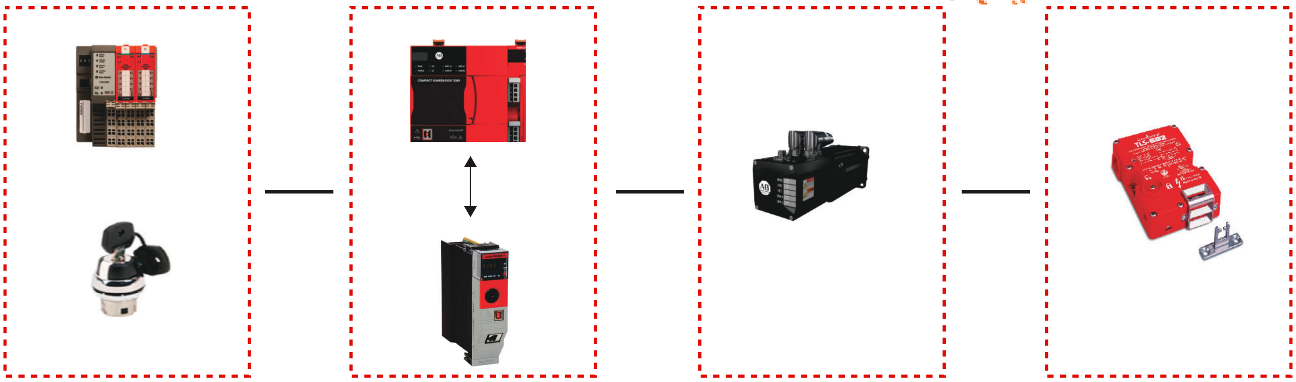
Application Technique

Original Instructions

Safely-Limited Speed (SLS) with Safe Direction (SDI) for ArmorKinetix Safety Function

Products: 1734 Point I/O Safety Modules, GuardLogix 5580 or Compact GuardLogix 5380 Controller, ArmorKinetix ERS5 Distributed Servo Motor with SIL 2 Encoder, TLS3-GD2 Locking Gate Switch

Safety Rating: PLd to ISO 13849-1: 2015



Rockwell Automation

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.

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 help 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 help 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 13857:2019 (Safety of Machinery – Safety distances to help prevent hazardous zones being reached by upper and lower limbs)

ANSI B11:19 2019 (Machines – Performance Criteria for Safeguarding)

Separating safeguards monitor a movable, 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)

EN ISO 13857:2019 (Safety of Machinery – Safety distances to help prevent hazardous zones being reached by upper and lower limbs)

ANSI B11:19 2019 (Machines – Performance Criteria for Safeguarding)

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

Introduction

This safety function application technique explains how to wire, configure, and program a GuardLogix® 5580 controller to interface with an ArmorKinetix® Distributed Servo Motor (DSM) 2198-DSM*xxx*-ERS5-*xxxxxx*-*xxxxxx* drive/motor combination to perform the Safely-Limited Speed (SLS) with Safe Direction (SDI) safety function. The ArmorKinetix DSM brings the encoder data into the GuardLogix safety task. The GuardLogix safety controller contains logic to monitor Safely-Limited Speed (SLS) and Safe Direction (SDI). When the hazard is rotating below the safe speed and in the correct direction, safety logic unlocks the locking guard door. A safety input module is used to monitor the guard locking switch and a safety output module is used to control the locking function of the locking guard door switch.

The motion control actuator for the safety functions in this document is the ArmorKinetix DSM motor. Any malfunction detected by the safety system results in a Safe Stop 1 (SS1) which is a safely monitored decel, followed by Safe Torque Off (STO).

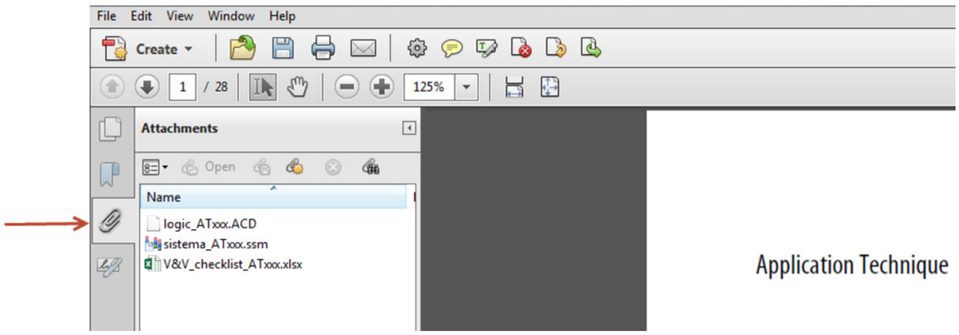
This example uses a GuardLogix controller, but you can substitute a Compact GuardLogix controller that supports the safety rating that is demonstrated in this safety function application technique. The Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA) calculations that are shown later in this document must be recalculated if different products are used.

Use Sample Project Files

Sample project files (ACD, SISTEMA, and Verification and Validation checklist) are attached to this document to help you implement this safety function.

To access these files, follow these steps.

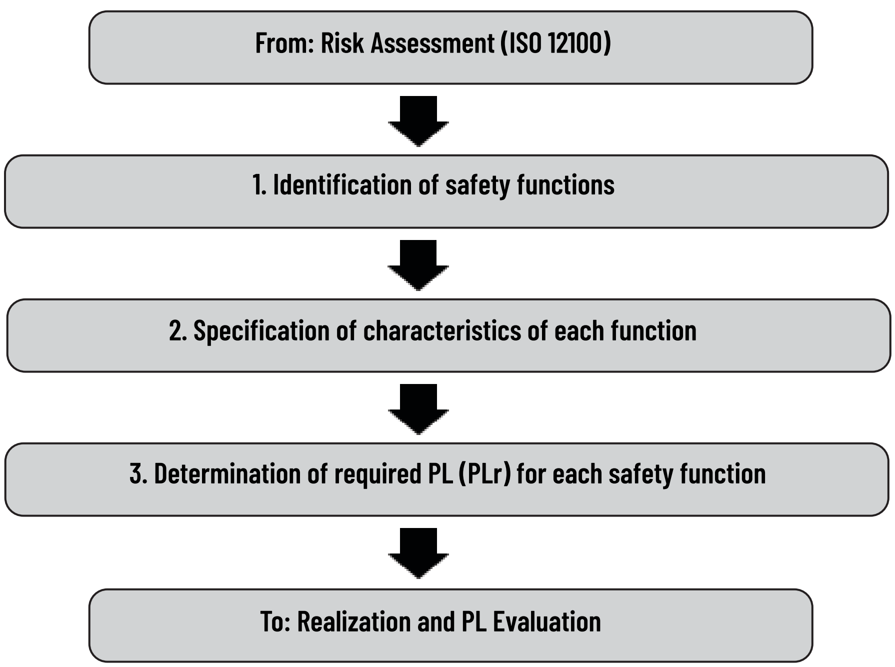
1. If you are viewing the PDF file in a browser and do not see the Attachments link, download the PDF file and open it in the Adobe Acrobat Reader application.
2. Click the Attachments link.
3. Right-click and save the desired file.



4. Open the file in the appropriate application.

Safety Function Realization: Risk Assessment

The Performance Level required (PLr) 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 that is required by the risk assessment is Performance Level d (PLd), for each safety function. A safety system that achieves 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.



Safely-Limited Speed (SLS) with Safe Direction (SDI) for ArmorKinetix Safety Functions

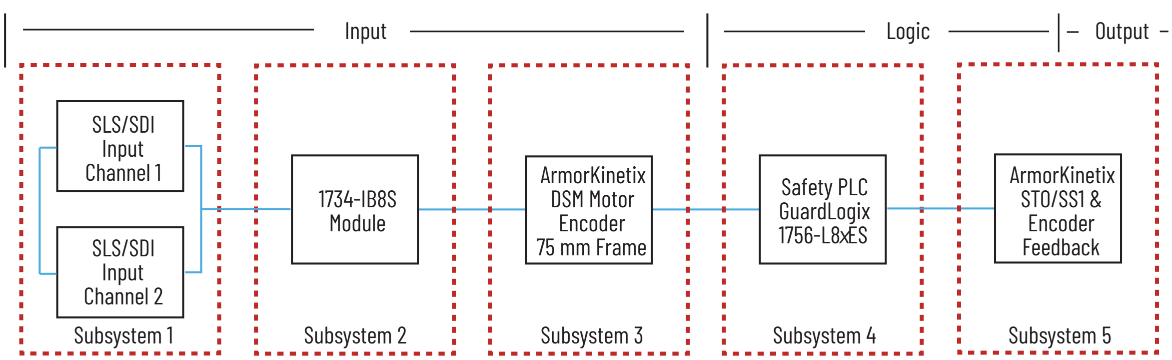
This application technique includes five safety functions:

