Application Technique

Allen-Bradley

Actuator Subsystems – Stop Cat. 0 or 1 via an Integrated Safety Controller and PowerFlex 527 Drive with Hardwired Safe Torque Off Safety Function

Products: GuardLogix 5570 or Compact GuardLogix 5370 Controller, PowerFlex 527 Drive

Safety Rating: Cat. 3, PLe to ISO 13849-1: 2008




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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).

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 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 take into consideration safety distance calculations, which are not part of the scope of this document.

Contact Rockwell Automation to find out 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 often must take into consideration 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)

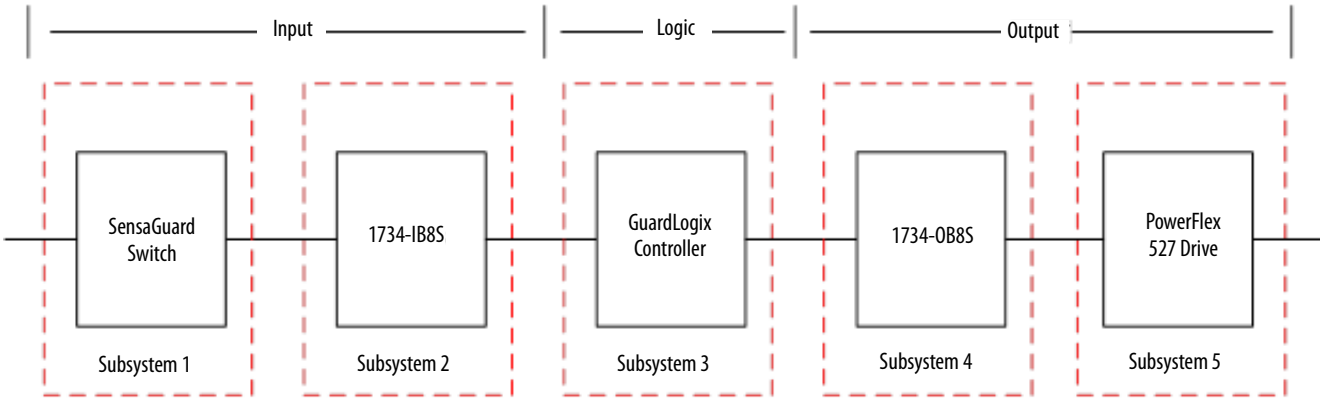
ANSI B11:19 2010 (Machines – Performance Criteria for Safeguarding)

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

Introduction

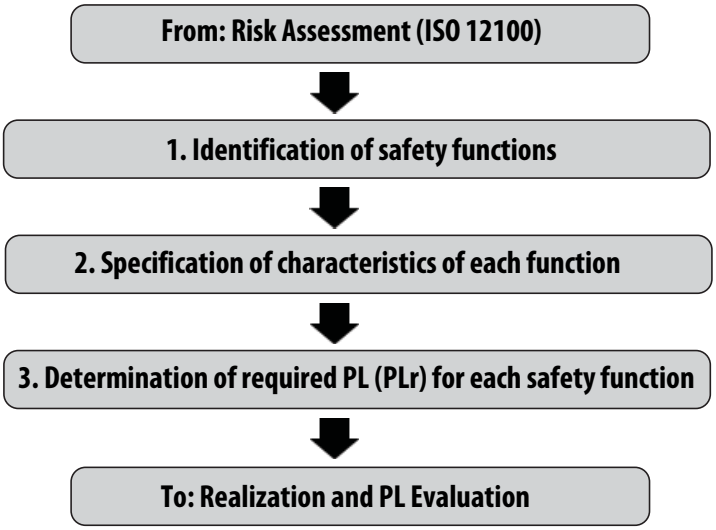
This safety function application technique is concerned primarily with the logic and output subsystems of a safety system. The document illustrates how to combine a GuardLogix® controller with a PowerFlex® 527 drive to provide a stop category 0 (remove power, coast to stop) or stop category 1 (controlled stop, remove power) via a hardwired connection to the Safe Torque Off (STO) inputs of the drive.

In an actual application, any typical, safety-input device can be used as the input subsystem if properly applied. A SensaGuard™ switch, as in Door-monitoring Interlock Switch with an Integrated Safety Controller Safety Function Application Technique, publication SAFETY-AT034, is used as a convenient example of an input subsystem in this document.



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.



Stop Safety Functions

This application technique includes two safety functions:

- Safety-related stop function initiated by a safeguard
- Prevention of an unexpected startup

Safety Function Requirements

The following sections describe the safety functions that are used in this application technique.

Safety-related Stop Function Initiated by a Safeguard

When a partial-access guard door is opened, the input subsystem initiates and maintains a stop command for the safety system to stop hazardous motion before a person can reach the hazardous area. The stop command cannot be reset until the guard door is closed.

Prevention of an Unexpected Startup

The safety system cannot be reset, and hazardous motion cannot be restarted while the guard door is open. Once the guard door is closed and the stop command is reset, a second action (pressing a Start button) is required before the hazardous motion can resume.

IMPORTANT	The vendor must provide probability of failure per hour (PFH) and all relevant functional safety data for all subsystems of this safety system necessary to prove that the overall safety functions meet the requirements for Performance Level d (PLd), per ISO 13849-1.

The safety functions in this application technique each meet or exceed the requirements for Category 3, Performance Level d (Cat. 3, PLd), per ISO 13849-1 and control reliable operation per ANSI B11.19.

Considerations for Safety Distance and Stopping Performance

Based on the selection of a sensor subsystem, the risk assessment determines if a safety distance calculation is required. Typically, a safety distance calculation is required if a non-separating sensor subsystem (such as a light curtain) is selected for the safety function. If a safety distance calculation is required for this safety function, the following documents can be referenced:

- GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication1756-RM099
- SafeBook 4 – Safety related control systems for machinery, publication SAFEBK-RM002
- Safety Function: Light Curtain Products: Light Curtain GuardLogix® Controller, publication SAFETY-AT056

Functional Safety Description

The GuardLogix controller and PowerFlex 527 drive with integrated Safe Torque Off use 1oo2 architecture to achieve the PFH values that are used in the PL calculation verification section of this document.

The GuardLogix controller logic monitors its safety inputs for valid status and faults. The controller monitors its internal circuitry for proper operation and faults. The controller monitors the 1734-IB8S inputs for valid status and faults. The controller logic monitors the 1734-OB8S safety module for proper, valid status and faults. When it receives a safety demand on its inputs or an invalid status or fault is detected, the GuardLogix controller logic deactivates its safety outputs and sends a safety stop command.

The PowerFlex 527 drive monitors its internal safety circuits for valid status and faults. When the GuardLogix controller de-energizes the drive STO inputs, or an invalid state or fault is detected, the STO feature of the drive forces the drive output power transistors to a disabled state. The hazardous motion that is controlled by the drive coasts or ramps to a stop. This feature does not provide electrical power isolation.

Hardwired Safety: Safe Torque Off Considerations for a Stop Category 1

In the event of a malfunction, it is possible that stop category 0 may occur. When designing the machine application, timing and distance must be considered for a coast to stop, as well as the possibility of the loss of control of a vertical load. The nature of a malfunction causing this condition could be if a hardwired STO input to the drive were to go low (that is, a wire falls off) before the drive has a chance to completely stop the motor. Use additional protective measures if this occurrence might introduce unacceptable risks to personnel.

Bill of Material

The logic and output subsystems in this document use these products.

Cat. No.	Description	Quantity
25C-V2P5N104	PowerFlex 527 drive, 120V AC, 2.5A, frame A	1
1783-US05T	Stratix® 2000 unmanaged Ethernet switch	1
1734-AENT	POINT I/O™ EtherNet/IP communication adapter	1
1734-TB	Module base with removable IEC screw terminals	4
1734-IB8S	POINT Guard I/O™ input safety module 24V DC	1
1734-OB8S	POINT Guard I/O output safety module 24V DC	1
800FM-G611MX10	800F reset push button, metal, guarded, blue, R, metal latch mount, one normally open contact, standard	2

Choose either the GuardLogix 5570 hardware list or the Compact GuardLogix 5370 hardware list.

