

Door Monitoring Interlock Switch with a Safety Relay and PowerFlex Drive with Safe Torque-off Safety Function

Products: E-stop Button, Trojan 5 Interlock Switch, Guardmaster® Safety Relay, PowerFlex® 525 Drive with Safe Torque-off

Safety Rating: CAT. 3, PLd 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.

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

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

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



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.

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)
- EN ISO 13857:2008 (Safety of Machinery – Safety distances to prevent hazardous zones being reached by upper and lower limbs)
- ANSI B11:19 2010 (Machines – Performance Criteria for Safeguarding)

Separating safeguards monitor a moveable, physical barrier that guards access to a hazard. See these publications for guidance in how to calculate compliant access times for safety systems that use separating safeguards, such as gates with limit switches or interlocks (including SensaGuard™ switches):

- EN ISO 14119:2013 (Safety of Machinery – Interlocking devices associated with guards - Principles for design and selection)
- EN ISO 13850:2015 (Safety of Machinery – Emergency-stop functions – Principles for design)
- EN ISO 13855:2010 (Safety of Machinery – Positioning of safeguards with respect to the approach speeds of parts of the human body)
- EN ISO 13857:2008 (Safety of Machinery – Safety distances to prevent hazardous zones being reached by upper and lower limbs)
- ANSI B11:19 2010 (Machines – Performance Criteria for Safeguarding)

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

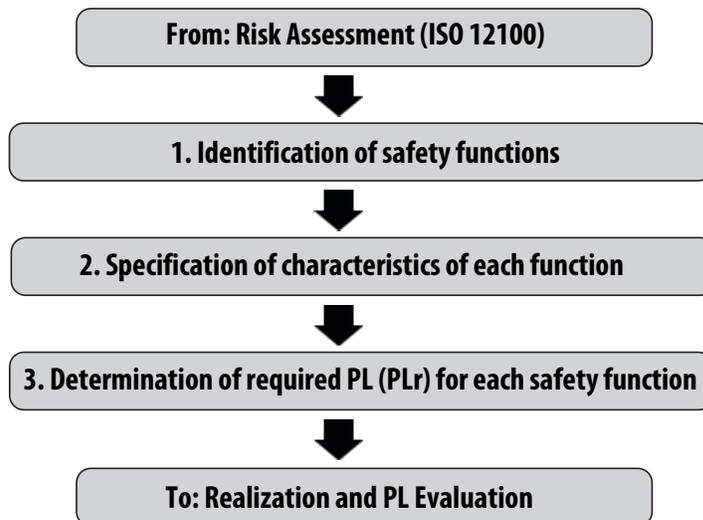
Introduction

This safety function application technique explains how to wire, configure, verify, and validate a safety system where a Guardmaster® dual-input safety relay monitors an E-stop and a Trojan® 5 tongue switch mounted on a gate. If the E-stop is pressed, the gate is opened, or a fault is detected in the monitoring circuit, the safety relay de-energizes the final control devices, in this case, the PowerFlex® 525 drive, via its two safe torque-off (STO) inputs.

This example uses a Guardmaster dual-input safety relay, but the concept is applicable to any suitable safety relay. This example uses an E-stop and a Trojan 5 tongue switch, but the concept is applicable to any dual-channel electromechanical device with at least two normally-closed contacts. The SISTEMA calculations that are shown later in this document must be recalculated by using data for the actual products used.

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 conducted 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.



Door-monitoring Safety Function

This application technique includes two safety functions:

- Removal of power from the motor when the E-stop is pressed.
- Removal of power from the motor when the gate is opened.

Safety Function Requirements

When the E-stop button is pressed or the guard gate is opened, these actions stop hazardous motion by removing power to the motor. When the E-stop is released and the guard gate is closed, power to the motor and hazardous motion does not resume until the safety system is reset, and a secondary action (Start button is pressed and released) occurs. Faults at the E-stop, gate interlock switch, wiring terminals, or safety relay are detected before the next safety demand.

The PowerFlex 525 drive monitors itself for input, internal, and output faults. When the PowerFlex 525 drive detects a fault, it turns off its outputs and removes power to the motor. The fault must be corrected, and power to the drive cycled, before the drive can be restarted. Faults at the safe torque-off (STO) inputs on the PowerFlex 525 drive can go undetected.

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.