1. Safely-Limited Speed monitoring (SLS)
2. Safe Direction monitoring (SDI)
3. Guard door unlock at Safely-Limited Speed and Safe Direction
4. Guard door unlock at standstill speed (with Safe Stop 1 monitoring)
5. Safe Stop and prevention of hazardous motion (with guard door lock/position monitoring)

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

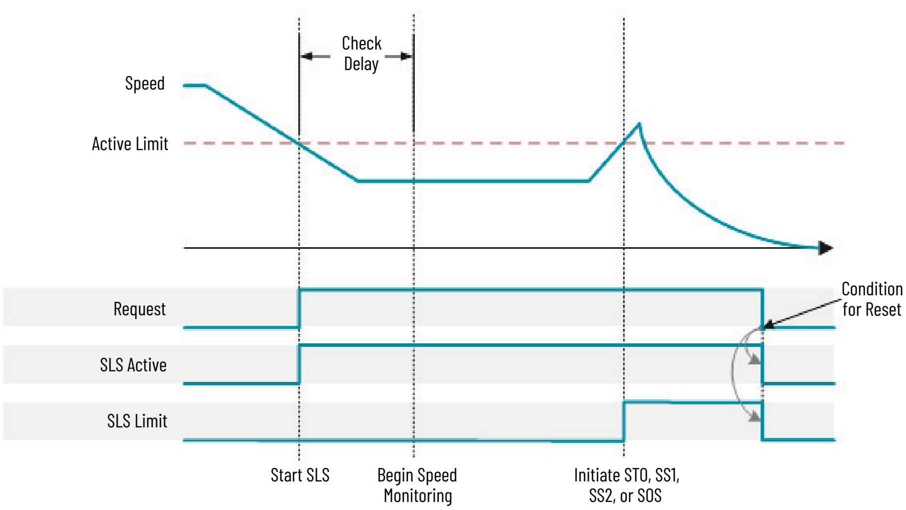
Safety Function Requirements

Safely-Limited Speed Monitoring (SLS)



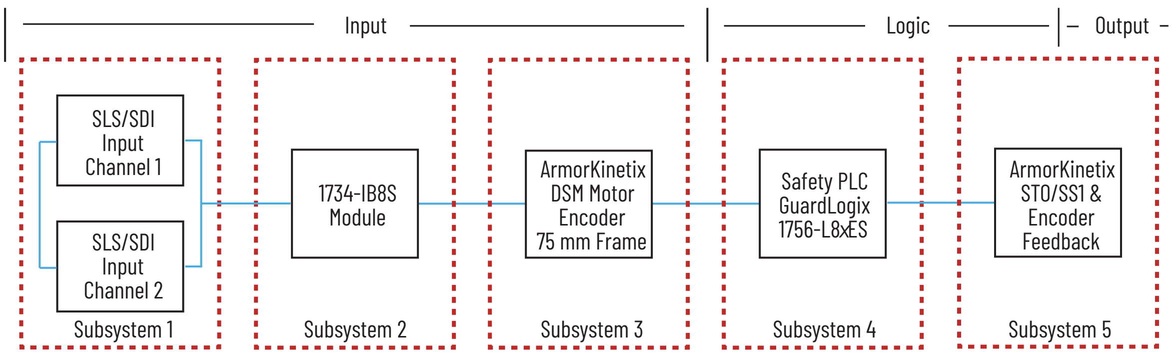
The SLS instruction monitors the encoder speed of the actuator to confirm that the speed does not go above the defined limit. When Safely-Limited Speed (SLS) is requested, the motor speed must get below the programmed speed limit before the SLS check time delay expires. After the delay expires, the speed must remain below the limit. If the programmed speed limit is exceeded after the delay expires, a Safe Stop 1 (SS1) is initiated to stop the axis. When the motor reaches standstill speed, the SS1 initiates an STO function that disables the axis and removes the ability to produce torque.

In this example, a two-position maintained key selector switch is used to request an SLS operation. When the key is in the SLS/SDI mode position, the key can be removed to maintain exclusive control while the task that requires SLS is performed.



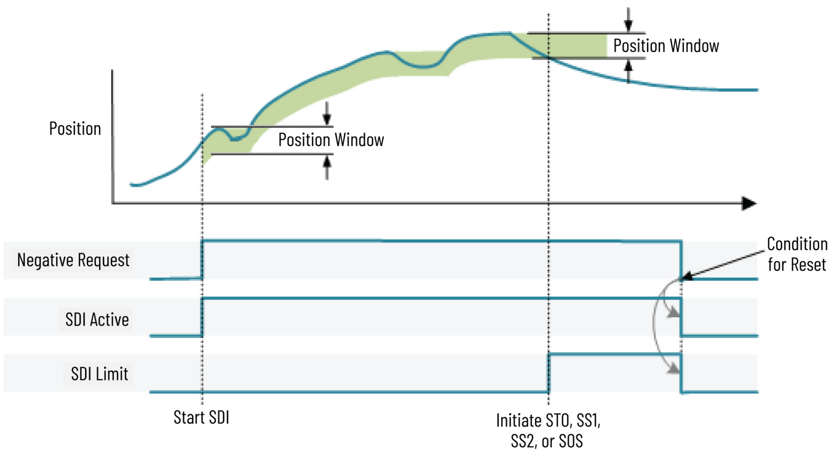
IMPORTANT	A risk assessment is used to determine the SLS limit for the application.

Safe Direction Monitoring (SDI)



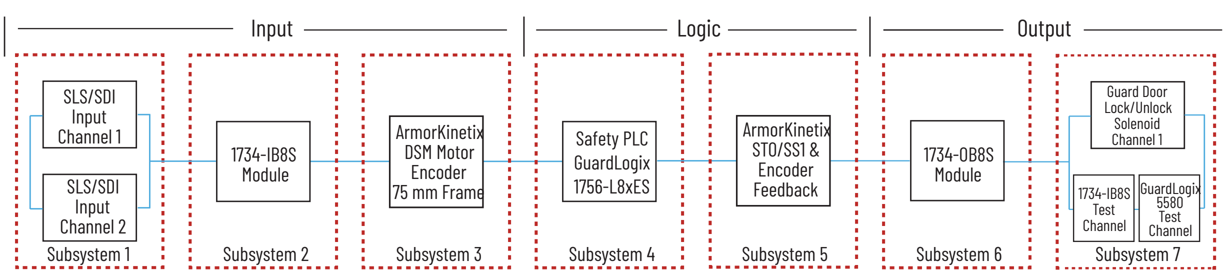
The SDI instruction monitors the direction of movement of the actuator to confirm that the position does not move in the incorrect direction more than the defined position window limit from the location where the excluded direction is identified. SDI instruction monitoring differs from safely limited position monitoring in that the window continues to move as long as the actuator is moving in the desired direction. When SDI is requested, the actuator can reverse direction but must stay within the programmed Position Window Limit. If the programmed position window limit is exceeded, a Safe Stop 1 (SS1) is initiated to stop the axis. When the motor reaches standstill speed, the SS1 initiates an STO function that disables the axis and removes the ability to produce torque.

In this example, a two-position maintained key selector switch is used to request SDI. When the key is in the SLS/SDI mode position, the key can be removed to maintain exclusive control while the task that requires SDI is performed.



IMPORTANT	Risk assessment is used to determine the Safe Direction and position window limit for the application.

Guard Door Unlock: Safely-Limited Speed with Safe Direction



Guard door unlock is a safety function used to protect people. The guard door unlock is a safety output function that is based on safety inputs that detect safe-to-enter conditions. All safe-entry conditions must be detected with safety integrity that meets the level of the unlock safety function.

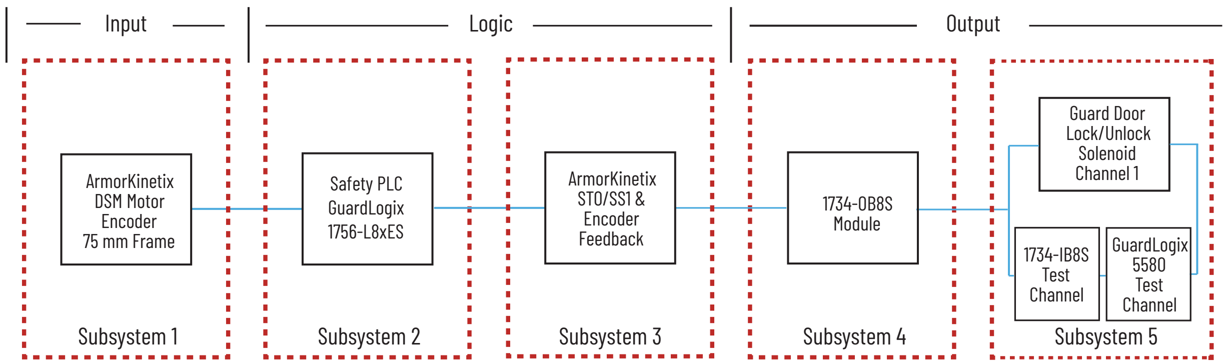
A locking gate switch is used to allow access to the hazardous area. SLS with SDI is the primary guard door unlock condition. After a configurable check delay occurs and the actuator is determined to be operating at a safe speed (SLS) in the desired direction (SDI), the guard door is allowed to unlock.