Controller	Cat. No.	Description	Quantity
GuardLogix 5570	1756-L71S 1756-L72S 1756-L73S	GuardLogix processor, 2.0 MB standard memory, 1.0 MB safety memory, or GuardLogix processor, 4.0 MB standard memory, 2.0 MB safety memory, or GuardLogix processor, 8.0 MB standard memory, 4.0 MB safety memory	1
	1756-L7SP	GuardLogix Safety Partner	1
	1756-EN2TR	ControlLogix® EtherNet/IP bridge, 10/100 Mbps, two-port, twisted-pair media	1
	1756-PA72	Power supply, 120/240V AC input, 3.5 A @ 24V DC	1
	1756-A7	Seven-slot ControlLogix® chassis	1
Compact GuardLogix 5370	1769-L30ERMS 1769-L33ERMS 1769-L36ERMS	Compact GuardLogix processor, 1.0 MB standard memory, 0.5 MB safety memory, or Compact GuardLogix processor, 2.0 MB standard memory, 1.0 MB safety memory, or Compact GuardLogix processor, 3.0 MB standard memory, 1.5 MB safety memory	1
	1769-PA4	Power supply, 120V/220V AC input, 2.0 A @ 24V DC	1

Setup and Wiring

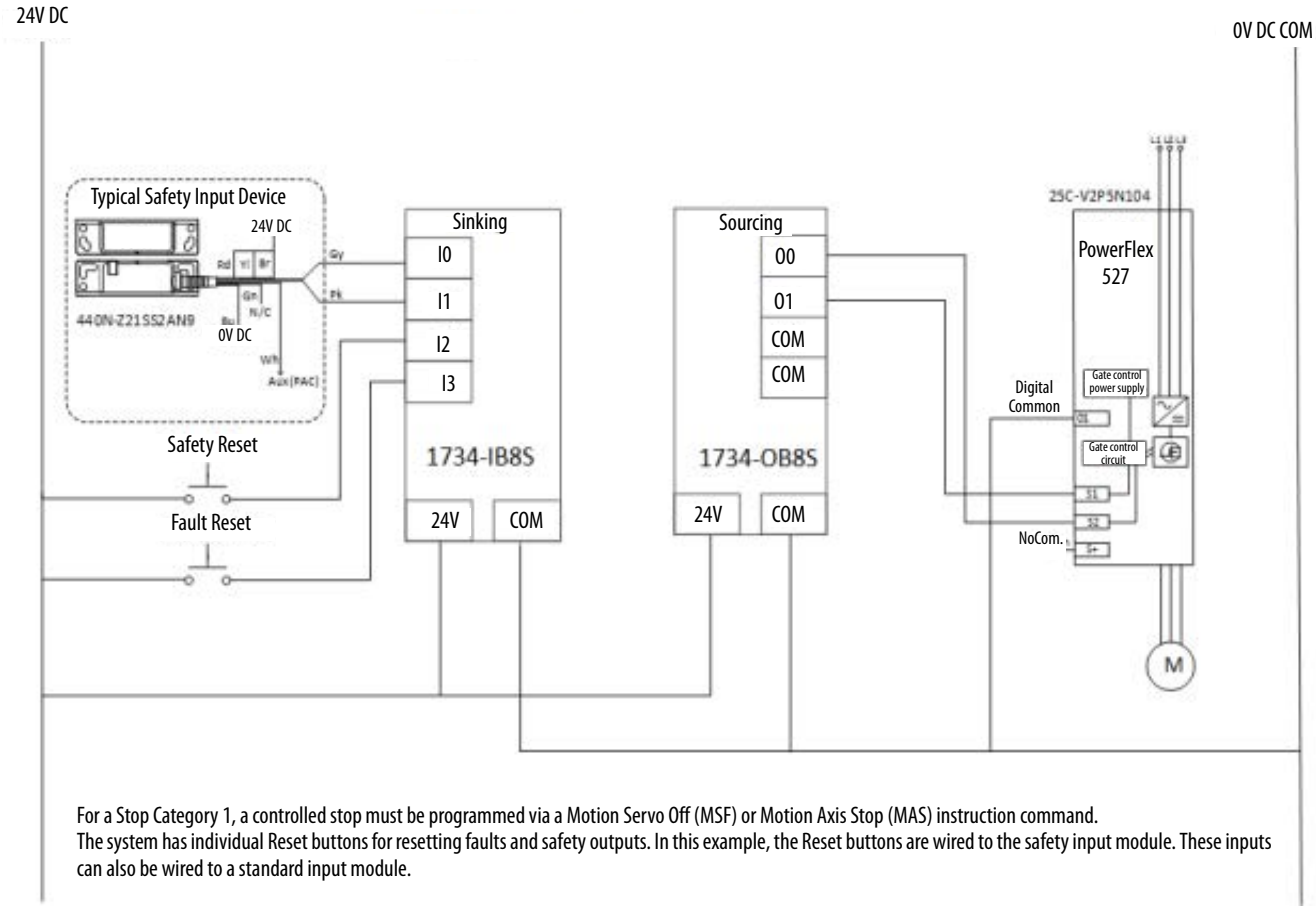
For detailed information on installing and wiring, refer to the publications listed in the Additional Resources on the back cover.

System Overview

The 1734-IB8S input module monitors the inputs from the safety input device, for example, a SensaGuard switch. The SensaGuard switch uses OSSD outputs, which conduct periodic testing of the outputs. Thus, it is the OSSD outputs that are testing the integrity of the wiring between the SensaGuard switch and the safety inputs. The final control device is the PowerFlex 527 drive. The S1 and S2 terminals of the drive are controlled by the 1734-OB8S safety output module. This is accomplished by using a Configurable Redundant Output (CROUT) instruction. The system is reset by a momentary push button from an HMI or physical button.

Electrical Schematic

Figure 1 - Stop Category 0 and 1



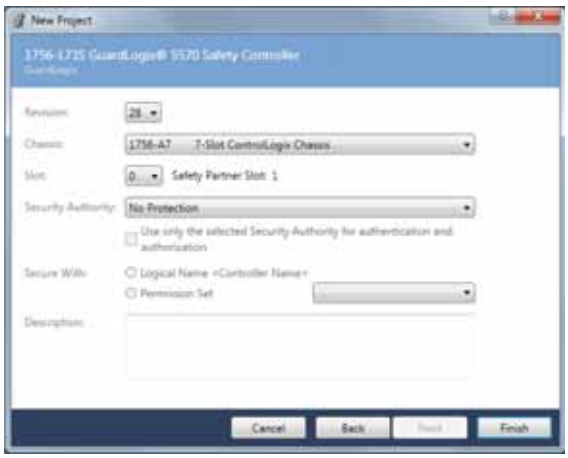
For a Stop Category 1, a controlled stop must be programmed via a Motion Servo Off (MSF) or Motion Axis Stop (MAS) instruction command.
The system has individual Reset buttons for resetting faults and safety outputs. In this example, the Reset buttons are wired to the safety input module. These inputs can also be wired to a standard input module.

Configuration

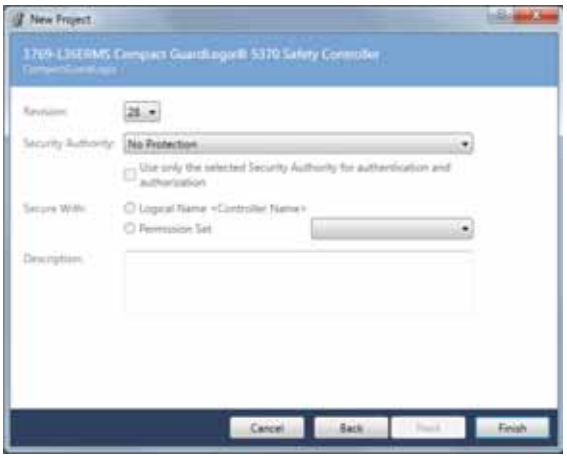
The following sections describe how to configure the GuardLogix controller, the POINT Guard I/O modules, and the PowerFlex drive by using the Studio 5000 Logix Designer® application, version 24 or later. If your application uses a Compact GuardLogix 5370 controller, version 28 or later of the Studio 5000 Logix Designer application is required. A detailed description of each step is beyond the scope of this document. Knowledge of the Logix Designer application is assumed.

