombinedInputStatus
0
Reset AENT:1:I.Pt05Data
0
O1
FP
2
AENT:1:I.Pt04Data
OSF
One Shot Falling
Storage Bit Wrk_Zone2_OSF
Output Bit Wrk_Zone2_FallingEdge
SB
OB
3
Wrk_Zone2_FallingEdge
Zone2_Door.O1
Zone2_K1K2.FP
Door_OK
Door_OK
4
Door_OK
Zone2_Enable_Pendant.O1
Energize_K1K2
5
CROUT
Configurable Redundant Output
CROUT Zone2_K1K2
Feedback Type NEGATIVE
Feedback Reaction Time (Msec) 500
Actuate Energize_K1K2
0
Feedback 1 AENT:1:I.Pt07Data
0
Feedback 2 AENT:1:I.Pt07Data
0
Input Status AENT:1:I.CombinedInputStatus
0
Output Status AENT:2:I.CombinedOutputStatus
0
Reset AENT:1:I.Pt05Data
0
O1
O2
FP
6
Zone2_K1K2.O1
Zone2_K1K2.O2
AENT:2:O.Pt00Data
AENT:2:O.Pt01Data

Calculation of the Performance Level

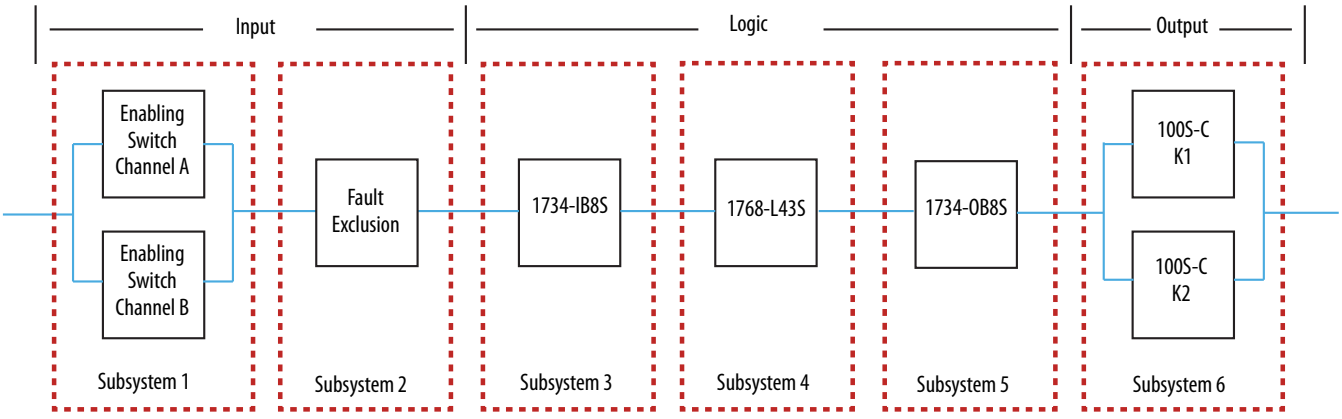
When properly implemented, this safety function can achieve a safety rating of Category 3, Performance Level d (CAT. 3, PLd), according to ISO 13849-1: 2008, as calculated by using the Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA).



The graphic displays the overall performance level achieved by each subsystem.



The enabling switch safety function can be modeled as follows.



Because these devices are electromechanical devices, the safety contactor data includes the following:

- Mean Time to Failure, dangerous (MTTFd)
- Diagnostic Coverage (DCavg)
- Common Cause Failure (CCF)

Functional safety evaluations of the electromechanical devices include the following:

- How frequently they are operated
- Whether they are effectively monitored for faults
- Whether they are properly specified and installed

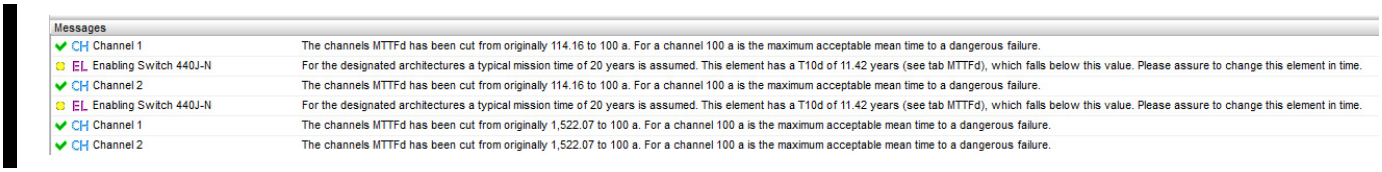
SISTEMA calculates the MTTFd by using B10d data provided for the contactors along with the estimated frequency of use, entered during the creation of the SISTEMA project.

The DCavg (99%) for the contactors is selected from the Output Device table of ISO 13849-1 Annex E, Direct Monitoring.

The CCF value is generated by using the scoring process outlined in Annex F of ISO 13849-1. The complete CCF scoring process must be performed when actually implementing an application. A minimum score of 65 must be achieved.

