

Safety Function: Light Curtain with a Dual-input Safety Relay

Products: Guardmaster Dual-input Safety Relay, GuardShield Light Curtain, 100S-C Safety Contactors

Safety Rating: CAT. 4, PL_e 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

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.

Safe Distance Calculations



ATTENTION: Compliant safety circuits must often include a safe 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 safe 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:

IEC 61496-1:2012 (Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests)

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.

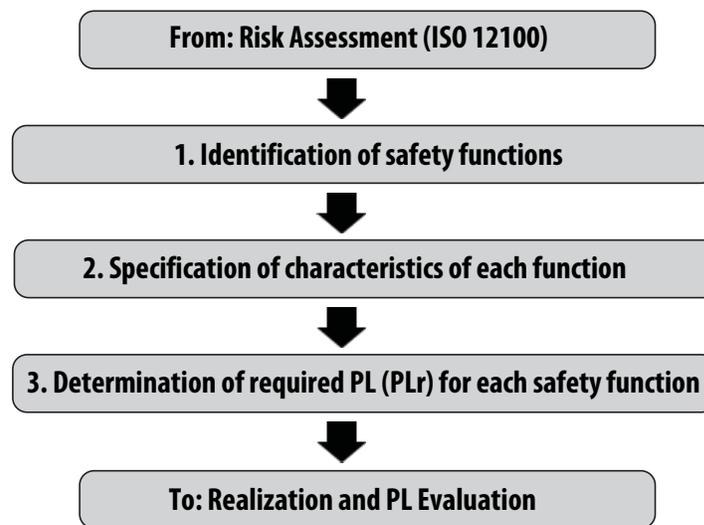
Introduction

This safety function application technique explains how to wire and configure a Guardmaster® dual-input safety relay to monitor both an E-stop and a GuardShield™ light curtain. When an object intrudes into the light curtain field-of-view, the E-stop is actuated, or a fault is detected in the monitoring circuit, the dual-input safety relay de-energizes the final control devices, in this case, a pair of 100S-C safety contactors.

E-stops are required in most applications. Safety systems that require both a sensing device, like a light curtain, and E-stop combination are common. The dual-input safety relay makes this safety system easy to implement in a single safety relay.

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.



Light Curtain Safety Function

This application technique includes two safety functions:

- Emergency stop initiated by intrusion into the light curtain field-of-view, point-of-operation control
- Emergency stop initiated by actuation of an emergency push button

Safety Function Requirements

The light curtain must be installed at a distance from the hazardous motion such that a user cannot reach the hazard before the motion has stopped. This distance is called the safe distance and is addressed in [Calculating Safe Distance on page 8](#).

An object that intrudes into the light curtain field-of-view stops the hazardous motion by removal of power to the motor. The system cannot be reset while an object is in the field of view. Once the object has left the field of view, pressing and releasing the Reset button (a separate action) resumes the hazardous motion. Pressing the E-stop button stops the hazardous motion by removal of power to the motor. Releasing the E-stop does not restart the hazardous motion. Once the E-stop is released, and any faults are cleared, pressing and releasing the Reset button resumes the hazardous motion.

Faults at the light curtain, wiring, or safety relay are detected before the next safety demand.

The safety system that is described in this application note is capable of connecting and interrupting power to motors rated up to 9A, 600V AC.

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

When an object intrudes into the light curtain field-of-view, the light curtain hazardous motion is stopped and prevented from restarting until the light curtain field-of-view is restored.

Likewise, when the E-stop is pressed, the hazardous motion is stopped and prevented from restarting until the E-stop is released.

Bill of Material

This application uses these products.