Configure the Controller and Add I/O Modules

1. In Logix Designer, create a project with a GuardLogix controller.

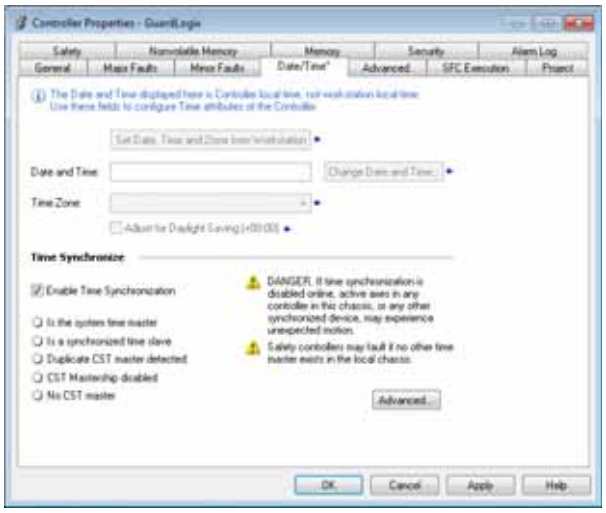


GuardLogix 5570 Controller

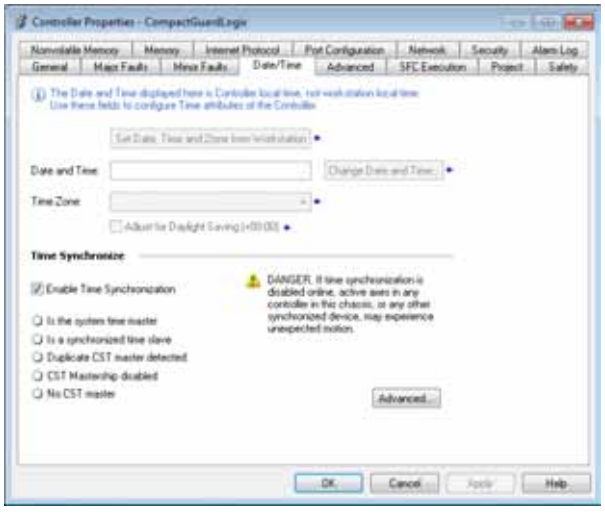


Compact GuardLogix 5370 Controller

2. Enable Time Synchronization for the controller.

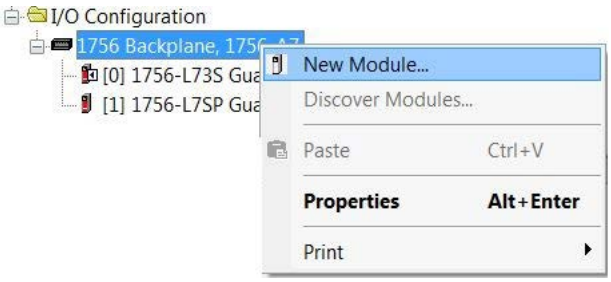


GuardLogix 5570 Controller

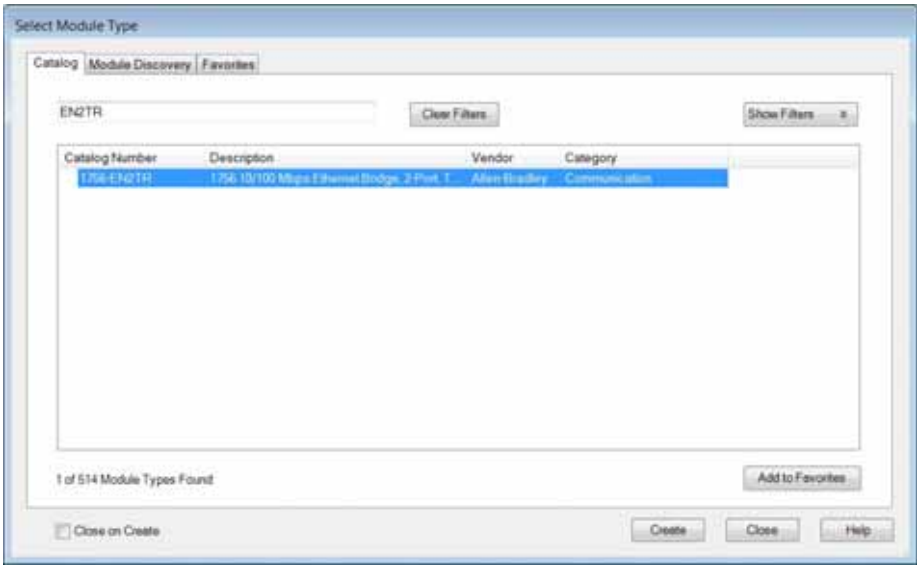


Compact GuardLogix 5370 Controller

3. If you are using a Compact GuardLogix 5370 controller, skip to step 9. Otherwise, in the Controller Organizer, add the 1756-EN2TR module to the 1756 Backplane.

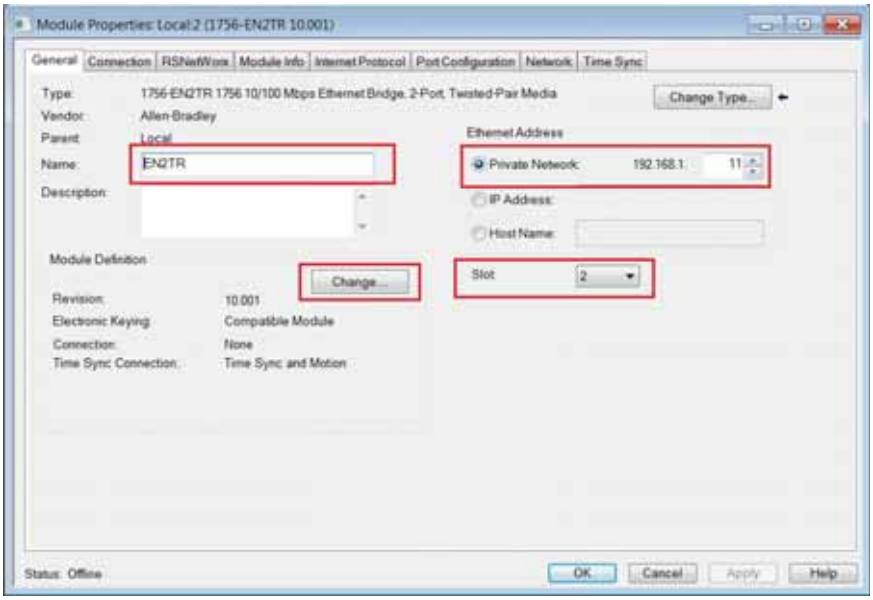


4. Type EN2TR into the filter section, select catalog number 1756-EN2TR, and click Create.

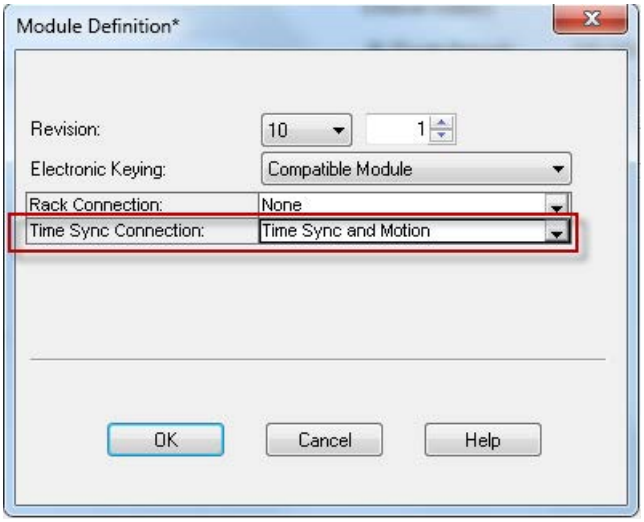


The 1756-EN2TR properties dialog box appears.