IMPORTANT	A risk assessment is used to determine the conditions necessary for a guard door unlock.

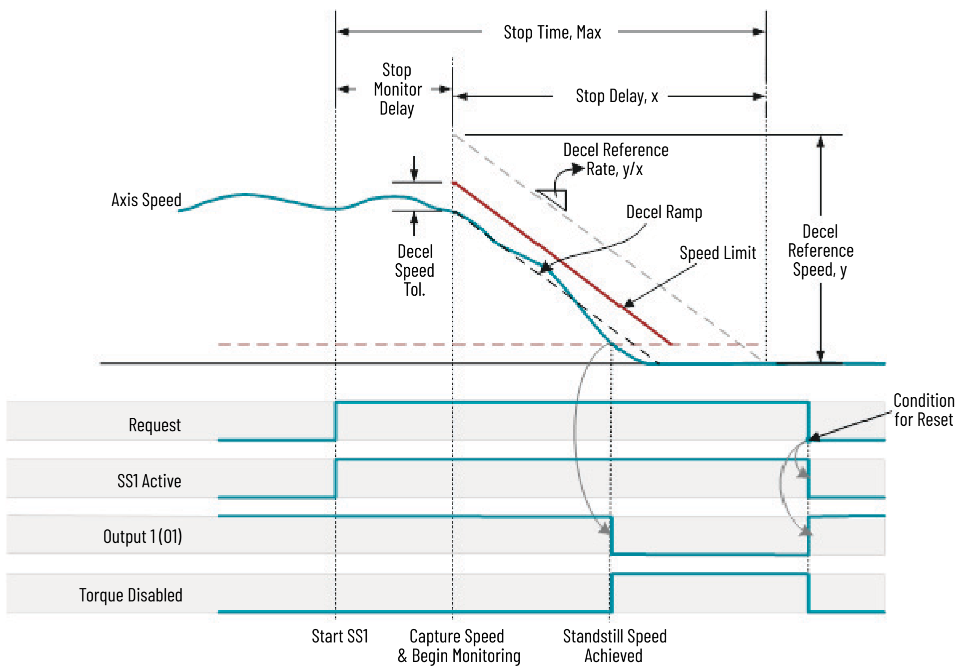
One safety output is used to control the unlock circuit. The safety outputs are rated Category 2/PLd when used as a single-channel output which meets the stated requirements of this application.

In this example, a two-position maintained key selector switch is used to request SLS and SDI simultaneously. When the key is in the SLS/SDI mode position, the key can be removed to maintain exclusive control while the task that requires SLS with SDI is performed. The triggering event is considered part of the safety function for this application.

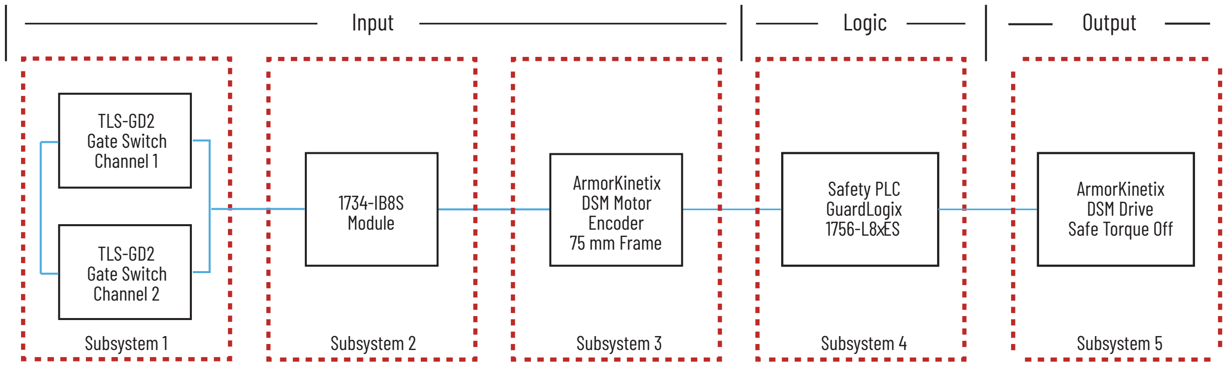
Guard Door Unlock: Zero Speed (SS1 and Standstill Monitoring)



When a Safe Stop is requested or a safety fault is detected, the actuator motor control executes an SS1. The SS1 monitors the encoder speed feedback to verify that the properly configured decel ramp is followed. When the configured Standstill speed is reached, the SS1 logic requests a Safe Torque Off (STO) and unlocks the guard door. If a deceleration fault occurs during the SS1 decel ramp, the STO executes immediately, and no SS1 standstill is declared.



Safe Stop and Prevention of Unexpected Startup



This example uses safety functions that are already described for the prevention of unexpected startup. A safe stop occurs when an SLS speed limit is exceeded or a SDI Position Window limit is exceeded during SLS with SDI guard door unlock. A safe stop also occurs when the guard door is unlocked or opens when not commanded, or a safety fault is detected. Safe Torque Off helps prevent an unexpected startup when a guard door is unlocked or open after completion of SS1. The machine safety zone is prevented from resetting until a safe running condition is confirmed.

Considerations for Safety Distance and Stopping Performance

The risk assessment determines if a safety distance calculation is required. Typically, a safety distance calculation is required for safe position and speed monitoring safety functions. If a safety distance calculation is required for this safety function, the following documents can be referenced:

- GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012
- Machinery SafeBook 5 – Safety related control systems for machinery, publication SAFEBK-RM002
- Light Curtain and GuardLogix Controller Safety Function Application Technique, publication SAFETY-AT191

Integrated Safety: Safe Stop 1 (SS1) Considerations for a Stop Category 1

Safe Stop 1 is a safely monitored decel followed by Safe Torque Off (STO) at standstill speed. If there is a malfunction, the most likely stop category is category 1. SS1 requires an application-specific configuration that includes considerations for machine speed, running inertias, and decelerations rates. SS1 may require configuration in both the controller and the drive. If not properly configured, or in a malfunction of the SS1 monitoring functions an STO may occur resulting in a category 0 stop. When designing the machine application, timing and distance must be considered for a coast-to-stop action, and the possibility of the loss of control of a vertical load. Use additional protective measures if a category 0 stop could introduce unacceptable risks to personnel.

Bill of Materials

This application technique uses these products.

Quantity	Cat. No.	Description
1	440G-T27181	TLS3-GD2 Power to Release safety interlock switch
1	800FM-KM22MX02	Two-position key selector switch, metal, maintained, right key removal, two N.C. contacts
1	1734-AENTR	24V DC EtherNet/IP™ adapter, two ports
4	1734-TB	Module base with removable IEC screw terminals
1	1734-IB8S	POINT Guard safety eight-point 24V DC sinking input module
1	1734-OB8S	POINT Guard safety eight-point 24V DC sourcing output module
1	1606-XLE240E	DC power supply, 24…28V DC, 240 W, 120/240V AC

Choose one of the following safety-controller hardware groups.

Quantity	Controller	Cat. No.	Description
1	GuardLogix 5580	1756-L81ES	GuardLogix Processor, 3 MB standard memory, 1.5 MB safety memory
		1756-L82ES	GuardLogix Processor, 5 MB standard memory, 2.5 MB safety memory
		1756-L83ES	GuardLogix Processor, 10 MB standard memory, 5 MB safety memory
		1756-L84ES	GuardLogix Processor, 20 MB standard memory, 6 MB safety memory
1		1756-PA72	Power supply, 120/240V AC input, 3.5 A @ 24V DC
1		1756-A7	Seven-slot ControlLogix® chassis
1	Compact GuardLogix 5380–SIL 2	5069-L306ERMS2	Compact GuardLogix processor, 0.6 MB standard memory, 0.3 MB safety memory
		5069-L310ERMS2	Compact GuardLogix processor, 1.0 MB standard memory, 0.5 MB safety memory
		5069-L320ERMS2	Compact GuardLogix processor, 2.0 MB standard memory, 1.0 MB safety memory
		5069-L330ERMS2	Compact GuardLogix processor, 3.0 MB standard memory, 1.5 MB safety memory
		5069-L340ERMS2	Compact GuardLogix processor, 4.0 MB standard memory, 2.0 MB safety memory
		5069-L350ERMS2	Compact GuardLogix processor, 5.0 MB standard memory, 2.5 MB safety memory
		5069-L380ERMS2	Compact GuardLogix processor, 8.0 MB standard memory, 4.0 MB safety memory
		5069-L3100ERMS2	Compact GuardLogix processor, 10.0 MB standard memory, 5.0 MB safety memory
1		5069-ECR	Right end cap and terminator
1		5069-RTB64-SCREW	5069 Compact I/O™ power terminal RTB kit for both 4- and 6-pin screw

Choose a ArmorKinetix Distributed Servo Motor.