The enabling switch has a single, mechanical actuator. Therefore, per annex D.8 of ISO13849-2 2012, a fault exclusion cannot be allowed. To account for this situation, Subsystem 2 (fault exclusion) is included in the SISTEMA calculations.

Note that a message has been added regarding the mission time of enabling switch elements (EL). An estimated annual number of 8760 cycles, one per hour, 24 hours a day, 365 days a year, was used to calculate the MTTFd. The note indicates that at that rate of use, the enabling switch should be replaced after 11.42 years of use.



Messages	
CH Channel 1	The channels MTTFd has been cut from originally 114.16 to 100 a. For a channel 100 a is the maximum acceptable mean time to a dangerous failure.
EL Enabling Switch 440J-N	For the designated architectures a typical mission time of 20 years is assumed. This element has a T10d of 11.42 years (see tab MTTFd), which falls below this value. Please assure to change this element in time.
CH Channel 2	The channels MTTFd has been cut from originally 114.16 to 100 a. For a channel 100 a is the maximum acceptable mean time to a dangerous failure.
EL Enabling Switch 440J-N	For the designated architectures a typical mission time of 20 years is assumed. This element has a T10d of 11.42 years (see tab MTTFd), which falls below this value. Please assure to change this element in time.
CH Channel 1	The channels MTTFd has been cut from originally 1,522.07 to 100 a. For a channel 100 a is the maximum acceptable mean time to a dangerous failure.
CH Channel 2	The channels MTTFd has been cut from originally 1,522.07 to 100 a. For a channel 100 a is the maximum acceptable mean time to a dangerous failure.

Verification and Validation Plan

Verification and validation play important roles in the avoidance of faults throughout the safety system design and development process. ISO 13849-2 sets the requirements for verification and validation. The standard calls for a documented plan to confirm that all of the safety functional requirements have been met.

Verification is an analysis of the resulting safety control system. The Performance Level (PL) of the safety control system is calculated to confirm that the system meets the required Performance Level (PLr) specified. The SISTEMA software is typically used to perform the calculations and assist with satisfying the requirements of ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that the system meets the specified requirements of the safety function. The safety control system is tested to confirm that all of the safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions in addition to potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

Prior to validating the system, confirm that the Compact GuardLogix controller has been wired and configured in accordance with the installation instructions. For information about how to wire and configure the controller, see the publications listed in the Additional Resources.

Verification and Validation Checklist

General Machinery Information			
Machine Name/Model Number			
Machine Serial Number			
Customer Name			
Test Date			
Tester Name(s)			
Schematic Drawing Number			
Controller Name			
Safety Signature ID			
Safety Network Number(s)			
RSLogix 5000 Software Version			
Safety Control System Modules			**Firmware Revision**
GuardLogix Safety Controller	1768-L43S		
CompactLogix Ethernet Bridge	1768-ENBT		
POINT Guard I/O Ethernet Adapter	1734-AENT		
POINT Guard I/O Input Modules	1734-IB8S		
POINT Guard I/O Output Modules	1734-OB8S		
GuardLogix Safety System Configuration and Wiring Verification			
Test Step	**Verification**	**Pass/Fail**	**Changes/Modifications**
1	Verify that the safety system has been designed in accordance with the GuardLogix Controller System Safety Reference Manual, listed in the Additional Resources.		
2	Verify that the safety application program has been designed in accordance with the GuardLogix Safety Application Instruction Safety Reference Manual, publication 1756-RM095.		
3	Visually inspect the safety system network to verify that the I/O is wired as documented in the schematics.		
4	Visually inspect the application program to verify that the safety system network and I/O module configuration is configured as documented.		
5	Visually inspect the application program to verify suitable safety certified instructions are used, and that the logic is readable, understandable, and testable with the aid of clear comments.		
6	Verify that all input devices are qualified by cycling their respective actuators. Monitor the status in the RSLogix 5000 Controller Tags window.		
7	Verify that all output devices are qualified by cycling their respective actuators. Monitor the status in the Controller Tags window.		
Normal Operation Verification - The GuardLogix safety system properly responds to all normal Start, Stop, Enabling, and Reset commands.			
Test Step	**Verification**	**Pass/Fail**	**Changes/Modifications**
1	Initiate a Start command. Both contactors should energize for a normal machine run condition. Verify proper machine status indication and safety application program indication.		
2	Initiate a Stop command. Both contactors should de-energize for a normal machine Stop condition. Verify proper machine status indication and safety application program indication.		