Functional Safety Description

Hazardous motion is stopped when the E-stop button is pressed or the guard gate is opened. Hazardous motion cannot be resumed until the E-stop is released, the guard gate is closed, and the Guardmaster dual-input safety relay is reset.

The normally-closed contacts of the E-stop are connected between the S11 and S21 pulse test outputs and the IN1 terminals S12 and S22 of the Guardmaster dual-input safety relay. The normally-closed contacts of the Trojan 5 switch are connected between the S11 and S21 pulsed outputs and the IN2 terminals S32 and S42 of the Guardmaster dual-input safety relay.

The normally-open safety outputs of the safety relay are connected between the 24V DC supply and the safe torque-off (STO) inputs of the PowerFlex 525 drive.

When all safety inputs of the safety relay are satisfied, no faults are detected, and the Reset button is pressed and released, the normally-open safety outputs close, which provides 24V DC to the STO inputs. Pressing the Start button on the PowerFlex 525 drive provides power to the controlled motor and hazardous motion begins.

Bill of Material

Cat. No.	Description	Quantity
440K-T11090	Tongue switch - Trojan 5: contacts (safety and aux): two normally closed, one normally open, BBM preference: break before make, actuator: standard, model type: standard, conduit entry: M20 conduit	1
800F-1YP8	800F one-hole enclosure E-stop station, plastic, pg, twist-to-release, 60 mm (2.36 in.), non-illuminated, two normally closed, one normally open.	1
440R-D22R2	Guardmaster dual input safety relay, two dual-channel universal inputs, two normally open safety outputs, one normally closed solid-state auxiliary output	1
25B-B2P5N104	PowerFlex 525 AC drive, with embedded EtherNet/IP and safety, 240V AC, three-phase, 0.5 HP, 0.4 kW normal duty; 0.5 HP, 0.4 kW heavy duty, frame A, IP20 NEMA / open type, no filter	1
800FP-U2E4F3PX11	800F two-position momentary multifunction- rd. plastic (IP66, 4/4x, IP65), position A- red ext. push button, position C-green flush push button, plastic latch mount, one normally open contact, one normally closed contact, standard, standard pack	1
800FP-R611PX10	800F reset, round plastic (type 4/4x/13, IP66), blue, R, plastic latch mount, one normally open contact, no normally closed contacts, standard, standard pack	1

Setup and Wiring

For detailed information on how to install and wire, refer to the publications listed in the [Additional Resources](#).

System Overview

The Guardmaster dual-input safety relay monitors the two normally-closed channels of the E-stop button. When the E-stop button is pressed, these two channels open, and the safety relay reacts by de-energizing its normally-open safety contacts, which removes 24V DC from the safe torque-off (STO) inputs of the PowerFlex 525 drive. The drive turns off its outputs and the motor coasts to a stop.

The safety relay monitors the two normally-closed channels of the Trojan 5 switch. When the guard gate is opened, these two channels open, and the safety relay reacts by de-energizing its normally-open safety contacts, which removes 24V DC from the STO inputs of the drive. The drive turns off its outputs and the motor coasts to a stop.