Quantity	Cat. No.	Description
1	2198-P031	Kinetix® 5700 DC bus supply
1	2198-PIM070	Kinetix 5700 Power Interface Module
1	2090-CDHIFS-12AF03	PIM to DSX Hybrid Cable - 3 m (9.8 ft)
1	2198-DSM016-ERS5-B0751M-WJ12AA	ArmorKinetix Integrated Motor Drive - ERS5, 460V, 75 mm (2.95 in.)

Setup and Wiring

For detailed information on how to install and wire the products in this application technique, refer to the publications that are listed in the Additional Resources on page 33.

System Overview

This application technique demonstrates how to achieve the safety functions with an ArmorKinetix Distributed Servo Motor. The bill of materials specifies a part number for the Distributed Servo Motor for simplicity, but multiple catalog numbers provide the same results.

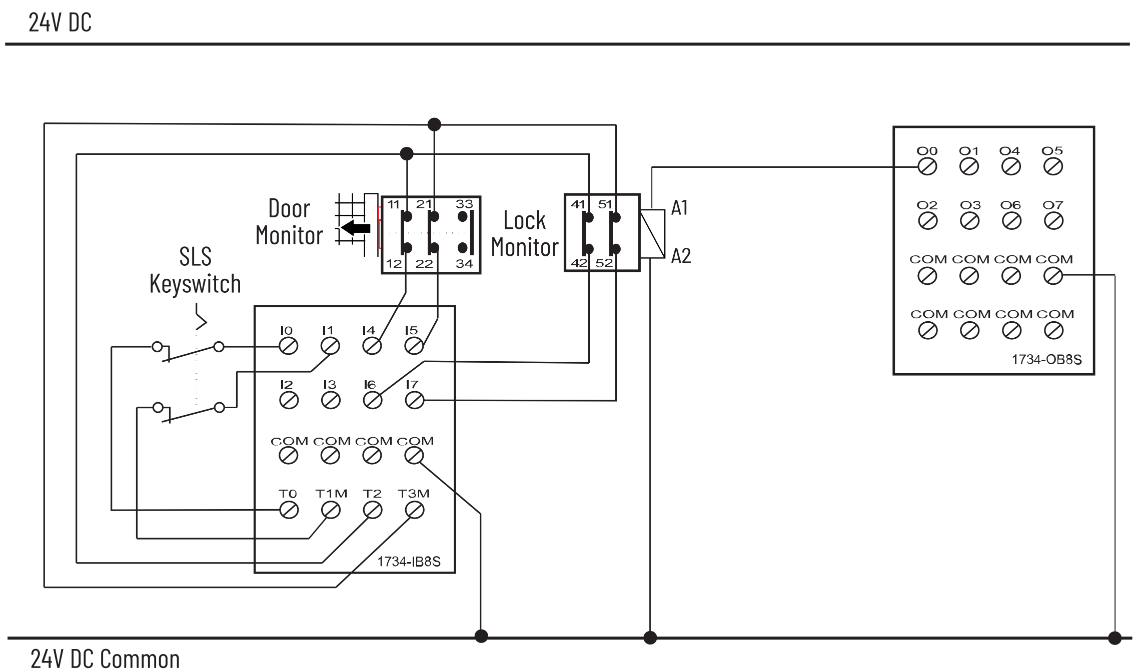
For the ArmorKinetix solution, the system requires a power supply and a Power Interface Module (PIM), but these components are not considered part of the safety system. Therefore, any of the Kinetix power supplies can be applied without affecting the safety rating of the system.

The safety functions covered in this document use an ERS5 ArmorKinetix distributed servo drive. Other Rockwell Automation CIP Safety drives with motion monitoring capability, when paired with a SIL 2 or higher encoder, could accomplish similar functionality. Only minor modifications to accommodate the hardware differences are required. If different products are used, recalculate the safety calculations that are shown later in this document.

The 440G-T guard locking switch is wired to the 1734-IB8S safety input module and the 1734-OB8S safety output module. Guard door input power is supplied from a test output that is configured as a pulse test. The dual-channel closed signal is connected to safety inputs 4 and 5. The dual-channel locked signals are connected to safety inputs 6 and 7. Safety output 0 controls the guard door unlock directly.

This example uses the SIL2 encoder attached to the motor shaft to provide single-feedback monitoring. In this example, safety speed and direction feedback are supplied by the DSMs integrated Hiperface DSL encoder. The frame size of the motor determines the integrated encoder. There are two different options for the SIL 2 encoder that is installed in the DSM. In this example, the smallest frame DSM with the W encoder option was used. All other frames use the T encoder option. The larger frames can be applied, but the calculations must be redone to reflect the variances in the ratings. The encoder is wired internally to the DSM feedback circuitry. The data for the encoder is passed directly to the safety channel of the drive.

Electrical Schematic



Network Architecture

GuardLogix 5580 Controller with remote Guard I/O™ (1)

- I/O Configuration
  - 1756 Backplane, 1756-A4
    - [1] 1756-L84ES GLX01
  - Ethernet
    - 1756-L84ES GLX01
    - 1734-AENTR/C PointIO_Block01
      - PointIO 3 Slot Chassis
        - [0] 1734-AENTR/C PointIO_Block01
        - [1] 1734-IB8S/B Point_Safety_Inputs01
        - [2] 1734-OB8S/B Point_Safety_Outputs01
    - 2198-P070 KNX_5700_DFE_Module01
    - 2198-PIM070 KNX_5700_PIM_Module01
    - 2198-DSM016-ERS5 KNX_5700_DSM_Module01

GuardLogix 5380 Controller with local Guard I/O

- I/O Configuration
  - 5069 Backplane
    - [0] 5069-L3100ERMS2 GLX01
  - A1/A2, Ethernet
    - 5069-L3100ERMS2 GLX01
    - 1734-AENTR/C PointIO_Block01
      - PointIO 3 Slot Chassis
        - [0] 1734-AENTR/C PointIO_Block01
        - [1] 1734-IB8S/B Point_Safety_Inputs01
        - [2] 1734-OB8S/B Point_Safety_Outputs01
    - 2198-P070 KNX_5700_DFE_Module01
    - 2198-PIM070 KNX_5700_PIM_Module01
    - 2198-DSM016-ERS5 KNX_5700_DSM_Module01

(1) When using a GuardLogix 5580 controller, slot 2 is reserved for the safety partner, which is required for SIL 3/PLe applications.

Configuration

The GuardLogix controller is configured by using the Studio 5000 Logix Designer® application, version 35 or later. You must create a project and add the ArmorKinetix and POINT I/O™ components. A detailed description of each step is beyond the scope of this document. Knowledge of the Logix Designer application is assumed.

For a Studio 5000 Logix Designer project file that you can import into your own project, see the attached ACD file. The attached ACD file includes a GuardLogix 5580 controller, but if you choose a 5380 controller, you can change the controller in the Logix Designer application. For instructions on how to access the attachments, see Use Sample Project Files on page 4.

Minimum Software Version	Product
Logix Designer application version 35	GuardLogix 5580 or Compact GuardLogix 5380 controller
Firmware revision 14	ArmorKinetix DSM with ERS5 option
Add-on Profile version 29.04	ArmorKinetix DSM

IMPORTANT Only the safety-related programming and configuration are discussed in this document. Standard motion control is required to satisfy the safety monitoring functions but is beyond the scope of this document.

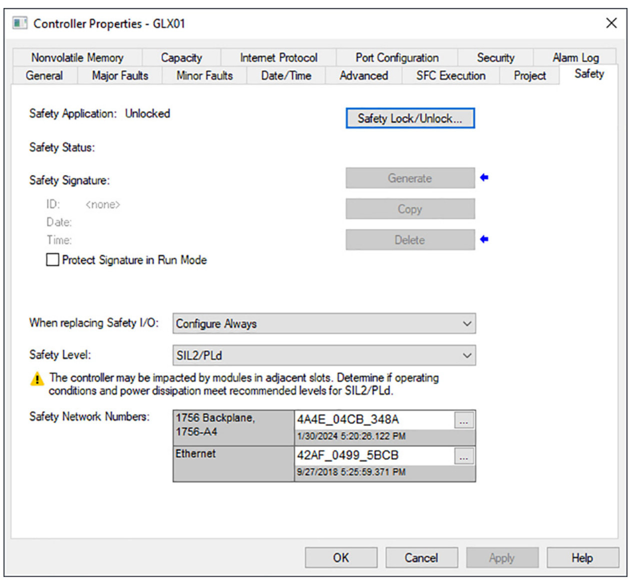
Create a Project with a GuardLogix Controller

If you are not using the attached ACD file, follow these steps to create a project. For instructions on how to access the attachments, see Use Sample Project Files on page 4.