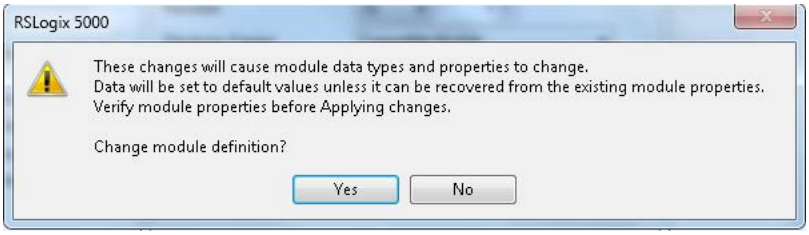
5. On the General tab, do the following:
   a. Name the module.
   b. Type its IP address.
      This example uses 192.168.1.11 for the IP address. Your IP address can differ.
   c. Select the proper slot.
   d. Click Change to modify the Module Definition.



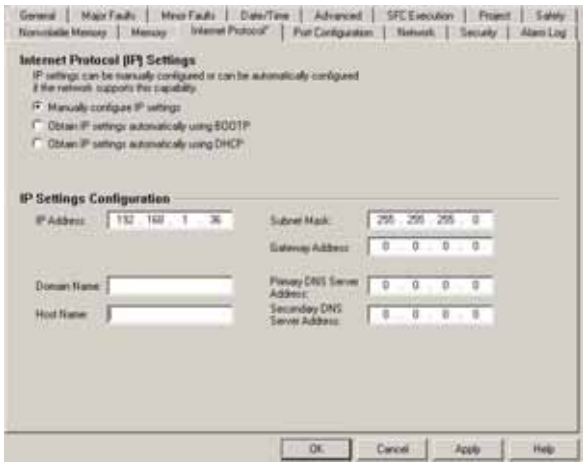
6. In the Module Definition dialog box, set the Time Sync Connection to Time Sync and Motion, and click OK.



7. Click Yes to confirm the changes.

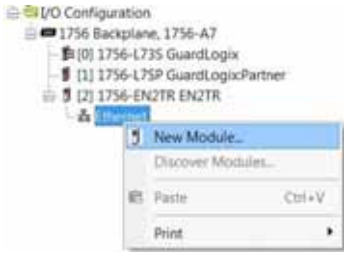


8. Click OK to save the changes and close the Select Module Type dialog box.
9. If you are using a Compact GuardLogix 5370 controller, set the IP address. Otherwise, skip this step.

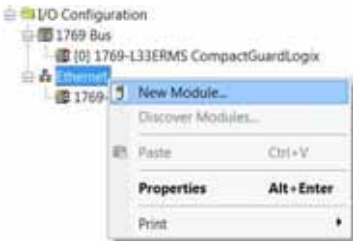


This example uses 192.168.1.36 as the IP address. Your IP address can differ.

10. Right-click the Ethernet connection and choose New Module.

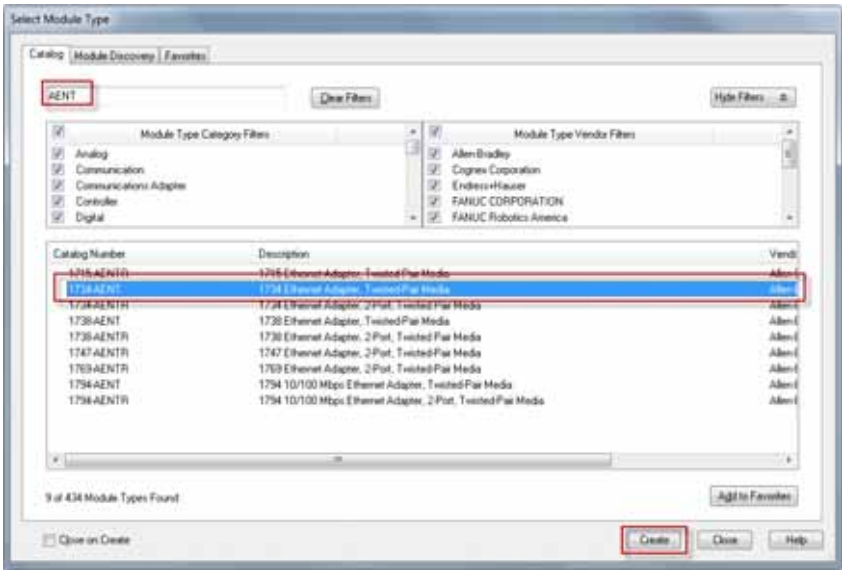


GuardLogix 5570 Controller Organizer



Compact GuardLogix 5370 Controller Organizer

11. In the Select Module Type dialog box, do the following:
    a. Type AENT into the filter box.
    b. Select the 1734-AENT catalog number for the POINT I/O Ethernet adapter.
    c. Click Create.



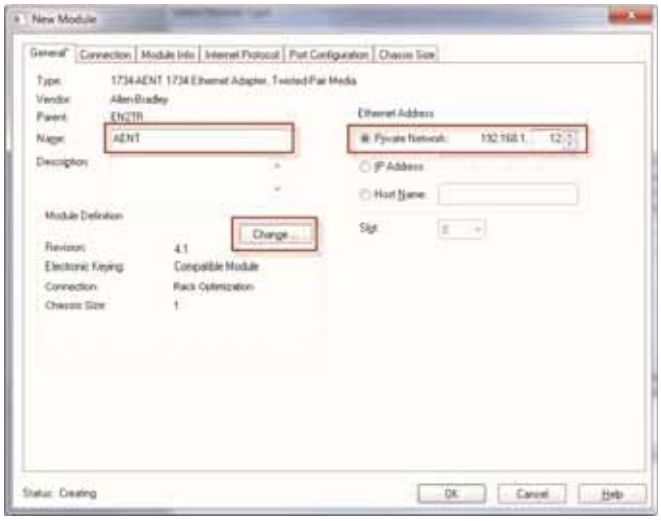
12. In the New Module dialog box, do the following:

a. Name the module.

b. Type its IP address.

This example uses 192.168.1.12 for the IP address. Your IP address can differ.

c. Click Change.



13. In the Module Definition dialog box, do the following:

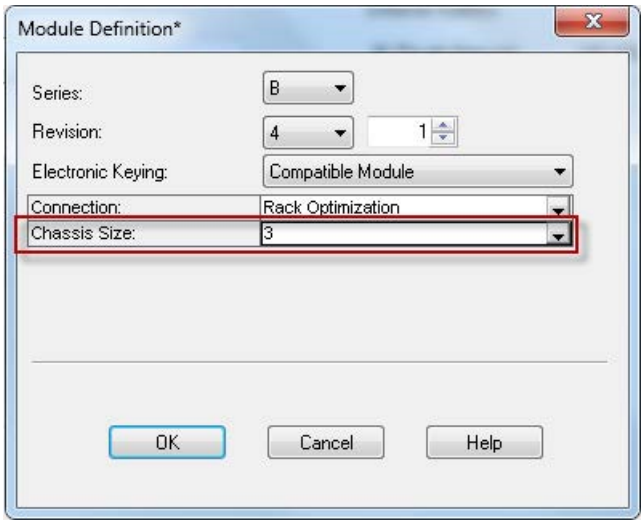
a. Set the Chassis Size as 3 for the 1734-AENT adapter.

Chassis size equals one for the adapter, plus the number of POINT I/O modules installed (physically present on the POINT I/O backplane). Therefore, for one input and one output module, the chassis size is 3.

b. Click OK.

c. Click Yes to confirm changes.

d. Click OK to complete module creation.