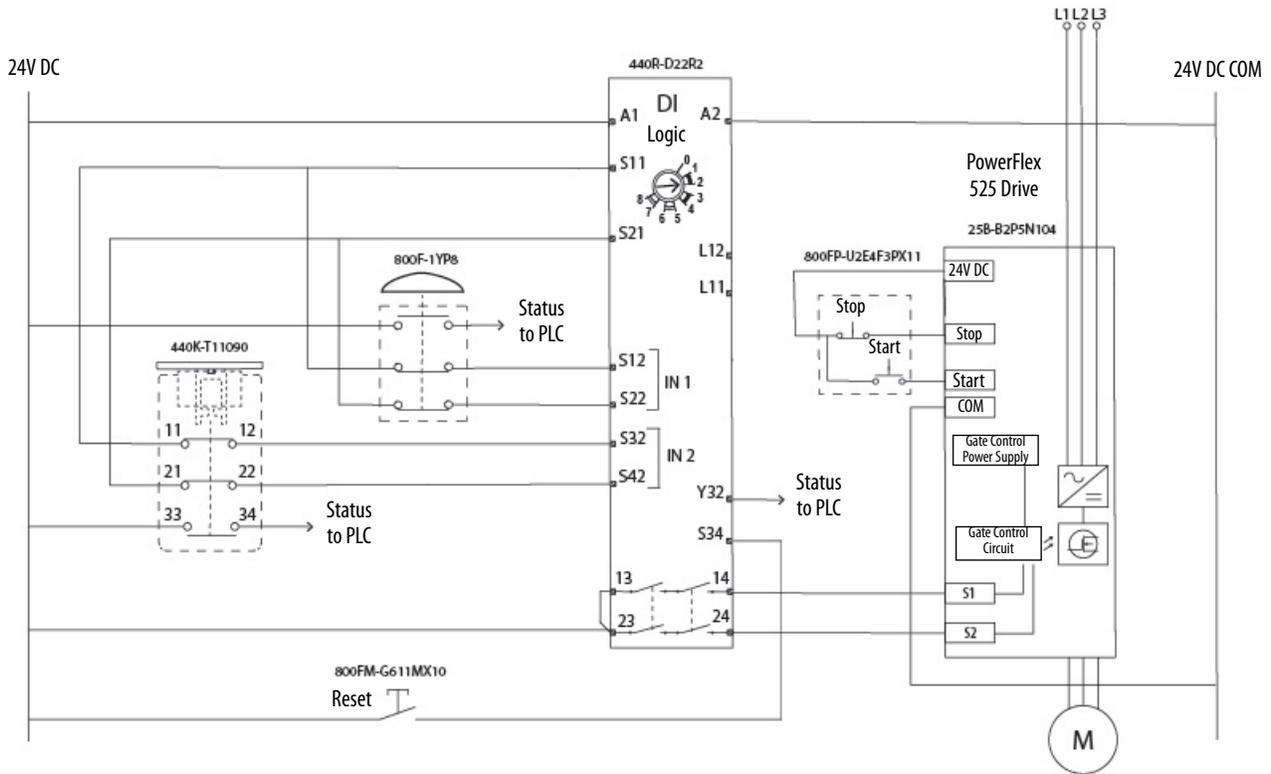
The safety relay monitors each input channel for a contact failed open (loose wire), a contact failed closed, a channel short to 24V DC supply, a channel short to 24V COM, and channel-to-channel shorts. When such a fault occurs, the safety relay de-energizes its normally-open safety contacts, which removes 24V DC from the STO inputs of the drive. The drive turns off its outputs and the motor coasts to a stop.

A single-input channel fault, a contact failed open, or a contact failed closed, is considered a minor fault, for example, a sticky contact. In the case of a single-channel fault, a successful cycle of that input occurs when both channels open and close properly, the fault clears, and the subsequent pressing and releasing of the Reset button energizes the safety outputs, which allows a start/restart of the motor.

An input-channel short fault is considered to be a major fault. An input-channel short fault can be an input-channel shorted to 24V DC, an input-channel shorted to 0V DC, or input-channels shorted together. When an input-channel short fault is detected, the safety relay de-energizes its outputs immediately, regardless of the state of the input devices. In the case of an input-channel short fault, the safety relay must first be powered down and the short found and removed. Then, power is restored to the safety relay to clear the fault. When the E-stop button is not pressed and the gate is closed, subsequent pressing and releasing of the Reset button energizes the safety outputs, which allows a start/restart of the motor.

The PowerFlex 525 drive monitors the STO inputs for single channel faults or shorts to 0V. If one input channel applies power or removes power when the other channel does not, the drive turns off its outputs and cannot be run until the fault is corrected. The drive must be power-cycled, and both STO inputs must be in the Applied Power state before the drive responds to the start/restart button.

Electrical Schematic



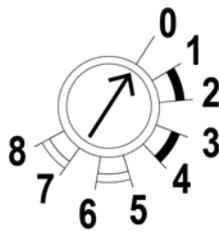
Configuration

The following sections provide instructions on how to configure the components of this safety function.

Configure the Guardmaster Dual-input Safety Relay

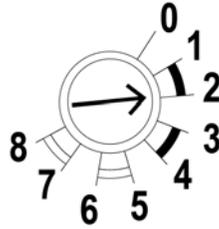
Follow these steps to configure the Guardmaster dual-input safety relay.

1. With power off, turn the rotary switch to position 0.



2. Apply power to the unit.
After the power-up test, the PWR/Fault status indicator blinks red.

- Turn the rotary switch to position 2.



The IN1 status indicator blinks the new setting. Position is set when the PWR/Fault status indicator is solid green.

- Lock in the configuration by cycling power to the unit.
Configuration must be confirmed before operation. Use the white space on the front of the device to record the unit setting.