Cat. No.	Description	Quantity
440L-P4JL0640YD	GuardShield safety light curtain, Res 14 mm, Pt Ht 640 mm, 64 beams, integrated laser alignment	1
889D-F4AC-2	DC Micro (M12), female, straight, 4-pin, PVC cable, yellow, unshielded, 22 AWG, IEC color coded, no connector, 2 m (6.56 ft)	1
889D-F8AB-2	DC Micro (M12), female, straight, 8-pin, PVC cable, yellow, unshielded, 24 AWG, IEC color coded, no connector, 2 m (6.56 ft)	1
800FM-G611MX10	800F push button, metal, guarded, blue, R, metal latch mount, 1 N.O. contact, 0 N.C. contact, standard, standard pack	1
800F-1YP3	800F 1-hole enclosure E-stop station, plastic, PG, twist-to-release 40 mm, non-illuminated, 2 N.C.	1
440R-D22R2	Guardmaster safety relay, 2 dual-channel universal inputs, 1 N.C. solid-state auxiliary outputs	1
100S-C09ZJ23C	MCS™ 100S-C safety contactor, 9A, 24V DC	2

Setup and Wiring

For detailed information on how to install and wire a light curtain with a dual-input safety relay, refer to the publications listed in the [Additional Resources](#).

System Overview

When an object intrudes into the light curtain field-of-view, the light curtain switches off its two PNP outputs (OSSDs). The safety relay responds by opening its two output relays. This removes 24V from the coils of the two safety contactors whose contacts open and remove power to the motor. The motor coasts to a stop category 0.

The light curtain's OSSD outputs turn on once its field-of-view is no longer interrupted.

The light curtain monitors its internal circuitry and its OSSD outputs for faults. When a fault in the internal circuitry or an output is detected, the light curtain responds by turning off its OSSD outputs.

The pulse test outputs S11 and S21 of the Guardmaster dual-input safety relay are run through the two N.C. contacts of the E-stop to inputs S12 and S22 respectively. When the E-stop is pressed, these circuits are interrupted. The dual-input safety relay responds by opening its safety contacts, removing 24V from the coils of the two 100S-C contactors whose contacts open, removing power to the motor. The motor coasts to a stop category 0.

The dual-input safety relay monitors the E-stop circuit for faults. Loose wires, shorts to 24V, shorts to GND, contacts failed closed, and cross faults are detected. When a fault is detected, the dual-input safety relay responds by opening its safety contacts, removing 24V from the coils of the two 100S-C contactors whose contacts open, removing power to the motor. The motor coasts to a stop category 0.