14. Right-click the PointIO 3 Slot Chassis and choose New Module.

GuardLogix 5570 Controller Organizer

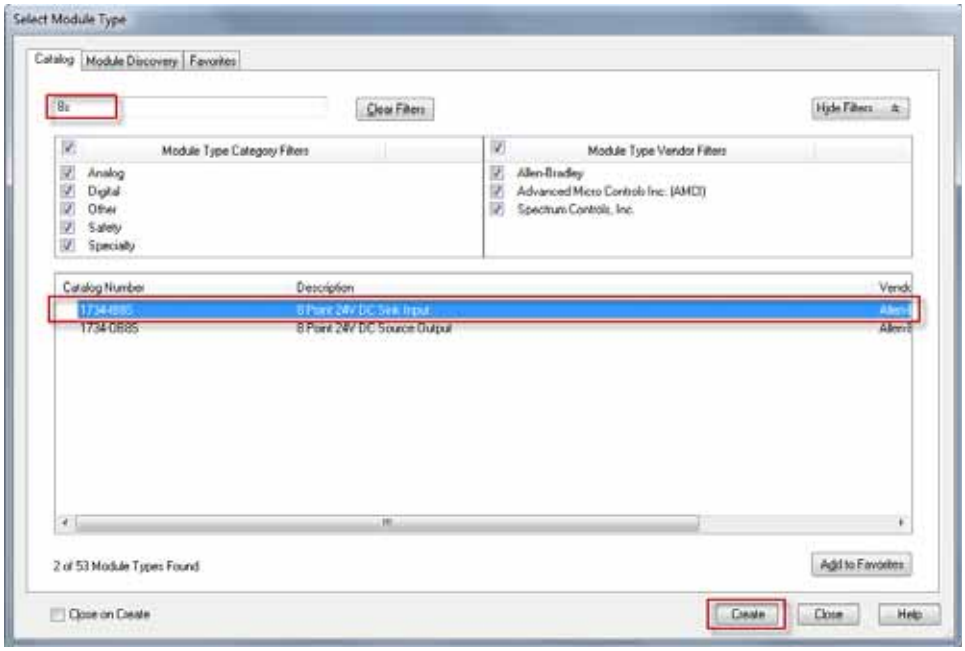
Compact GuardLogix 5370 Controller Organizer

15. In the Select Module Type dialog box, do the following:

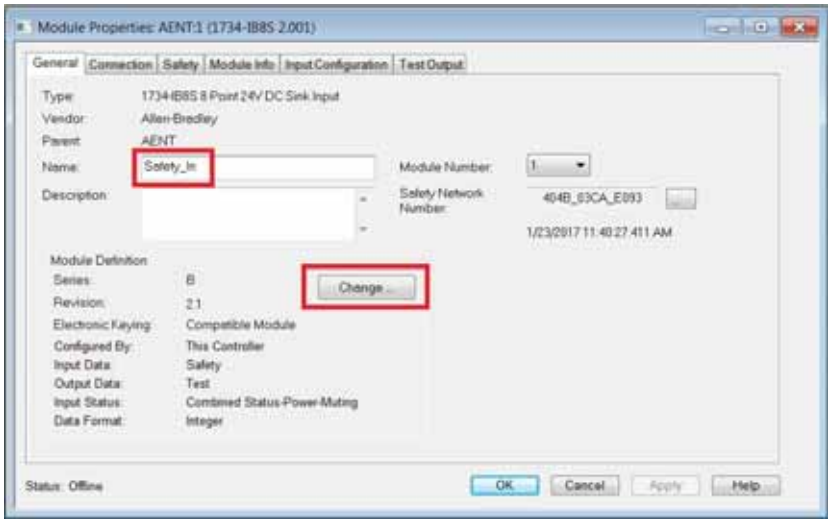
a. Type 8s in the filter field.

b. Select catalog number 1734-IBS.

c. Click Create.



16. In the New Module dialog box, name the device 'Safety_in' and click Change.



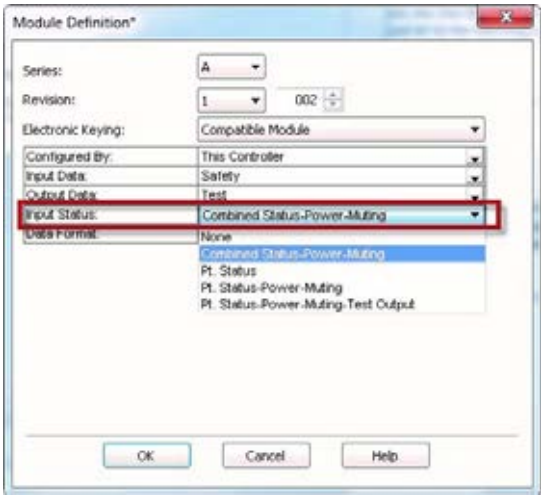
17. In the Module Definition dialog box, do the following:

a. Change the Input Status to Combined Status-Power_Muting.

b. Click OK.

c. Click Yes to confirm the changes.

d. Click OK.



18. Repeat steps 15...17 to add the 1734-OB8S safety output module.

a. In the Module Properties dialog box, name the device 'Safety_Out' and click Change.

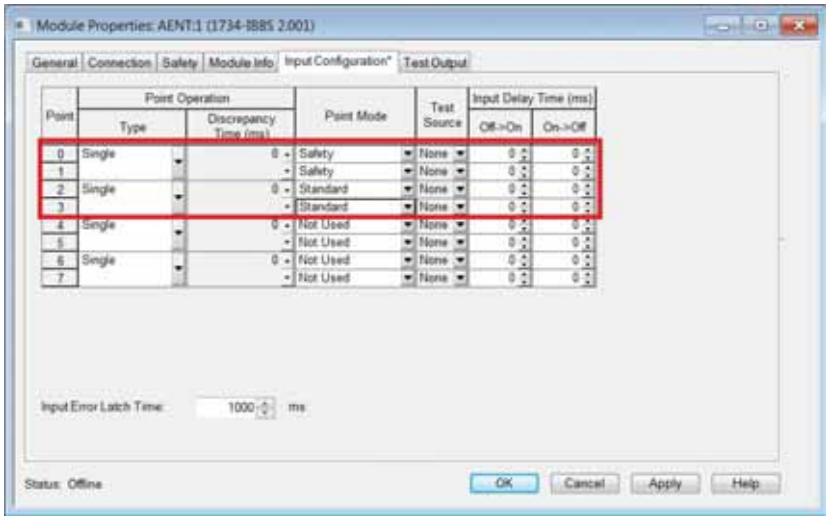
b. Change the Input Status to 'Combined Status-Readback-Power'.

19. Close the Select Module window once the 1734-OB8S module is added.

Configure the I/O Modules

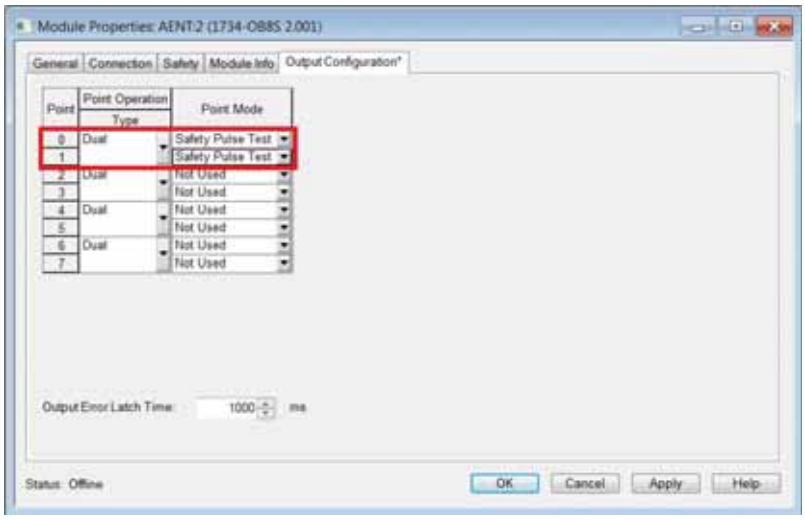
Follow these steps to configure the POINT Guard I/O modules.