1. In the Logix Designer application, create a project at revision 35 or later with a GuardLogix controller.

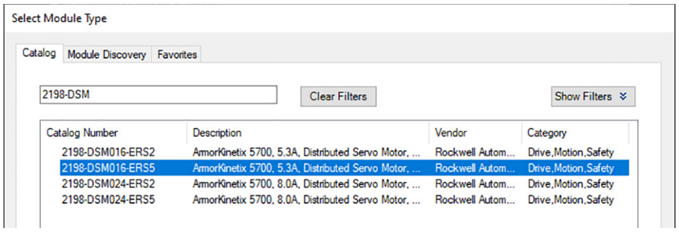
IMPORTANT If you use a GuardLogix 5580 controller, you must configure the safety level of the controller on the Safety tab of the Module Properties dialog box. The default setting is SIL 2, PLd. For SIL 3, PLe operation, you must have a 1756-L8SP Safety Partner installed to the right of the primary controller.

2. Set the IP address for the controller.
3. On the controller Safety tab, select SIL2/PLd Safety Level. This example has a PL requirement of PLd. The Primary only (no L8SP partner) GuardLogix 5580 is capable of PLd.



ArmorKinetix Configuration - Device Definition

1. Add the Kinetix 5700 power supply and Power Interface Module (PIM) to the I/O configuration. These components are required, but not part of the safety function.
2. Set the IP address for the Kinetix 5700 power supply and PIM.
3. Create Motion Group
4. Create axes for the Kinetix 5700 power supply and PIM. Associate the Axes with the Kinetix 5700 power supply and PIM hardware.
5. Add a 2198-DSMxxx-ERS5 Distributed Servo Motor to the I/O Configuration.

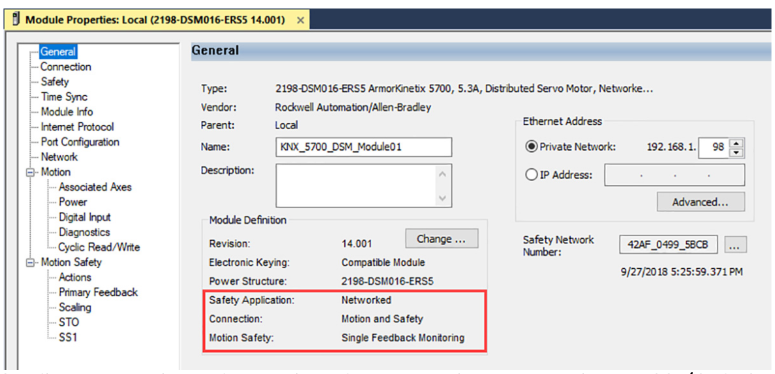


6. Set the IP address for the ArmorKinetix DSM.

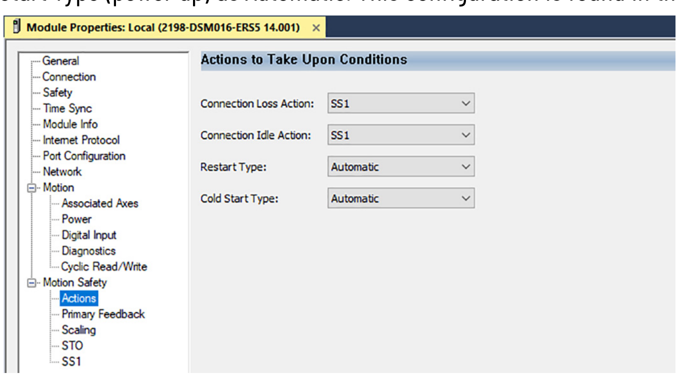
ArmorKinetix Configuration - Initial Safety Configuration

1. Configure the General safety properties of the Advanced Safety drive as shown in the following table. Secondary feedback is not required to achieve PLd for the safety function being used in this example. This configuration is found in the drive properties.

Safety Application	Networked
Connection	Motion and safety
Motion Safety/Safety Instance	Single feedback monitoring

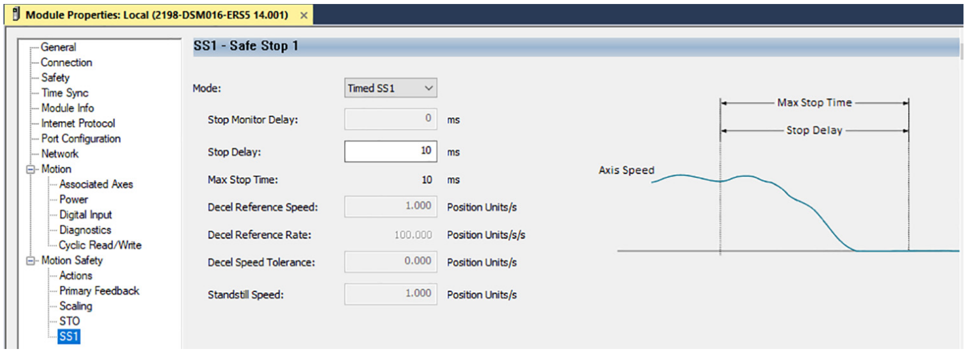


2. Configure the drive safety actions for connection loss and idle as SS1 (Safe Stop 1). Configure the Restart Type (normal stop) and Cold Start Type (power up) as Automatic. This configuration is found in the Module Safety>Actions category.

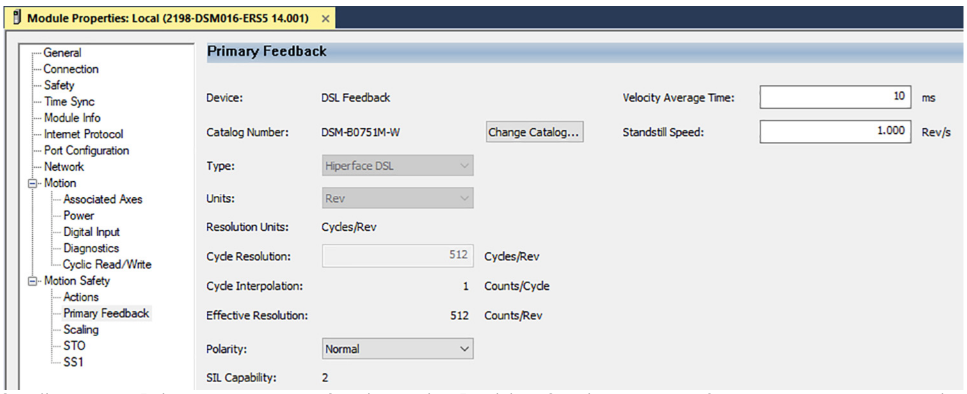


IMPORTANT	If you have the Connection Loss Action and Connection Idle Action set for SS1 instead of STO, the SS1 function must be properly configured in the drive.

3. Configure Safe Stop 1 (SS1) per the safety assessment. In this example, we configured the mode as Timed SS1 with a Stop Delay of 10 ms.



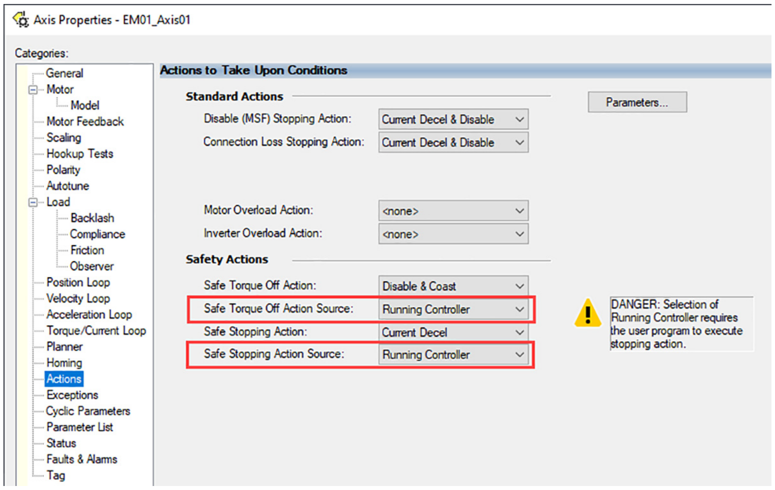
4. Configure the Safety Primary Feedback based on the drive hardware and feedback resolution selected. The effective resolution varies depending on the feedback device used.