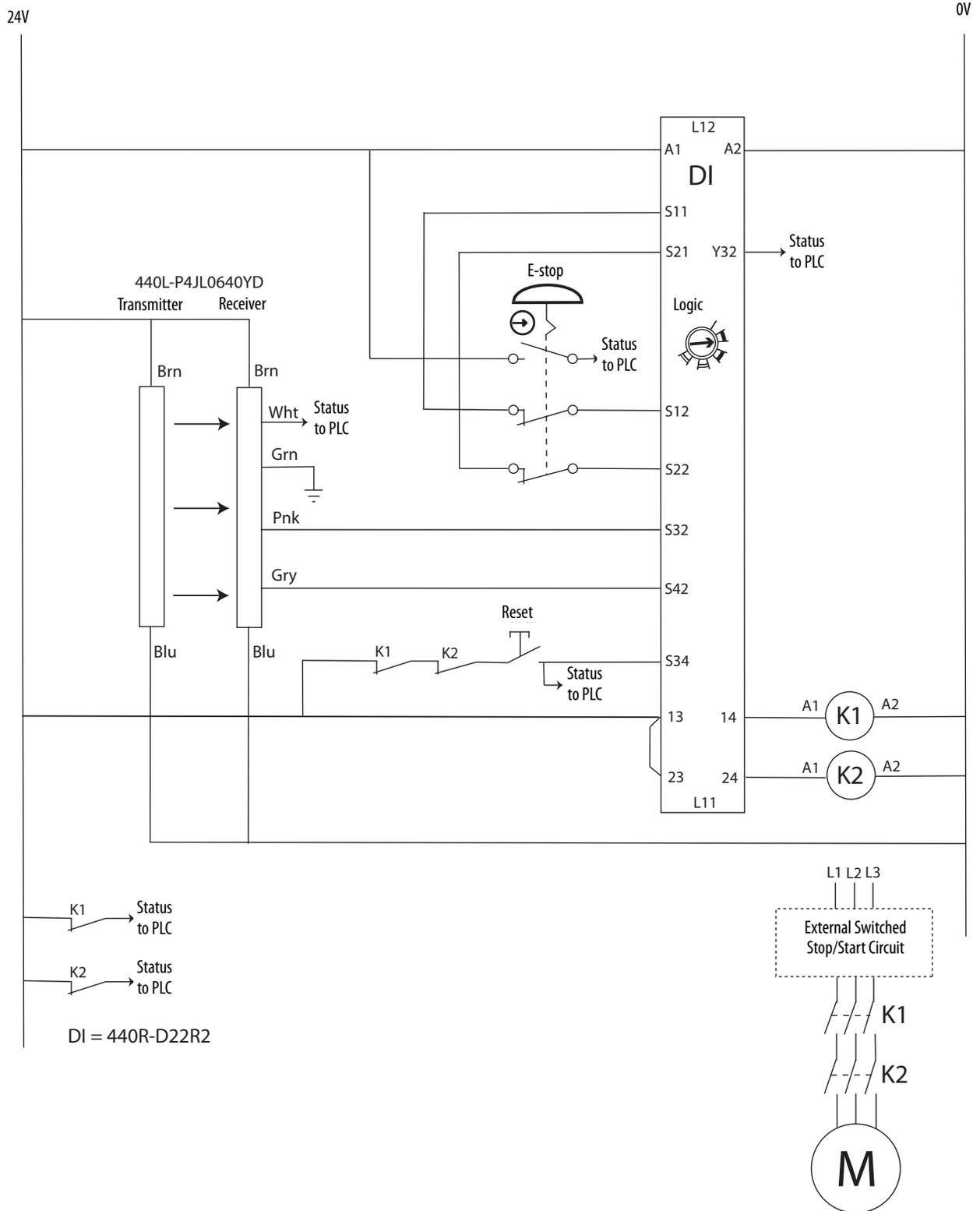
Two N.C. contacts, one from each of the safety contactors, are connected as part of the reset circuit. The safety relay can be reset only if both safety contactors are in a proper, de-energized state.

The safety relay cannot be reset while the E-stop remains actuated or while the light curtain OSSD outputs are off. Once the E-stop has been released, or the light curtain OSSD outputs turn on, pressing and releasing the Reset button (a separate, deliberate action) resumes the hazardous motion. The Reset button must be pressed for more than a quarter-second and less than 3 seconds. A shorter press is ignored; a longer press is ignored.

The safety relay checks itself for internal faults, faults on its inputs and wiring, and monitors the safety contactors via the contactors N.C. contacts in the reset circuit.

No single fault results in the safety system failing to perform its safety function. A single fault is detected before the next demand on the safety system. The system cannot be reset until the fault is corrected.

Electrical Schematic



Installation

Refer to the installation instructions and user manuals listed under [Additional Resources on page 17](#) for guidance on how to install and maintain the different parts of this system.

Calculating Safe Distance

A safety light curtain provides no physical barrier between personnel and the hazardous motion. The safety light curtain must be installed at a sufficient distance from the hazardous motion so that an operator putting a hand through the light curtain cannot reach the hazard before it has stopped. This distance is referred to as the safe distance (Ds). The safe distance that is required varies from installation to installation and, therefore, must be calculated for each specific application. This application technique uses the ANSI formula:

$$D_s = K \times (T_s + T_c + T_r - T_{bm}) + D_{pf}$$

K: the standard hand speed of 63 inches per second

Ts: the stop time of the machine

Tc: the response time of the safety system

Tr: the response time of the presence-sensing device

Tbm: additional time allowed for the brake monitor (if any) to compensate for variations in normal stopping time

Dpf: the distance a standard hand could possibly move through the light curtain before it is detected. This is a fixed value based on the light curtain resolution.