1. Right-click the 1734-IB8S safety input module and select Properties.
2. Click the Input Configuration tab and configure the module as shown.



IMPORTANT Reset signals do not have to be wired to safety input modules. Therefore, the reset buttons wired to bits I2 and I3 are configured as standard input signals.

3. Click OK.
4. Right-click the 1734-OB8S safety output module and select Properties.
5. Click the Output Configuration tab and configure the module as shown.



6. Click OK.

Configure the PowerFlex 527 Drive

The PowerFlex 527 drive is configured by using the Studio 5000 Logix Designer® application, version 24 or later. A detailed description of how to fully configure the PowerFlex 527 drive is beyond the scope of this document. Knowledge of the Logix Designer application is assumed. See the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002, for further details.

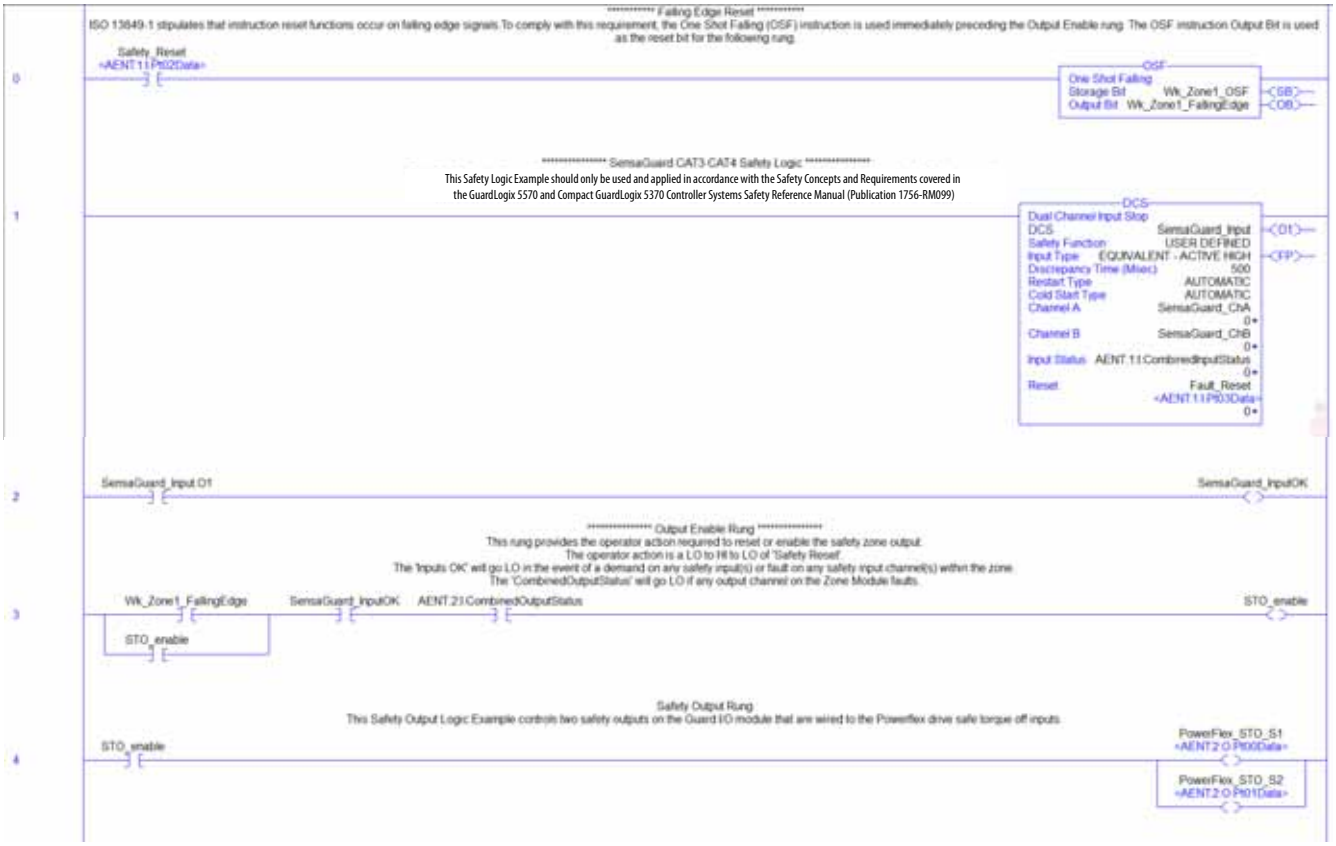
Programming

The following sections illustrate how to program a stop category 0 and a stop category 1.

Stop Category 0

The Dual Channel Input Stop (DCS) instruction monitors dual-input safety devices whose main function is to stop a machine safely, for example, an E-stop, light curtain, or safety gate. This instruction can only energize Output 1 when both safety inputs, Channel A and Channel B, are in the active state as determined by the Input Type parameter, and the correct reset actions are implemented. The DCS instruction monitors dual-input channels for consistency (Equivalent - Active High) and detects and traps faults when the inconsistency is detected for longer than the configured Discrepancy Time (ms).

The safety application code prevents outputs from restarting if the input channel resets automatically, providing anti-tie down functionality for the Circuit Reset. The InputOK status is used as a permissive to the safety outputs.