Configure the PowerFlex 525 Drive

Configuration of the PowerFlex 525 drive is beyond the intended scope of this application technique. Other than configuring the drive to use the local Stop/Start button that is required by this application technique and disabling the "Safe Open En" to prevent unnecessary drive faults, the aspects of the drive configuration relative to performing its particular application tasks are not relevant to this application technique. See the drive publications listed in the [Additional Resources](#) section for guidance on how to install and configure the drive.

Parameter Group	Parameter #	Parameter Name	(set to)Value	Purpose
Basic Program	P046	Start Source 1	2 - Digin TrmBlk	Configure the 3-Wire Start/Stop
Terminal Blocks	t062	Digin TermBlk 02	49 - 3-Wire Start	Configure the 3-Wire Start/Stop
	t063	Digin TermBlk 03	51 - 3-Wire Dir	Configure the 3-Wire Start/Stop
	t105	Safety Open En	1-FaultDisable	STO input is NOT considered a fault

Calculation of the Performance Level

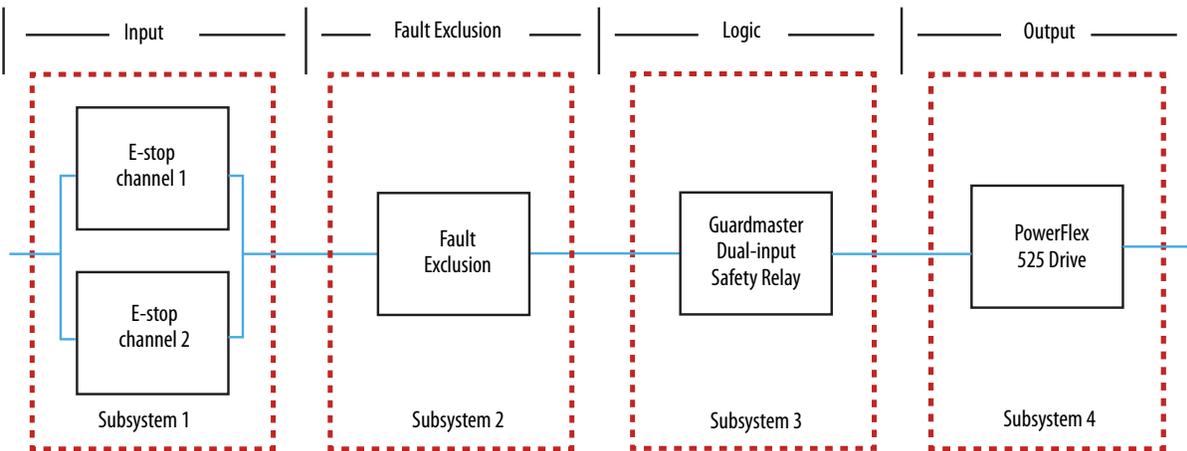
When properly implemented, these safety functions can achieve a safety rating of Category 3, Performance Level d (CAT. 3, PLd), according to ISO 13849-1: 2008, as calculated by using the Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA).



The values for the E-stop function are shown in the graphic.

Sta...	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the category
✓SB	E-Stop	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled
✓SB	fault Exclusion	e	0	not relevant	not relevant	not relevant	4	fulfilled
✓SB	Monitoring Safety Relay: GSR-DI	e	4.35E-9	not relevant	not relevant	not relevant	4	fulfilled
✓SB	AC Drive: PowerFlex 525 with SafeTorque Off	d	8.13E-10	not relevant	not relevant	not relevant	3	fulfilled

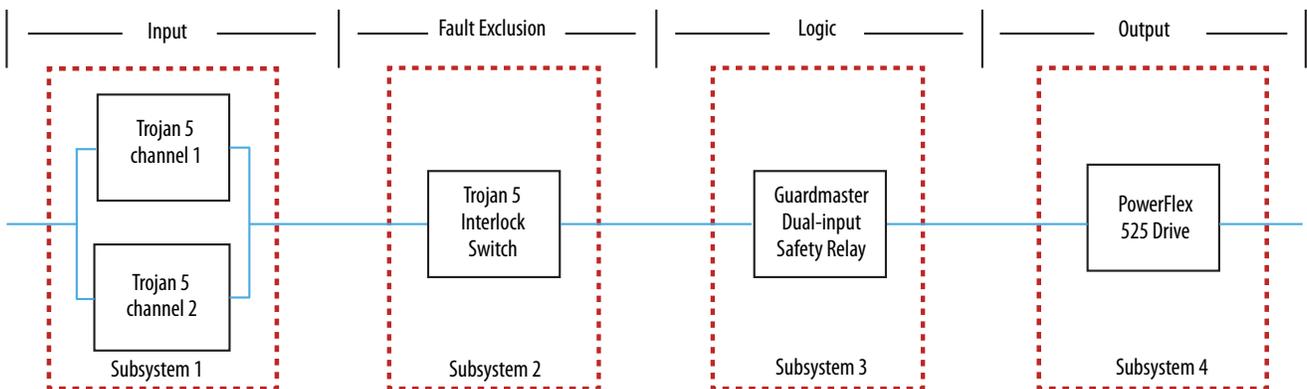
The E-stop safety function can be modeled as shown in the diagram.