In this application technique, the values are:

K: 63 inches per second

Ts: 250 ms

Tc: 50ms (35 ms, DI plus 15 ms K1/K2)

Tr: 20 ms

Tbm: 0 - none used in this application

Dpf: 1 inch (23.8 mm)

$$DS = (63 \times .32) + 1 = 21.16 \text{ inches}$$

The light curtain must not be mounted closer than 21.16 inches from the hazardous motion being guarded against.

The following information shows same calculation using EN ISO 13855.

$$S = (K \times T) + C$$

S: minimum distance, in millimeters (mm)

K: is a parameter, in millimeters per second (mm/s), derived from data on approach speeds of the body or parts of the body

T: is the overall stopping performance in seconds

C: is the intrusion distance in mm

In this application technique, the values are:

$$K = 1600 \text{ mm per second}$$

$$T = 320 \text{ ms (Machine Stopping Time + Reaction time of the light curtain + Reaction time of the DI safety relay and contactors K1/K2)}$$

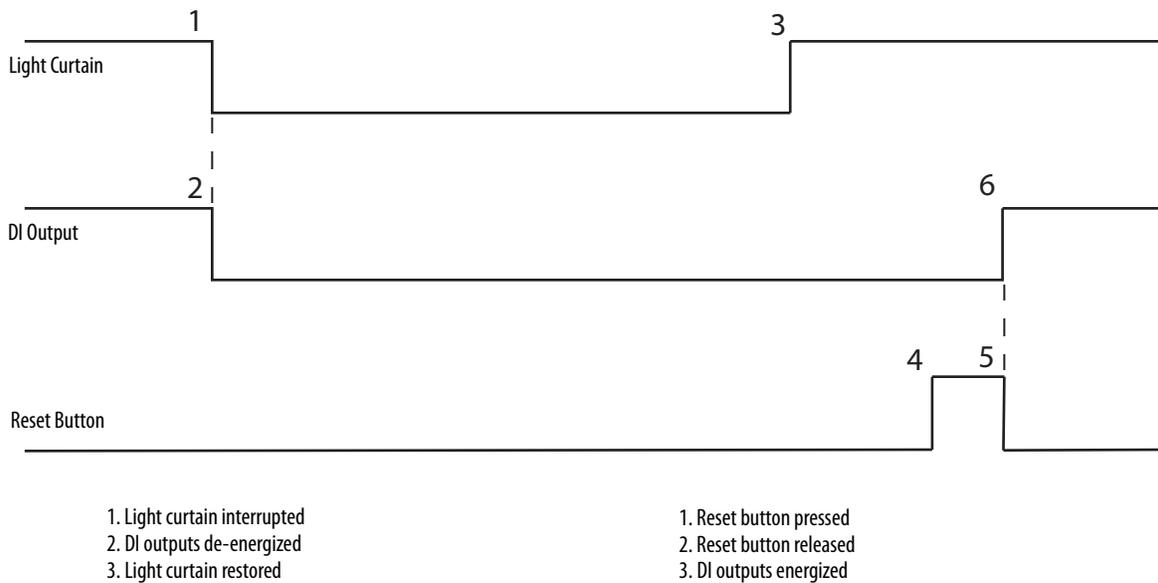
$$C = 8(d-14) \text{ but not less than } 0 \text{ where } d \text{ is the resolution of the light curtain}$$

$$S = 1600 \times .320 + 8(14 - 14)$$

The light curtain must not be mounted closer than 512 mm (approx. 21 in.) from the hazardous motion being guarded against.

Timing Chart

The diagram provides a visual illustration of the operation of the light curtain.



Configuration

The following sections provide information on how to configure the light curtain and the safety relays.

Configure the Light Curtain

The GuardShield 440L light curtain uses dip switches to configure it for different applications. This application uses the default settings. No switch changes are necessary.