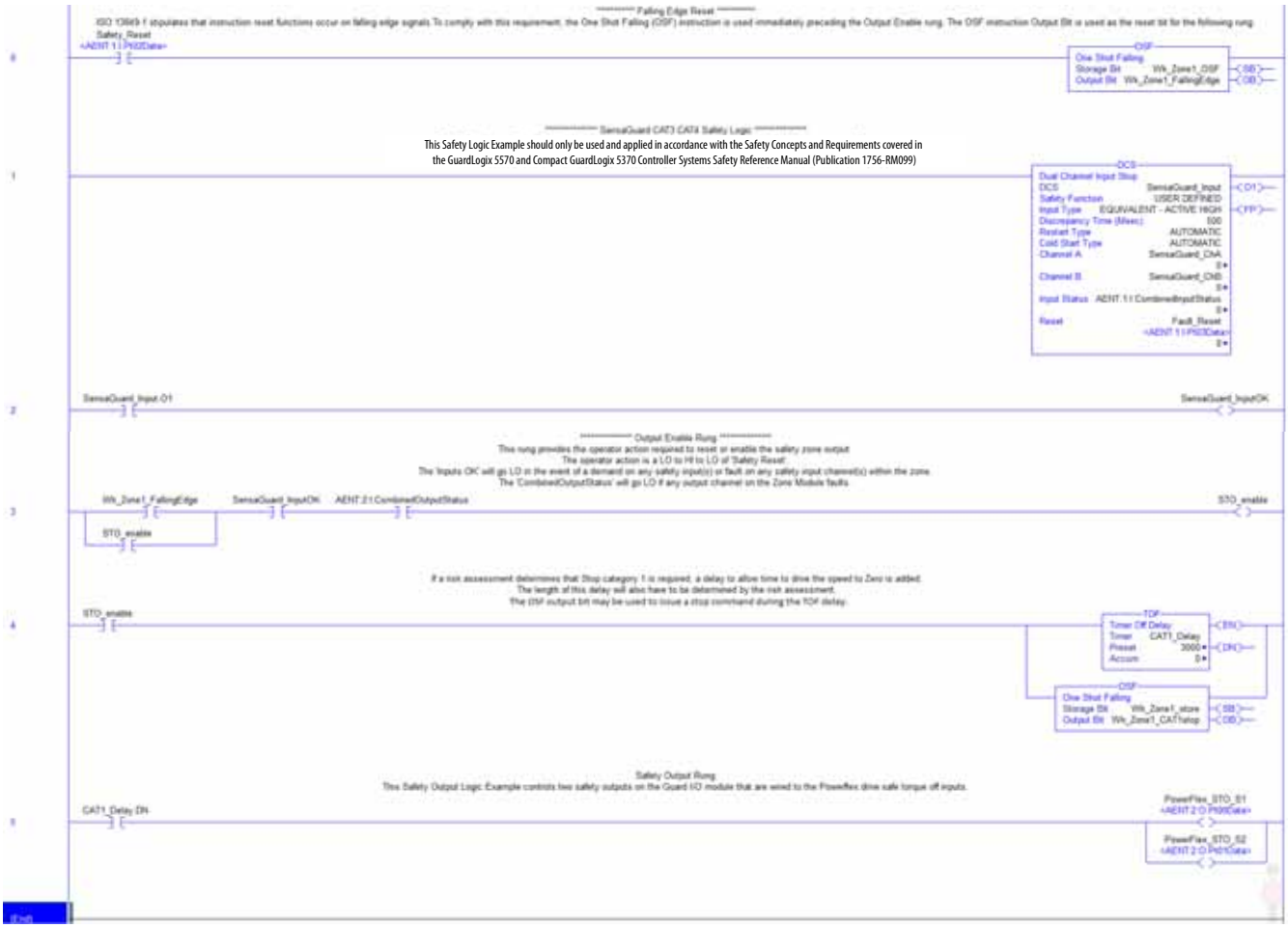


Stop Category 1

For general operation, the Dual Channel Input Stop (DCS) instruction monitors dual-input safety devices whose main function is to stop a machine safely, for example, an E-stop, light curtain, or safety gate. This instruction can only energize Output 1 when both safety inputs, Channel A and Channel B, are in the active state, as determined by the Input Type parameter, and the correct reset actions are implemented. The DCS instruction monitors dual-input channels for consistency (Equivalent - Active High) and detects and traps faults when the inconsistency is detected for longer than the configured Discrepancy Time (ms).

The safety application code prevents outputs from restarting if the input channel resets automatically, providing anti-tie down functionality for the Circuit Reset. The InputOK status is used as a permissive in the safety output routines.

This example uses a three-second time delay before dropping out the safety outputs to achieve stop category 1. Your delay must be determined during the safety engineering phase. The exact time is based on evaluation or testing to determine the proper Timer Off Delay (TOF) value necessary to ensure that the STO outputs are de-energized at the proper time. During this time delay, you must add additional code to attempt to drive the speed to zero. After the delay, the safety output is de-energized regardless of whether the speed has actually reached zero. If your system has zero-speed monitoring, you can drop the safety output when the speed reaches zero or the time delay expires.



Falling Edge Reset

ISO 13849-1 stipulates that instruction reset functions must occur on falling edge signals. To comply with this requirement, a One Shot Falling (OSF) instruction has been added and the OSF instruction Output Bit tag is used as the reset bit.

Calculation of the Performance Level

When properly implemented, the Power Flex 527 drive with hardwired Safe Torque Off (STO) can be used in a safety function that has a Performance Level required (PLr) rating of Category 3, Performance Level e (Cat. 3, PLe), according to ISO 13849-1: 2008, as calculated by using the Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA).

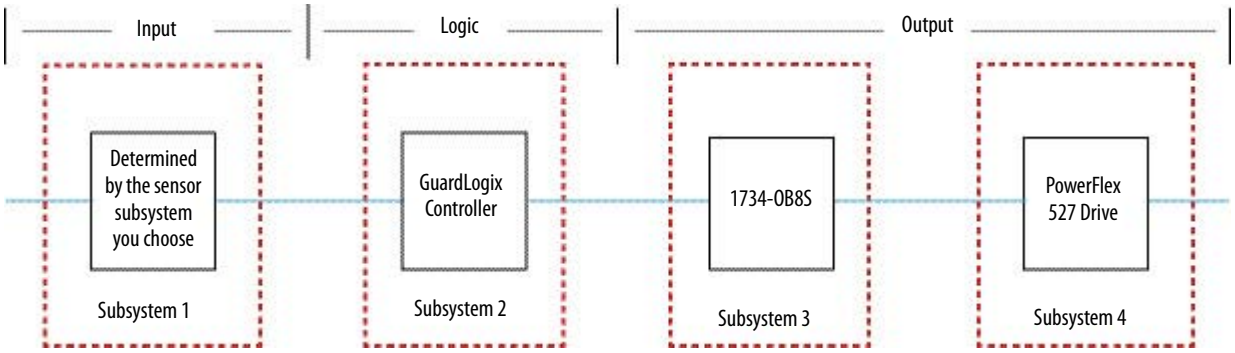
IMPORTANT To calculate the PL of your entire safety function, you must include the sensor subsystems along with the logic and actuator subsystems shown here. Depending on the sensor subsystems and devices you choose, the overall safety rating of your system could be reduced. An example that describes how to calculate the safety rating for a complete safety function appears in the section titled Complete Safety Function PL Calculation Example on page 20.

The functional safety data for the GuardLogix Controller, 1734-IB8S and 1734-OB8S modules, and the PowerFlex 527 drive is provided by the Rockwell Automation® SISTEMA library.

The (logic) GuardLogix 5570 controller subsystem uses 1.2% of PLe bandwidth. The (logic) Compact GuardLogix 5370 controller subsystem uses 1.5% of PLe bandwidth.

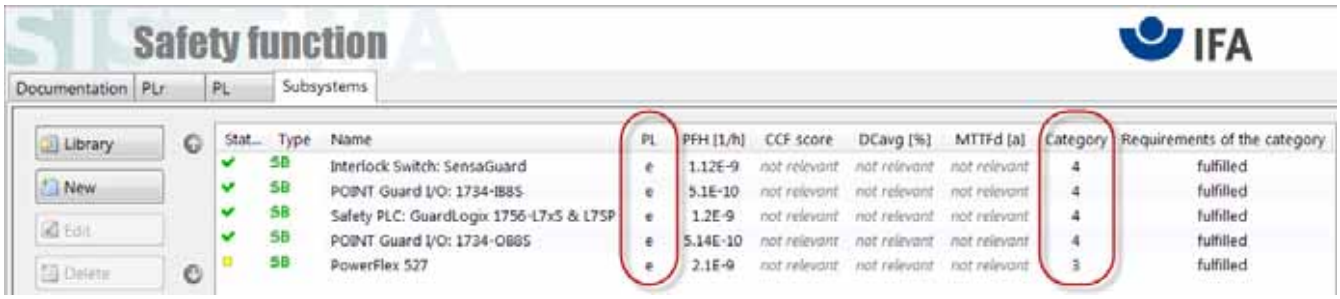
Sta...	Name	PL	PL-Softw...	PFHD [...	CCF score	MTTFD [a]	Category	Requirements of the category
✔ SB	Safety PLC: GuardLogix 1756-L7xS & L7SP	e	e	1.2E-9	*not relevant*	*not relevant*	4	fulfilled
✔ SB	Safety PLC: Compact GuardLogix 5370	e	e	1.5E-9	*not relevant*	*not relevant*	4	fulfilled

The overall safety system can be modeled as follows.



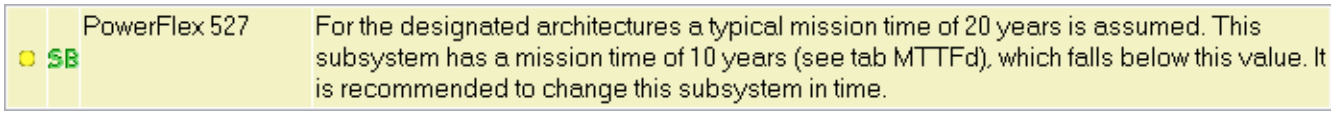
Complete Safety Function PL Calculation Example

The rest of the SISTEMA calculation in this document features a SensaGuard switch as an example of a typical safety input device. The functional safety data for the SensaGuard switch is also provided by the Rockwell Automation SISTEMA library. It also assumes the use of a Compact GuardLogix controller.



The PowerFlex 527 safety function achieves its necessary PLr.

The PowerFlex 527 drive subsystem has a mission time of 10 years.



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.

IMPORTANT The following plan assumes a stop category 0 is being used. You must make appropriate adaptations to the plan if your safety function requires a stop category 1.