5. Configure the Primary Feedback Scaling. With Position Scaling set at 512, the Feedback Resolution in the SFX instruction produces an actual speed of 1.0 when velocity is 1 revolution per second.

Axis Configuration

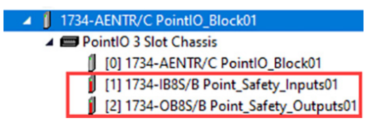
1. Create an axis for the DSM and associate the axis with the DSM hardware.
2. Configure the STO and SS action source as Running Controller. This configuration is done in the Actions category of the axis properties. This setting indicates that the safety and standard program of the GuardLogix controller controls speed when SLS mode is requested, and STO execute stopping actions if SLS does not operate correctly.



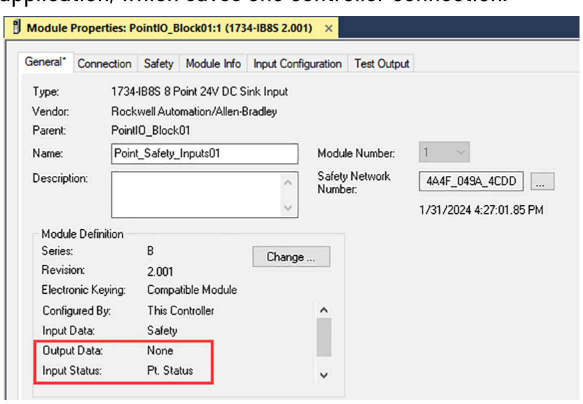
IMPORTANT	With this configuration, all conditions that require the drive to stop or enter a Safe Torque Off state, except for communication faults, must be managed in the controller.

Point I/O Configuration

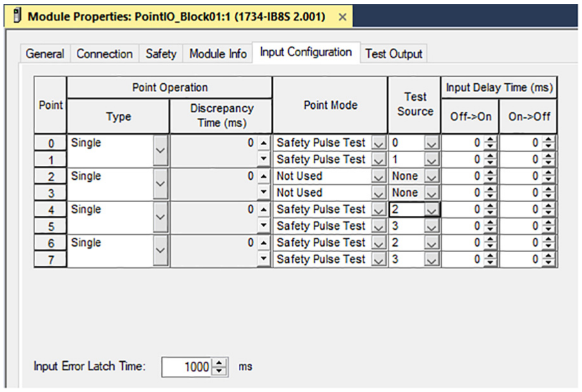
1. Add the Point I/O Ethernet adapter and set the IP address.
2. Add Point I/O modules. Two are required for this application, a safety IB8S input module and a safety OB8S output module.

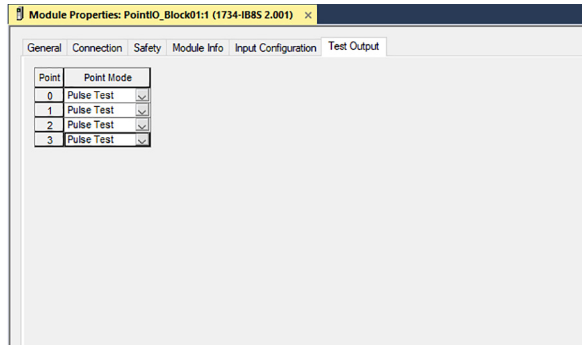


3. On the General tab of the Module Definition, configure the IB8S Input Status for Pt. Status to generate an individual point status tag for each channel. Configure the Output Data as None because the use of the Test Outputs as standard outputs is not required in this application, which saves one controller connection.

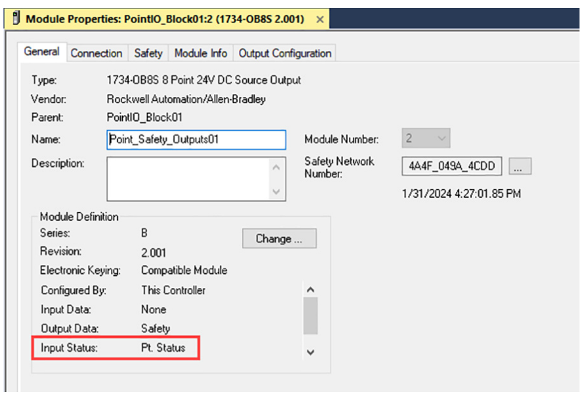


4. The IB8S Input Configuration tab represents the input wiring points that is used in this example (Keyswitch points 0 and 1, Door Monitor points 4 and 5, Lock Monitor points 6 and 7). Test outputs 0 and 1 source the 24V DC for the SLS mode keyswitch. Test outputs 2 and 3 source the 24V DC for the door monitor and lock monitor channels. All four test outputs must be configured for pulse test in this application.

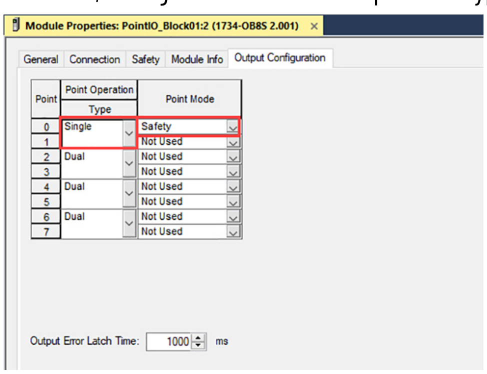




5. On the General tab of the Module Definition, configure the OB8S Input Status for Pt. Status to generate an individual point status tag for each channel.



6. In this application, the only safety output that is required is the door lock solenoid. On the Output Configuration tab of the Module Definition, configure the OB8S Point Operation Type for points 0 and 1 as Single and the Point Mode for point 0 as Safety.



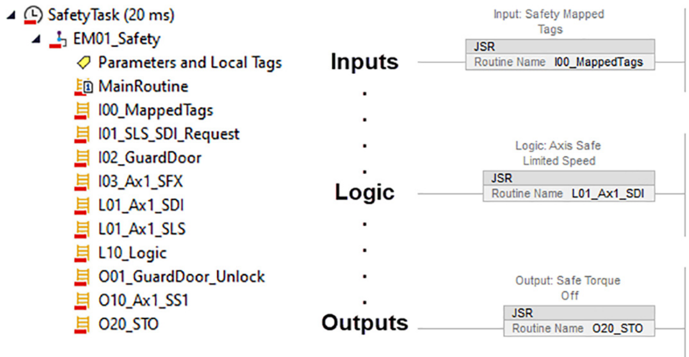
Programming

For controller logic that you can download to your controller, see the attached ACD file. For instructions on how to access the attachments, see Use Sample Project Files on page 4.

The following sections describe the logic used to accomplish this safety function. Not every rung has been described in this document. The straightforward rungs have been omitted to reduce the size of the document. Reference the attached ACD file to see all logic used.

Programming Safety - General Task Configuration

1. For modularity, and following application software guidance from safety standards, the safety zone program has been broken into routines for input, logic, and output. Be sure to call all routines from the MainRoutine.



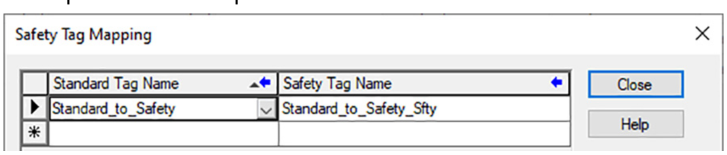
2. Map safety tags using User Defined Type (UDT).
   a. Create Standard and Safety tags of the same Data Type.