Table 1 - Receiver–Factory Settings

Switch	Switch Function	Default Setting	Description
1	Mode Activation–Combination activates one of the following modes: Guard only, Start interlock, Restart interlock	ON	Guard Only
2		ON	
3	MPCE Monitoring disable	ON	Disabled
4	Fixed Blanking Activate	OFF	Disabled
5	Floating Blanking Activate–Single Beam	OFF	Switches 5 and 6 cannot be activated ON at the same time.
6	Floating Blanking Activate–Two Beams	OFF	
7	Set Beam Coding	OFF	Disabled
8	Not used	OFF	

Table 2 - Transmitter–Factory Settings

Switch	Switch Function	Default Setting	Description
1	Set Beam Coding	OFF	Disabled
2	Machine Test Signal	OFF	OFF–Signal High active. No connection or connect normally open. ON–Signal Low active. Connect normally closed.

Configure the Safety Relays

The Guardmaster 440R-D22R2 dual-input safety relay must be configured for LOGIC 2 (L12 OR IN 1 AND IN 2), as described in the Guardmaster Safety Relay DI Installation Instructions, publication [440R-IN037](#).



Calculation of the Performance Level

The Performance Level that is required from the risk assessment is Performance Level d (PLd).

When properly implemented, the safety functions described here can achieve a CAT. 4, PLe according to ISO 13849-1: 2008, as calculated by using the Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA).

Calculations for the E-stop safety function are based on one operation per month of the E-stop.

Calculations are based on the light curtain safety function being operated once an hour, 24 hours a day, 365 days a year, for a total of 8760 operations a year. Bear in mind that the 100S-C contactors are used in both safety functions, so in their calculations are based on 17520 operations per year.

The screenshot shows the 'Safety functions' tab in the SISTEMA Project interface. A table lists two safety functions: 'Light Curtain' and 'E-Stop'. The 'PLr' and 'PL' columns are circled in red, showing 'd' for both functions.

Sta...	Name	Type	PLr	PL
✓SF	Light Curtain	Safety-related stop function initiated by safeguard	d	e
✓SF	E-Stop	Emergency stop function	d	e

The Performance Level and Category achieved by each subsystem of the light curtain safety function, as calculated by SISTEMA, is shown below.

The screenshot shows the 'Subsystems' tab for the 'Light Curtain' safety function. A table lists three subsystems: 'Light Curtain: GuardShield 440L Type 4 - Single', 'Monitoring Safety Relay: GSR-DI', and '100S Contactors'. The 'PL' and 'Category' columns are circled in red, showing 'e' and '4' respectively for all subsystems.

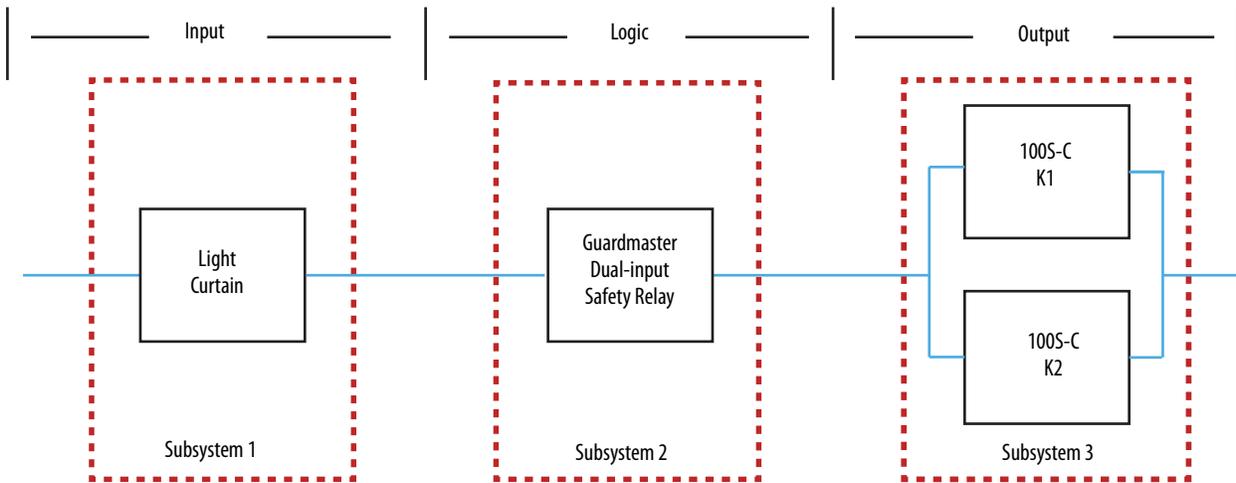
Sta...	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the category
✓SB	Light Curtain: GuardShield 440L Type 4 - Single	e	3.17E-9	not relevant	not relevant	not relevant	4	fulfilled
✓SB	Monitoring Safety Relay: GSR-DI	e	4.35E-9	not relevant	not relevant	not relevant	4	fulfilled
✓SB	100S Contactors	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled

The Performance Level and Category achieved by each subsystem of the E-stop safety function, as calculated by SISTEMA, is shown below.

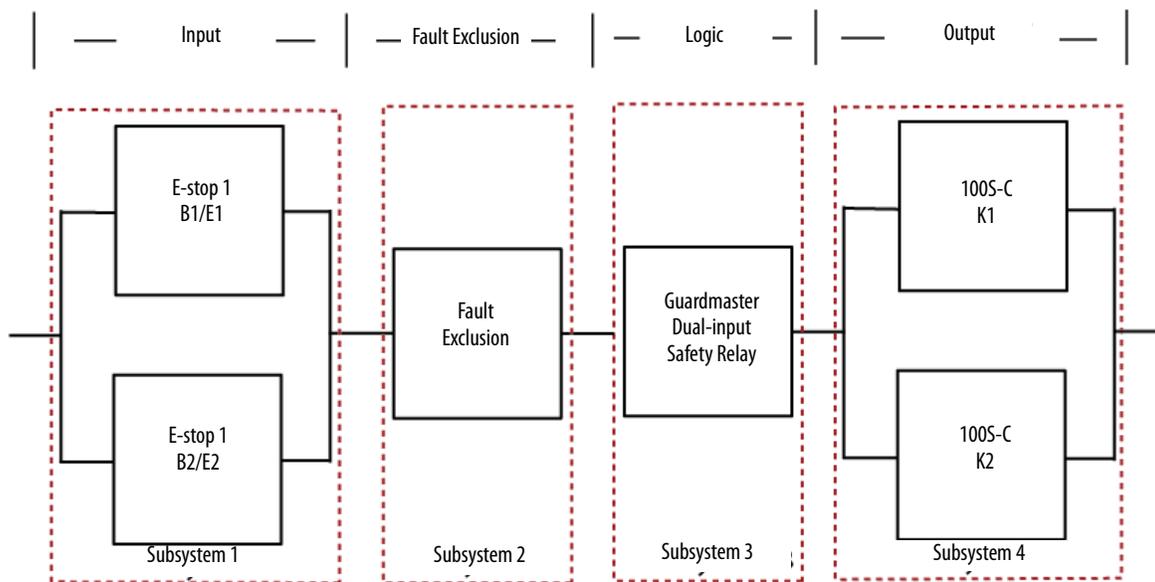
The screenshot shows the 'Subsystems' tab for the 'E-Stop' safety function. A table lists four subsystems: 'E-Stop', 'Fault Exclusion per EN ISO 13849-2:2012', 'Monitoring Safety Relay: GSR-DI', and '100S Contactors'. The 'PL' and 'Category' columns are circled in red, showing 'e' and '4' respectively for all subsystems.

Sta...	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the cate...
✓SB	E-Stop	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled
✓SB	Fault Exclusion per EN ISO 13849-2:2012	e	3.16E-8	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	100S Contactors	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled

The light curtain safety function can be modeled as follows.