Verification and Validation Checklist

General Machinery Information			
Machine Name/Model Number			
Machine Serial Number			
Customer Name			
Test Date			
Tester Name(s)			
Schematic Drawing Number			
Safety Control System Modules	**Catalog Numbers**		**Firmware Revision**
GuardLogix Safety Controller, or Compact GuardLogix Safety Controller	1769-L30ERMS, 1769-L33ERMS, or 1769-L36ERMS 1756-L71S, 1756-L72S, or 1756-L73S		
ControlLogix EtherNet/IP Bridge	1756-EN2TR		
POINT I/O Ethernet Adapter	1756-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 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099.		
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 and verify that the I/O is wired as documented in the schematics.		
4	Visually inspect the Logix Designer application program to verify that the safety system network and I/O module configuration is configured as documented.		

Verification and Validation Checklist (continued)

5	Visually inspect the Logix Designer application program to verify that suitable safety-certified instructions are used. The logic must be 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 Controller Tags window of the Logix Designer application.		
7	Verify that all output devices are qualified by cycling their respective actuators. Monitor the status in the Controller Tags window of the Logix Designer application.		
Normal Operation Verification - The safety system responds properly to all normal Start, Stop, Reset, and safety inputs.			
Test Step	**Verification**	**Pass/Fail**	**Changes/Modifications**
1	Initiate a Start command. The PowerFlex 527 drive Safe Torque Off (STO) feature energizes for a normal machine run condition. Verify proper machine status indication and safety application program indication.		
2	Initiate a Stop command. The PowerFlex 527 drive STO feature de-energizes for a normal machine stop condition. Verify proper machine status indication and safety application program indication.		
3	While the system continues to run, place a demand on the sensor subsystem. The PowerFlex 527 drive STO feature de-energizes with a INHIBIT M05 - SAFE TORQUE OFF inhibit. Verify proper machine status indication and safety application program indication. Repeat for all sensor subsystems.		
4	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. The PowerFlex 527 drive STO feature remains de-energized for a normal safe condition. Verify proper machine status indication and safety application program indication.		
5	While the system is stopped with the sensor subsystems in a safe state, initiate a Reset command. The PowerFlex 527 drive STO feature remains de-energized. Verify proper machine status indication and safety application program indication.		
GuardLogix Controller and Network Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the system continues to run, remove the EtherNet/IP network connection between the PowerFlex 527 drive and the controller. The PowerFlex 527 drive STO feature de-energizes. Verify proper machine status indication and I/O connection status in the safety application program.		
2	Restore the EtherNet/IP connection and allow time to re-establish communication. Verify that the PowerFlex 527 drive STO feature does not automatically energize.		
3	While the system continues to run, switch the controller out of Run mode. The PowerFlex 527 drive de-energizes. Return the controller to Run mode. The PowerFlex 527 STO feature remains de-energized. Verify proper machine status indication and safety application program indication.		
Safety Output Tests			
Test Step	**Verification and Validation**	**Pass/Fail**	**Changes/Modifications**
1	Initiate a Safety Reset command. The PowerFlex 527 drive STO feature energizes for a normal machine run condition. 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.			
Input Device, GuardLogix Controller Input Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	To find a safety function application technique that uses the type of input device you plan to use along with a GuardLogix controller, refer to: http://www.marketing.rockwellautomation.com/safety-solutions/en/MachineSafety/OurSafetySolutions/safety_functions Use the input section of that validation procedure as a guide to test your input device.		

Verification and Validation Checklist (continued)

Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
GuardLogix Controller, PowerFlex Drive Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the machine continues to run, remove the wire from terminal S1 of the PowerFlex drive. The hazardous motion must coast to a stop. The POINT Guard I/O modules are not affected. The PowerFlex drive has a SAFE FLT 09 - SS IN fault.		
2	Replace the wire to terminal S1. Press the drive Start button. The drive must not respond. The SAFE FLT 09 - SS IN fault remains.		
3	Cycle power to the drive and wait until it is in a STOPPED state. The SAFE FLT 09 - SS IN fault is cleared. Press the Start button. The hazardous motion starts.		
4	While the hazardous motion continues to run, jump 24V to terminal S1 of the PowerFlex drive. The hazardous motion coasts to a stop. The 1734-OB8S module faults. The PowerFlex drive has a SAFE FLT 09 - SS IN fault.		
5	Press and release the Reset button. The PowerFlex drive does not respond to the Start button. The SAFE FLT 09 - SS IN fault of the PowerFlex drive remains.		
6	Remove the jumper. Press the start button on the drive. The SAFE FLT 09 - SS IN fault on the PowerFlex drive remains.		
7	Cycle power to the drive and wait until it is in a 'STOPPED' state. The SAFE FLT 09 - SS IN fault is cleared. Press the start button. The hazardous motion starts.		
8	While the hazardous motion continues to run, jump 0V to terminal S1 of the PowerFlex drive. The hazardous motion coasts to a stop. The PowerFlex drive has an INHIBIT M05 - SAFE TORQUE OFF inhibit.		
9	Remove the jumper. Press the Start button on the drive. The drive must not respond. The INHIBIT M05 - SAFE TORQUE OFF fault remains.		
10	Press and release the Reset button. The PowerFlex does not respond to the Start button. The INHIBIT M05 - SAFE TORQUE OFF inhibit on the PowerFlex drive is cleared.		
11	Repeat steps 1...10 using PowerFlex terminal S2 in place of terminal S1. The system responses must be the same as before.		

IMPORTANT In addition to the verification and validation steps that are provided here, consult the application technique for your input subsystem for the steps that are required to validate the input device. Safety function application techniques are available at http://marketing.rockwellautomation.com/safety/en/safety_functions.

Additional Resources

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

Resource	Description
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Describes the GuardLogix controller system. Provides instructions on how to develop, operate, or maintain a GuardLogix controller-based safety system that uses the Studio 5000 Logix Designer application, version 21 or later.
GuardLogix 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to install, configure, and operate a GuardLogix 5570 controller in a Studio 5000 Logix Designer application.
Compact GuardLogix 5370 Controllers User Manual, publication 1769-UM022	Provides information on how to install, configure, and program the Compact GuardLogix 5370 controllers in the Logix Designer application.
GuardLogix Safety Application Instruction Safety Reference Manual, publication 1756-RM095	Describes the Rockwell Automation GuardLogix Safety Application Instruction Set. Provides instructions on how to design, program, or troubleshoot safety applications that use GuardLogix controllers.
Safety Function: Light Curtain Products – Light Curtain, GuardLogix Controller, publication SAFETY-AT056	Provides an example of a GuardLogix controller-based safety distance calculation.
Door-monitoring Interlock Switch with an Integrated Safety Controller Safety Function Application Technique, publication SAFETY-AT034	Provides instructions on how to wire, configure, and program a Compact GuardLogix controller and POINT Guard I/O module to monitor a SensaGuard switch mounted on a door.
SAFEBOOK 4: Safety Related Control Systems for Machinery, publication SAFEBK-RM002	Provides information about safety distance calculations.
POINT Guard I/O Safety Modules User Manual, publication 1734-UM013	Provides instructions on how to install and operate a system that use POINT Guard I/O modules.
Integrated Motion on the Ethernet/IP Network Reference Manual, publication MOTION-RM003	Provides details about the AXIS_CIP_DRIVE motion control axis attributes and the Logix Designer application Control Modes.
Logix5000 Controllers Motion Instructions Reference Manual, publication MOTION-RM002	Provides details about the motion instructions that are available for a Logix5000™ controller.
PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002	Provides detailed information on how to install, configure, operate, and maintain a PowerFlex 527 adjustable frequency AC drive.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines on how to install a Rockwell Automation industrial system.
Product Certifications website, available from the Product Certifications link on http://ab.rockwellautomation.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:

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	www.rockwellautomation.com/knowledgebase
Local Technical Support Phone Numbers	Locate the phone number for your country.	www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	www.rockwellautomation.com/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	www.rockwellautomation.com/global/support/pcdc.page

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the How Are We Doing? form at http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf.

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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