Controller Tags - GLX01(controller)

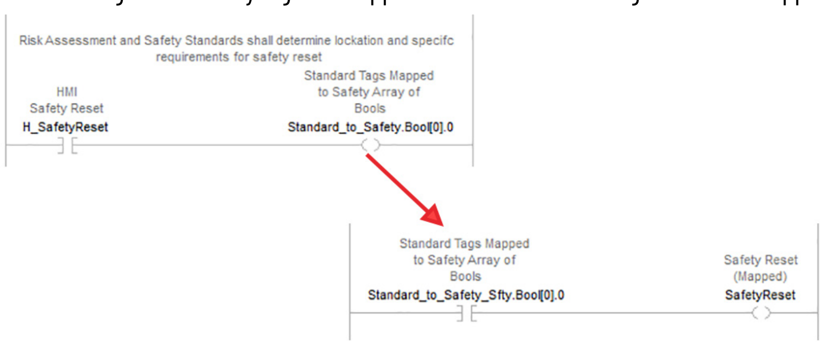
Scope: GLX01 Show: All Tags Safe

Name	Value	Data Type	Description
◢ Standard_to_Safety	{...}	UDT_Mapped_Tags	Standard Tags Mapped to Safety
▷ Standard_to_Safety.Bool	{...}	DINT[10]	Standard Tags Mapped to Safety Array of Bools
▷ Standard_to_Safety.DINT	{...}	DINT[20]	Standard Tags Mapped to Safety Array of Dints
▷ Standard_to_Safety.REAL	{...}	DINT[20]	Standard Tags Mapped to Safety Array of Reals
◢ Standard_to_Safety_Sfty	{...}	UDT_Mapped_Tags	Standard Tags Mapped to Safety
▷ Standard_to_Safety_Sfty.Bool	{...}	DINT[10]	Standard Tags Mapped to Safety Array of Bools
▷ Standard_to_Safety_Sfty.DINT	{...}	DINT[20]	Standard Tags Mapped to Safety Array of Dints
▷ Standard_to_Safety_Sfty.REAL	{...}	DINT[20]	Standard Tags Mapped to Safety Array of Reals

A best practice is to map a UDT of information.



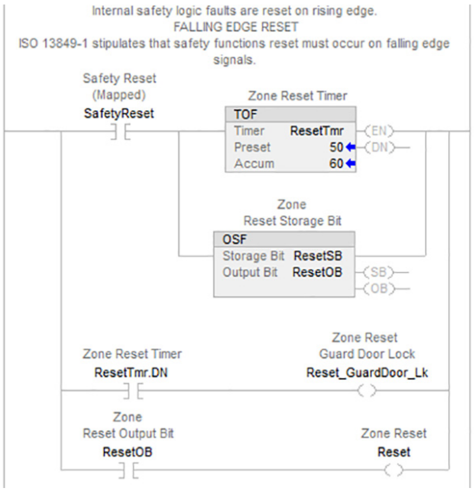
3. The reset signal for safety logic is mapped from the standard logic with the mapped alias.



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 is used on the reset rung. Then, the OSF instruction Output Bit tag is used as the reset bit for the STO output rung.

Risk Assessment and Safety Standards shall determine the location and specific requirements for safety reset.

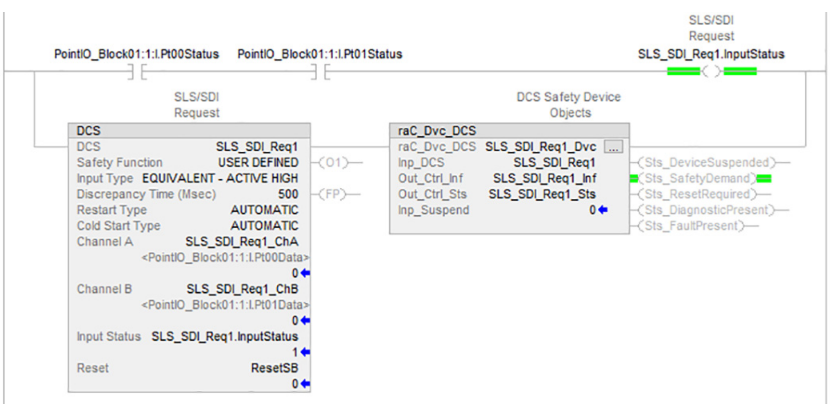


Programming - Input I01_SLS_SDI_Request

Rung 0

Table 1 - SLS/SDI Keyswitch Input

Parameter	Description
InputStatus	Combine the input status of the inputs before the DCS.
DSC	Dual Channel Stop instruction for monitoring two inputs and associated I/O status.
raC_Dvc_DCS	The optional raC_Dvc_DCS AOI connects DCS to HMI Faceplate (ME, SE, PV5000). To find this information, go to rok.auto/pcdc, and search for Safety Device Library.



Rung 1

Table 2 - SLS/SDI Summary

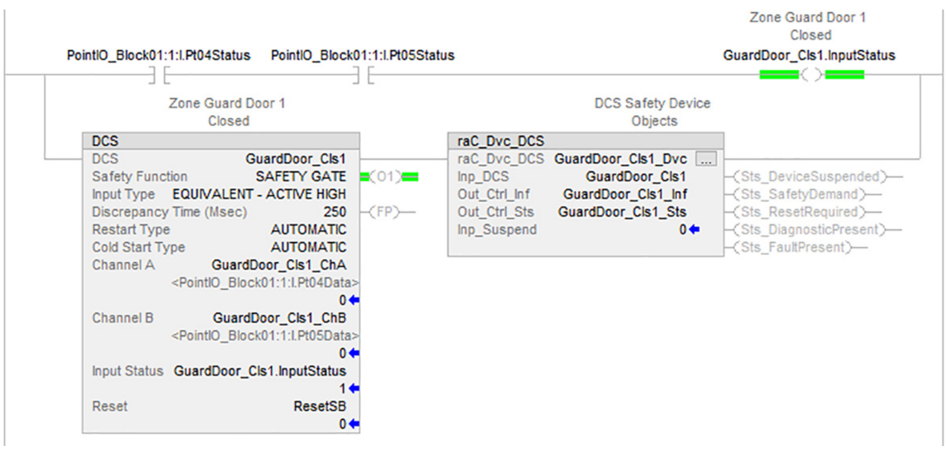
Parameter	Description
SLS_Req_CycleTmr	Timer to help prevent rapid requests that can cause GD_Unlock CROUT.FP
SLS_ReqInit	Request to initiate SLS
SDI_ReqInit	Request to initiate Safe Direction

Programming - Input I02_GuardDoor

Rung 0

Table 3 - Guard Door Closed Input

Parameter	Description
InputStatus	Combine the input status of the inputs before the DCS.
DSC	Dual Channel Stop instruction for monitoring two inputs and associated I/O status.
raC_Dvc_DCS	The optional raC_Dvc_DCS AOI connects DCS to HMI Faceplate (ME, SE, PV5000). To find this information, go to rok.auto/pcdc, and search for Safety Device Library.



Programming - Input I03_Ax1_SFX

The Input SFX routine brings safe speed and position feedback into the safety task.

Rung 0

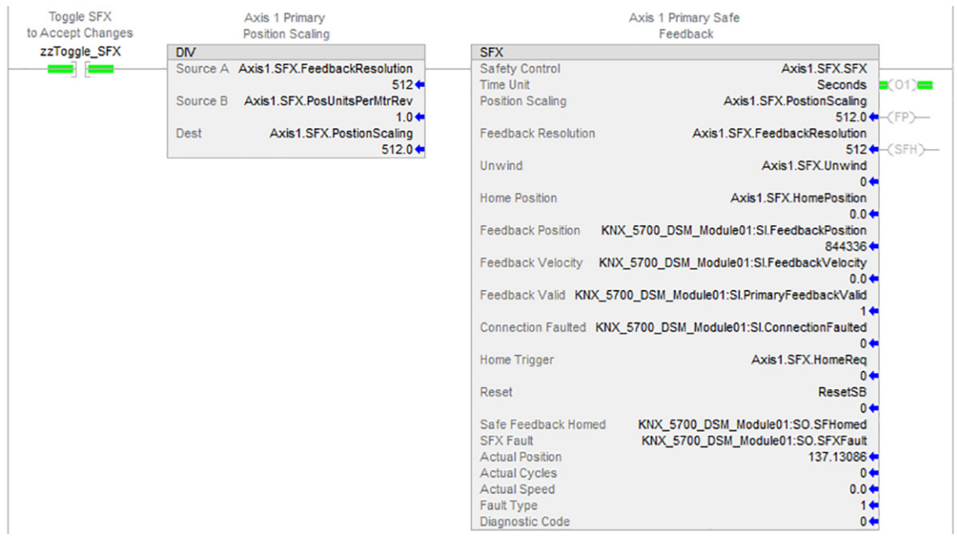
Table 4 - Primary Feedback Valid

Parameter	Description
SI.PrimaryFeedbackValid	Primary feedback status from drive. This bit is ON when the safety feedback is connected and functioning properly. This bit is OFF if the drive detects an issue with the feedback signal.
zzValidateFeedback	Toggling this bit clears the Feedback Valid signal to the SFX instruction to simulate a feedback fault.
Axis1_PrimaryFeedbackValid	Internal bit to send feedback status to the SFX instruction.

Rung 1

Table 5 - Primary Feedback Scaling

Parameter	Description
zzToggle_SFX	Changes to SFX configuration parameters initialize when SFX is first put on scan. Toggling the SFX rung during commissioning accepts new values.
DIV	Feedback resolution is taken directly from the safety module feedback properties. PositionUnitsPerMtrRev: Application scaling factor. This example = 1 rev/rev Position Scaling: Counts/rev
SFX	Safe Feedback Interface Monitors safety position, velocity, and feedback status Scales position and velocity to proper units. SFX.ActualPosition, SFX.ActualSpeed Controls safe position homing.