The E-stop safety function can be modeled as follows.



Because the E-stop and 100S contactors are electromechanical devices, the safety contactor data includes the following:

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

The 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 that is 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 DCavg (99%) for the E-stop is selected from the Input Device table of ISO 13849-1 Annex E, Cross Monitoring.

The CCF value is generated by using the scoring process that is 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 emergency stop function is a complementary protective measure that is intended to be used with other safeguarding measures and protective devices to sufficiently reduce risk. The emergency stop function shall be designed not to impair the effectiveness of the other protective devices or safety functions. EN ISO 13849-2:2012 Annex D, Table D.8 allows a fault exclusion for mechanical aspects to be used for emergency stop devices in accordance with IEC 60947-5-5 as long as the maximum number of operations is considered.

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 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 validating the system, confirm that the Guardmaster 440C-CR30 configurable safety relay has been 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			
Input Devices			
Configurable Safety Relay			
Safety Contactor			
Safety Wiring and Relay Configuration Verification			
Test Step	Verification	Pass/Fail	Changes/Modifications
1	Confirm that all components' specifications are suitable for the application. Refer to Basic Safety Principles and Well-tried Safety Principles from ISO 13849-2.		
2	Visually inspect the safety relay circuit to confirm that it is wired as documented in the schematics.		
3	Confirm that the configuration in the dual-input safety relay is the correct, intended configuration.		
Normal Operation Verification - The safety system responds properly to all normal Start, Stop, Reset, and E-stop, inputs.			
Test Step	Verification	Pass/Fail	Changes/Modifications
1	Confirm that the system is powered up, the E-stop is not pressed, and the light curtain is not interrupted. Confirm that the ON status indicator on the dual-input safety relay is blinking.		
2	Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors. If the machine requires an additional start, provide that start. The machine begins to operate.		
3	While the machine continues to run, press the E-stop button. The dual-input safety relay de-energizes its safety outputs and the contactors. The machine stops.		

Verification and Validation Checklist

4	Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
5	Release the E-stop button. Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		
6	While the machine continues to run, interrupt the light curtain. The dual-input safety relay de-energizes its safety outputs and de-energies the contactors. The machine stops.		
7	While the light curtain is interrupted, press and release the Reset button of the dual-input safety relay. The safety relay does not respond.		
8	Restore the light curtain. Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Light Curtain Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	While the machine continues to run, remove the light curtain wire from terminal S32 of the dual-input safety relay. The safety relay immediately de-energizes its safety outputs. The machine stops.		
2	Reconnect the wire. Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
3	Interrupt the sensing plane on the light curtain, and then restore it.		
4	Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs.		
5	Repeat steps 1 . . . 4 by using the light curtain wire on S42.		
6	Short the light curtain input on S32 to 24V. After a brief time, the dual-input safety relay de-energizes its safety outputs. The red OSSDs OFF status indicator on the light curtain receiver flashes.		
7	Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
8	Cycle Power to the light curtain receiver and the dual-input safety relay. The red OSSDs OFF status indicator no longer flashes and the OUT status indicator on the safety relay blinks.		
9	Press and release the Reset on the dual-input safety relay. The safety relay energizes its safety outputs.		
10	Repeat steps 6 . . . 9 by using the light curtain input on S42 rather than S32.		
11	Short the light curtain input on S32 to 0V. After a brief time, the dual-input safety relay de-energizes its safety outputs. The red OSSDs OFF status indicator on the light curtain receiver flashes.		
12	Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
13	Cycle power to the light curtain receiver and the dual-input safety relay. The red OSSDs OFF status indicator no longer flashes and the OUT status indicator on the safety relay blinks.		
14	Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs.		
15	Repeat steps 11 . . . 14 by using the light curtain input on S42 rather than S32.		
16	Short the light curtain input on S32 to S42. After a brief time, the dual-input safety relay de-energizes its safety outputs. The red OSSDs OFF status indicator on the light curtain receiver flashes.		