Verification and Validation Checklist

3	While the system is stopped, and with the door interlock switch open, remove the enabling switch from the interlocked storage station. Both contactors should remain de-energized and open for a normal, safe condition. Verify proper machine status indication and safety application program indication.		
4	While the system is stopped, engage the enabling switch. Both contactors should remain de-energized and open for a normal, safe condition until the Jog button is pressed. Verify proper machine status indication and safety application program indication.		
5	While the system is stopped, engage the enabling switch to the middle position and repeatedly press the Jog button. Both contactors should energize when the Jog button is pressed and de-energize when it is released. Verify proper machine status indication and safety application program indication.		
6	While the system continues to jog, fully release the enabling switch. Both contactors should de-energize and open for a normal, safe condition. Verify proper machine status indication and safety application program indication. Repeat for the fully-engaged position.		
7	Initiate Reset command. Both contactors should remain de-energized. Verify proper machine status indication and safety application program indication.		
Validation of Safe Response to Abnormal Operation - The GuardLogix safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Enabling Switch Input Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the system continues to jog, remove the enabling switch Channel 1 wire from the safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify that the system is unable to reset and restart with fault. Restore Channel 1 and repeat for Channel 2.		
2	While the system continues to jog, short the enabling switch Channel 1 of the safety I/O to 24V DC. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault. Restore Channel 1 and repeat for Channel 2.		
3	While the system continues to jog, short the enabling switch Channel 1 of the safety I/O to 0V DC. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault. Restore Channel 1 and repeat for Channel 2.		
4	While the system continues to jog, short the enabling switch Channels 1 and 2 of the safety I/O. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault. Restore Channel 1 and 2 wiring.		
5	While the system continues to jog, remove the enabling switch Channel 1 wire from the Safety I/O. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault. Restore Channel 1 and repeat for Channel 2.		
6	While the system continues to jog, short the enabling switch Channel 1 of the safety I/O to 24V DC. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault. Restore Channel 1 and 2 wiring.		
7	While the system continues to jog, short the enabling switch Channel 1 of the safety I/O to 0V DC. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault. Repeat for Channel 2.		
8	While the system continues to jog, short the enabling switch Channels 1 and 2 of the safety I/O. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault.		

Verification and Validation Checklist

9	While the system continues to jog, short Channel 1 to Test Source 1 of the safety I/O. Press the enabling switch. Both contactors should de-energize. Verify proper machine status indication and safety application program indication. Verify that the system is unable to reset and restart with fault.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
GuardLogix Controller and Network Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the system continues to run, remove the Ethernet network connection between the safety I/O and the controller. All contactors should de-energize. Verify proper machine status indication and I/O connection status in the safety application program.		
2	Restore the safety I/O module network connection and allow time to re-establish communication. Verify the connection status bit in the safety application program. Repeat for all safety I/O connections.		
3	While the system continues to run, switch the controller out of Run mode. All contactors should de-energize. Return the key switch back to Run mode. All contactors should remain de-energized. Verify proper machine status indication and safety application program indication.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Safety Contactor Output Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	Initiate a Start command. Both contactors should energize for a normal machine run condition. Verify proper machine status indication and safety application program indication.		
2	While the system continues to run, remove the contactor feedback from the safety I/O. All contactors should remain energized. Initiate a Stop command and attempt a Reset command. The system should not restart or reset. Verify proper machine status indication and safety application program indication.		
3	While the system continues to run, short the contactor feedback to the safety I/O. All contactors should remain energized. Initiate a Stop command and attempt a Reset command. The system should not restart or reset. Verify proper machine status indication and safety application program indication.		

Additional Resources

These documents contain more information about related products from Rockwell Automation.

Resource	Description
Compact GuardLogix Controllers User Manual, publication 1768-UM002	Provides information on how to configure, operate, and maintain Compact GuardLogix controllers.
POINT Guard I/O Safety Modules User Manual, publication 17 34-UM013	Provides information on how to install, configure, and operate POINT Guard I/O safety modules.
GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093	Contains detailed requirements for how to achieve and maintain safety ratings with the Compact GuardLogix controller system in an RSLogix 5000 project.
GuardLogix Controllers User Manual, publication 1756-UM020	Provides information on how to install, configure, operate, and maintain a GuardLogix 5560 or 5570 controller in RSLogix 5000 projects.
GuardLogix 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to install, configure, operate and maintain a GuardLogix 5570 controller in the Studio 5000® environment.
GuardLogix 5570 Controller Systems Safety Reference Manual, publication 1756-RM099	Contains detailed requirements for how to achieve and maintain safety ratings with the GuardLogix 5570 controller system in the Studio 5000 environment.
GuardLogix Safety Application Instruction Set Safety Reference Manual, publication 1756-RM095	Provides detailed information on the GuardLogix safety application instruction set.
Safety Accelerator Toolkit Quick Start, publication IASIMP-QS005	Provides a step-by-step guide on how to use the design, programming, and diagnostic tools in the safety accelerator toolkit.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines on how to install a Rockwell Automation® industrial system.
Safety Products Catalog, publication S117-CA001 Website http://www.rockwellautomation.com/rockwellautomation/catalogs/overview.page	Provides information about Rockwell Automation safety products.
Product Certifications website, available from the Product Certifications link on http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

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.

Notes:

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

For more information on Safety Function Capabilities, visit:

http://marketing.rockwellautomation.com/safety/en/safety_functions

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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Publication SAFETY-AT055D-EN-P - January 2016
Supersedes Publication SAFETY-AT055C-EN-P - November 2015