The values for the door-monitoring interlock switch are shown in the graphic.

Sta...	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the category
✓SB	Trojan 5	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled
✓SB	Fault Exclusion for tongue switch Single Actuator	d	3.16E-7	not relevant	not relevant	not relevant	3	fulfilled
✓SB	Monitoring Safety Relay: GSR-DI	e	4.35E-9	not relevant	not relevant	not relevant	4	fulfilled
✓SB	AC Drive: PowerFlex 525 with SafeTorque Off	d	8.13E-10	not relevant	not relevant	not relevant	3	fulfilled

The door monitoring safety function can be modeled as shown in the diagram.



Because the E-stop and interlock switch are electromechanical devices, certain data must be considered, including the following:

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

The functional safety evaluations of electromechanical devices include the following:

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

Additionally, because these devices are electromechanical devices, a fault exclusion must be considered when calculating the safety ratings. A fault exclusion subsystem is added to each safety function in the SISTEMA project and adjusted to reflect its effect.

In the case of the E-stop button, ISO 13849-2:2012, Annex D allows a fault exclusion for mechanical aspects (one actuator operating two channels) of emergency stop devices in accordance with IEC 60947-5-5. Since the estimated maximum number of E-stop button operations (8760/year) is not considered to be excessive, this fault exclusion itself has no effect on the category or performance level achieved by the E-stop safety function. To reflect this configuration in the SISTEMA project, the category and performance level of the fault exclusion subsystem were manually entered as Category 4 and Performance Level e.

A fault exclusion is not allowed for mechanical aspects (one actuator operating two channels) of an interlock switch. To reflect this configuration in the SISTEMA project, the category and performance level of the fault exclusion subsystem were manually entered as Category 3 and Performance Level d.

SISTEMA calculates the MTTFd by using B10d data provided in the Rockwell Automation SISTEMA library for the E-stop button and interlock switch, along with the estimated frequency of use, entered during the creation of the SISTEMA project. This example presumes that the E-stop is operated or tested 8760 times a year. The interlock switch would also be operated 8760 times a year.

The DCavg (99%) for the E-stop button is selected from the Input Device table of ISO 13849-1:2008 Annex E, “Cross monitoring of input signals without dynamic test.”

The DCavg (99%) for the interlock switch is selected from the Input Device table of ISO 13849-1:2008 Annex E, “Cross monitoring of input signals without dynamic test.”

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 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 safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions and potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

Before the Guardmaster safety relay system is validated, confirm that the safety relay is wired and configured in accordance with the installation instructions.

Verification and Validation Checklist

General Machinery Information			
Machine Name/Model Number			
Machine Serial Number			
Customer Name			
Test Date			
Tester Name			
Schematic Drawing Number			
Guardmaster Safety Relay Model	440R-D22R2		
PowerFlex Drive	25B-B2P5N104		
Safety Wiring and Relay Configuration Verification			
Test Step	Verification	Pass/Fail	Changes/Modifications
1	Visually inspect the safety relay circuit to confirm that it is wired as documented in the schematics.		
2	Visually inspect the configuration switch settings of the safety relay to confirm that they are correct as documented.		
Normal Operation Verification - The safety system responds properly to all normal Start, Stop, Reset, E-stop, and Trojan Switch inputs.			
Test Step	Verification	Pass/Fail	Changes/Modifications
1	Confirm that no one is in the guarded area.		
2	Confirm that the E-stop button is released.		
3	Confirm that the gate is closed.		
4	Confirm that the motor is stopped.		
5	Apply power to the safety system.		
6	Confirm that the motor does not start on powerup.		
7	Confirm that the PWR/Fault, IN1, and IN2 status indicators of the Guardmaster dual-input safety relay are green.		
8	Confirm that the OUT status indicator of the safety relay blinks green.		
9	Press and release the Reset button. The OUT status indicator of the safety relay turns steady green (ON). The motor does not start.		
10	Press the Start button on the drive to start the motor. The motor starts.		
11	Press the Stop button on the drive to stop the motor. The motor coasts to a stop. The safety relay does not trip.		
12	Press the Start button to start the motor.		
13	Press the E-stop button. The safety system trips and the IN1 and OUT status indicators turn OFF. The IN2 status indicator remains ON. The motor coasts to a stop. Do not release the E-stop button.		
14	Press and release the Reset button. The IN1 and OUT status indicators of the safety relay remain OFF. The motor does not start.		