Verification and Validation Checklist

17	Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
18	Cycle power to the light curtain receiver and the dual-input safety relay. The red OSSDs OFF status indicator no longer flashes.		
19	Press and release the Reset on the dual-input safety relay. The safety relay energizes its safety outputs.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
E-stop Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
	Note: Steps 1 . . . 8 validate proper E-stop operation in both the case of a single, loose wire, and in the case of one E-stop channel failing to open when the E-stop is pressed.		
1	While the machine continues to run, remove the E-stop wire on S12. The dual-input safety relay de-energizes its safety outputs and the contactors. The machine stops.		
2	Reconnect the wire to S12. Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
3	Release the E-stop button. Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
4	Press and release the E-stop button. Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		
5	Repeat steps 1 . . . 4 by using S22 in place of S12.		
6	While the machine continues to run, briefly jump 24V to E-stop terminal S12. The dual-input safety relay de-energizes its safety outputs and the contactors. The machine stops. The PWR/Fault status indicator on the dual-input safety relay is steady red.		
7	Press and release the Reset button on the dual-input safety relay, The safety relay does not respond.		
8	Cycle power to the dual-input safety relay. When the OUT status indicator on the safety relay begins to blink, press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		
9	Repeat steps 6 . . . 8 by using S22 in place of S12.		
10	While the machine continues to run, briefly jump 0V to E-stop terminal S12. The dual-input safety relay de-energizes its safety outputs and the contactors. The machine stops. The PWR/Fault status indicator on the dual-input safety relay is steady red.		
11	Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
12	Cycle power to the dual-input safety relay. When the OUT status indicator on the safety relay begins to blink, press and release the Reset button on the safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		
13	Repeat steps 10 . . . 12 by using S22 in place of S12.		
14	While the machine continues to run, briefly jump terminal S12 to terminal S22. The dual-input safety relay de-energizes its safety outputs and the contactors. The machine stops. The PWR/Fault status indicator on the safety relay blinks red.		
15	Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
16	Cycle power to the dual-input safety relay. When the OUT status indicator on the safety relay begins to blink, press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		

Verification and Validation Checklist

Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Guardmaster Dual-input Safety Relay Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	While the machine continues to run, turn the DI LOGIC rotary switch from the proper 2 position to position 5. The PWR/Fault status indicator blinks red-green twice, pauses steady green, and then repeats the red-green blinking. The machine continues to run.		
2	Confirm that the response of the dual-input safety relay to E-stop and light curtain inputs continues to be normal.		
3	Return the DI LOGIC setting to 2. The red-green blinking stops. The PWR/Fault status indicator is steady green. The system continues to operate normally.		
Validation of Safe Response to Abnormal Operation - The safety system responds properly to all foreseeable faults with corresponding diagnostics.			
Contactor Feedback - Guardmaster Dual-input Safety Relay Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	While the machine continues to run, break the connection between the K1 and K2 N.C. feedback contacts of the contactors. The machine continues to run.		
2	Press the E-stop button or interrupt the light curtain. The dual-input safety relay de-energizes its safety outputs and de-energizes the contactors. The machine stops.		
3	Release the E-stop or restore the light curtain. Press and release the Reset button on the dual-input safety relay. The safety relay does not respond.		
4	Restore the connection between the K1 and K2 N.C. feedback contacts of the contactors.		
5	Press and release the Reset button on the dual-input safety relay. The safety relay energizes its safety outputs and the contactors, which allows the machine to begin operating. Start the machine.		

Additional Resources

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

Resource	Description
Guardshield Type 4 and Guardshield Remote Teach User Manual, publication 440I-UM003	Provides instructions on how to install, configure, and maintain a Guardshield safety light curtain.
Guardmaster Safety Relay DI Installation Instructions, publication 440R-IN037	Provides instructions on how to install, configure, and reset a Guardmaster dual-input safety relay.
Safety Contactors with DC Coil Installation Instructions, publication 100S-IN006	Provides instructions on how to install 100S-C safety contactors.
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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