Verification and Validation Checklist

15	Release the E-stop button. The IN1 status indicator turns ON and the OUT status indicator blinks. The motor does not start.		
16	Press and release the Reset button. The OUT status indicator of the safety relay turns steady green (ON). The motor does not start.		
17	Press the Start button to start the motor.		
18	Open the gate. The safety system trips. The IN2 and OUT status indicators turn OFF. The IN1 status indicator remains ON. The motor coasts to a stop. Do not close the gate.		
19	Press and release the Reset button. The IN2 and OUT status indicators of the safety relay remain OFF. The motor does not start.		
20	Close the gate. The IN2 status indicator turns ON. The OUT status indicator blinks. The motor does not start.		
21	Press and release the Reset button. The OUT status indicator of the safety relay turns steady (ON). The motor does not start.		
22	Press the Start button to start the motor.		

Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.

E-stop, Guardmaster Dual-input Safety Relay Tests

Test Step	Validation	Pass/Fail	Changes/Modifications
1	While the motor continues to run, remove the E-stop input wire at terminal S12 of the Guardmaster dual-input safety relay. The safety relay immediately trips and de-energizes the STO inputs of the drive. The motor coasts to a stop. The IN1 and OUT status indicators turn OFF.		
2	Reconnect the wire to S12. The safety relay does not respond. Press and release the Reset button. The safety relay does not respond.		
3	Cycle the E-stop button. The IN1 status indicator is ON and the OUT status indicator blinks. Press and release the Reset button. The OUT status indicator is steady (ON).		
4	Press the Start button. The motor starts to run. This step is skipped in the following tests.		
5	While the motor continues to run, jump the E-stop input wire at terminal S11 to terminal S12 of the safety relay. The safety relay does not trip.		
6	Press the E-stop button. The safety relay immediately trips and the IN1 and OUT status indicators turn OFF.		
7	Release the E-stop button. Press and release the Reset button. The safety relay does not respond.		
8	Remove the jumper from S11 to S12. Press and release the E-stop. The IN1 status indicator is ON and the OUT status indicator blinks. Press and release the Reset button. The OUT status indicator is steady (ON).		
9	Repeat steps 1...8 to test E-stop channel 2. Use S21 in place of S11 and S22 in place of S12.		
10	Briefly short the E-stop input wire at terminal S12 of the safety relay to 24V DC. The safety relay immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
11	Press and release the Reset button. The safety relay does not respond.		
12	Cycle power to the safety relay. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
13	Briefly short the E-stop input wire at terminal S12 of the safety relay to 0V DC. The safety relay immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
14	Press and release the Reset button. The safety relay does not respond.		

Verification and Validation Checklist

15	Cycle power to the safety relay. Verify that the PWR/Fault, IN1, and IN2 status indicators are green. Verify that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
16	Repeat steps 11...15 to test E-stop input channel 2. Use S22 in place of S12.		
17	Briefly short the E-stop terminal S12 to terminal S22 of the safety relay. The safety relay immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
18	Press and release the Reset button. The safety relay does not respond.		
19	Cycle power to the safety relay. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Trojan Switch, Guardmaster Dual-input Safety Relay Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	Remove the Trojan input wire at terminal S32 of the Guardmaster dual-input safety relay. The safety relay immediately trips and de-energizes the safety inputs of the drive. The motor coasts to a stop. The IN2 and OUT status indicators turn OFF.		
2	Reconnect the wire to S32. The safety relay does not respond. Press and release the Reset button. The safety relay does not respond.		
3	Open and close the gate. The PWR/Fault, IN1, and IN2 status indicators are green (ON). The OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
4	Jump the Trojan input wire at terminal S11 to terminal S32 of the safety relay. The safety relay does not respond.		
5	Open the gate. The safety relay immediately trips. The IN2 and OUT status indicators turn OFF.		
6	Close the gate. Press and release the Reset button. The safety relay does not respond.		
7	Remove the jumper from S11 to S32. Open and close the gate. The IN2 status indicator is ON and the OUT status indicator blinks. Press and release the Reset button. The OUT status indicator is steady (ON).		
8	Repeat steps 1...7 to test Trojan channel 2. Use S21 in place of S11 and S42 in place of S32.		
9	Briefly short the Trojan input wire at terminal S32 of the safety relay to 24V DC. The safety relay immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
10	Press and release the Reset button. The safety system does not respond.		
11	Cycle power to the safety relay. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
12	Briefly short the Trojan input wire at terminal S32 of the safety relay to 0V DC. The safety relay immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
13	Press and release the Reset button. The safety relay does not respond.		
14	Cycle power to the safety relay. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
15	Repeat steps 1...14 to test Trojan input channel 2. Use S42 in place of S32.		
16	Briefly short the Trojan input terminal S32 to terminal S42 of the safety relay. The safety relay immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
17	Press and release the Reset button. The safety relay does not respond.		

Verification and Validation Checklist

18	Cycle power to the safety relay. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Logic Switch Setting, Guardmaster Dual-input Safety Relay Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	While the system continues to run, turn the Logic rotary switch on the Guardmaster dual-input safety relay from the proper position 2 to position 4. The motor continues to run. The PWR/Fault status indicator blinks red/green twice then remains green and repeats the pattern.		
2	Press and release the E-stop button. The system trips and the motor stops. The PWR/Fault status indicator blinks red/green twice, then remains green and repeats the pattern. The OUT status indicator blinks, requesting a Reset.		
3	Press and release the Reset button. The OUT status indicator turns steady green, which indicates that the safety relay has reset. The PWR/Fault status indicator continues to blink red/green twice, then remains green and repeats the pattern.		
4	Press the Start button. The motor starts and the PWR/Fault status indicator continues to blink red/green twice then remains green and repeats the pattern.		
5	Set the rotary switch back to position 2. After a moment, the PWR/Fault status indicator turns steady green.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Safety Output, PowerFlex 525 Drive Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	Power up the safety system. Confirm that the E-stop is released and the gate is closed. Press and release the Reset button to start/reset the Guardmaster dual-input safety relay. Press the Start button. The motor starts.		
2	While the motor continues to run, remove the wire from terminal 14 of the safety relay. The safety relay does not trip. The drive trips and the motor stops.		
3	Reconnect the wire to terminal 14. The drive does not start. Press the Start button. The drive does not start.		
4	Power down the drive, then power it up. Once the drive is fully powered up, press the Start button. The motor starts.		
5	While the motor continues run, remove the wire from terminal 24 of the safety relay. The safety relay does not trip. The drive trips and the motor stops.		
6	Reconnect the wire to terminal 24. The drive does not start. Press the Start button. The drive does not start.		
7	Power down the drive, then power it up. Once the drive is fully powered up, press the Start button. The motor starts.		

Additional Resources

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

Resource	Description
Guardmaster Safety Relay DI Installation Instructions, publication 440R-IN037	Provides guidance on how to install, commission, operate, and maintain the Guardmaster 440R-D22R2 safety relays.
Guardmaster Safety Relay DI/DIS Quick Start Guide, publication 440R-TG002	Provides guidance on how to troubleshoot a 440R-D22R2 safety relay installation.
PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001	Provides guidance on how to install, start, and troubleshoot the PowerFlex 520-series adjustable frequency AC drives.
Global Short Circuit Current Ratings Product Profile, publication SCCR-PP001	Provides the short-circuit current rating (SCCR) selection tables for component drive circuits.
PowerFlex 520-Series AC Drive Specifications Technical Data, publication 520-TD001	Provides information on the PowerFlex 525-series AC drives.
Trojan 5 and 6 Installation Instructions, publication 440K-IN002	Provides guidance on how to install, start, and troubleshoot the Trojan 5 and 6 switches.
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, http://www.rockwellautomation.com/global/certification/overview.page	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.

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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Publication SAFETY-AT126B-EN-P - July 2016

Supersedes Publication SAFETY-AT126A-EN-P - January 2014

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