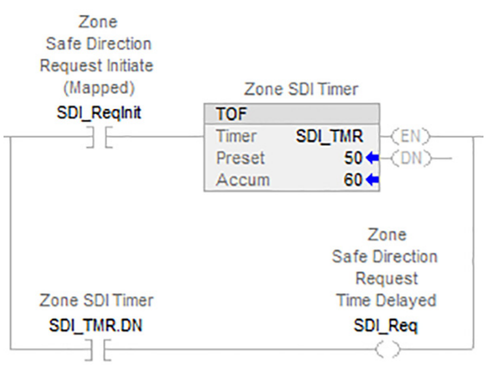


Programming - Logic L01_Ax1_SDI

The Logic SDI routine performs the Safe Direction logic.

Rung 0

SDI is used as one of the criteria for guard door unlocking. When an SDI request is removed, the timer allows time for the Guard Door to lock before stopping SDI monitoring. The timer preset value is dependent upon the guard locking device lock and feedback response time. The time should be set slightly higher than the amount of time that is required to see the locked feedback signals after lock solenoid output is de-energized.



Rung 1

Table 6 - SDI Request

Parameter	Description
SDI_Req	SDI request from Rung 0
ResetSB	If the SDI is at Limit or faulted, then the SDI.Req must be removed to reset.

Table 7 - SDI Instruction

Parameter	Description
MOV	Actual Position visual for the programmer to see what position the SDI is monitoring.
SDI	Safe Direction instruction Position does not move in the undesired direction more than the Position Window. This parameter can be programmatically changed. Feedback SFX is the SFX being monitored. SDI Active, Limit, Fault values sent to the drive for pass through standard tags.

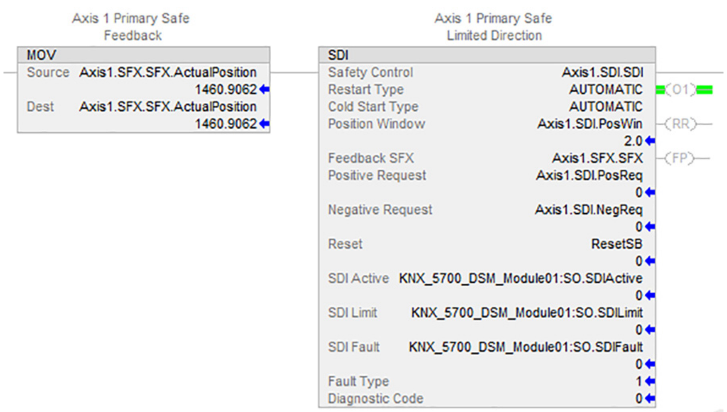
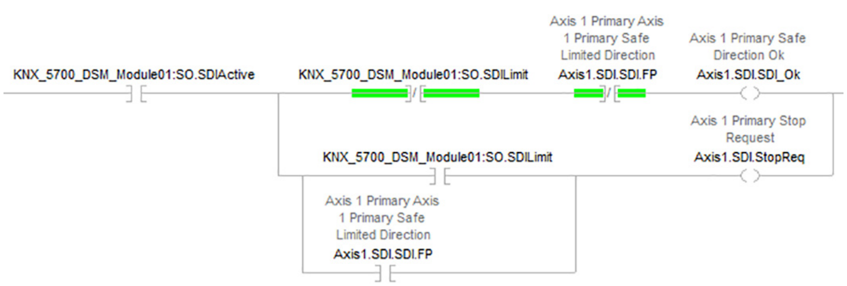


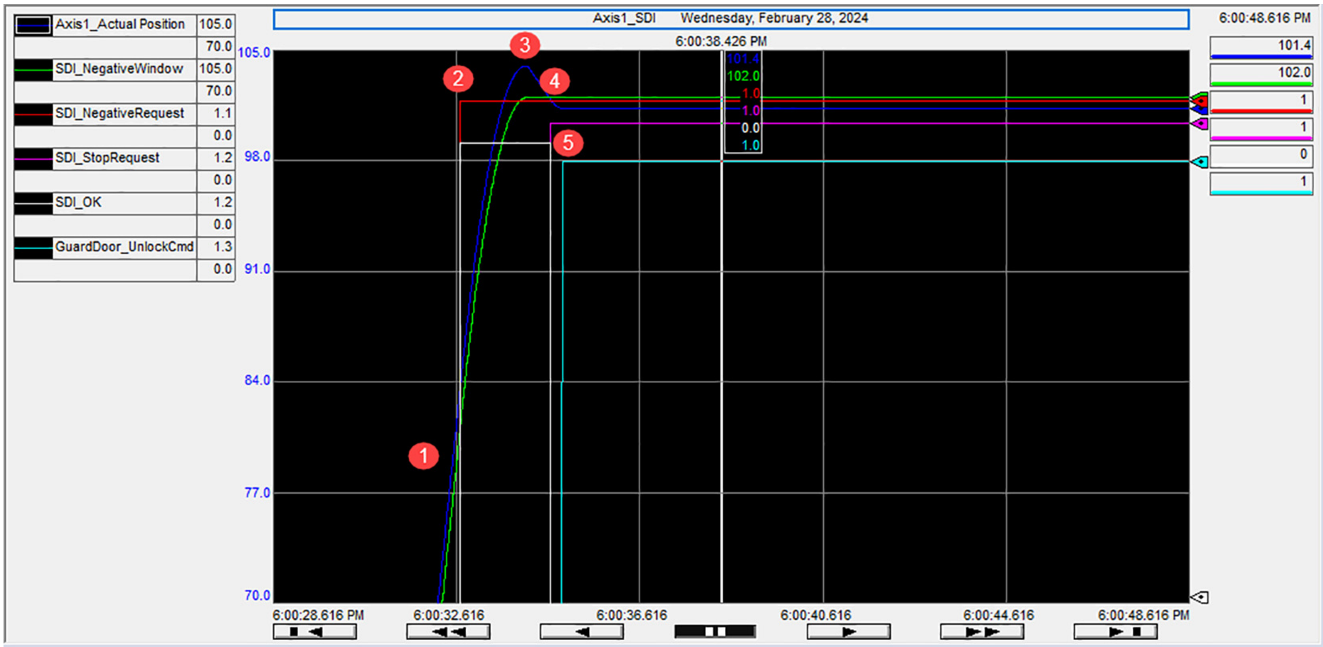
Table 8 - SDI Output Status

Parameter	Description
Ok	IF SDI is Active, not at limit, no SDI fault THEN SDI is OK. SDI Limit is the key variable for SDI movement beyond the position window. SDI does not fault when exceeding the position window.
StopReq	IF SDI is Active, and (limit or SDI fault) THEN SDI Stop Request. Safe stop the application due to SDI malfunction or outside position the window in the undesired direction. In this example, initiate Safe Stop 1.



Example of Safe Direction Monitoring

This example shows the key elements of Safe Direction monitor for undesired direction.



1. The axis is running in the positive direction.
2. With an SDI_Req active, an SDI_Request is sent to the SDI instruction.
3. Direction reverses.
4. Direction exceeds the position window in the negative direction. SDI StopRequest is issued which initiates an SS1.
5. SS1 completes. Standstill is achieved and the guard door unlocks.

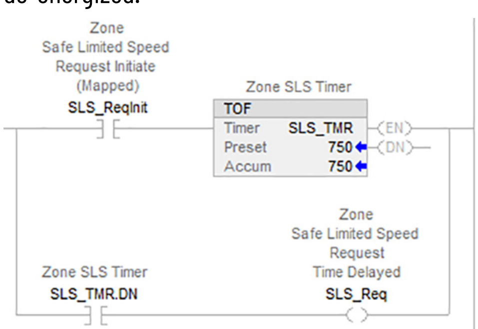
A trend can be used to verify timing of the safety functions. Understanding sequential logic timing is important to allow time for a system to respond and help prevent nuisance tripping.

Programming - Logic L01_Ax1_SLS

The Logic SLS routine performs the safely monitored speed logic.

Rung 0

SLS is used as one of the criteria for guard door unlocking. When an SLS request is removed, the timer allows time for the Guard Door to lock before stopping SLS monitoring. The timer preset value is dependent upon the guard locking device lock and feedback response time. The time should be set slightly higher than the amount of time that is required to see the locked feedback signals after lock solenoid output is de-energized.



Rung 1

Table 9 - SLS Request

Parameter	Description
SLS_Req	SLS request from Rung 0.
ResetSB	If the SLS is at Limit or faulted, then the SLS.Req must be removed to reset.
Axis1.SLS.Req	Control bit used by the SLS instruction to initiate SLS monitoring.

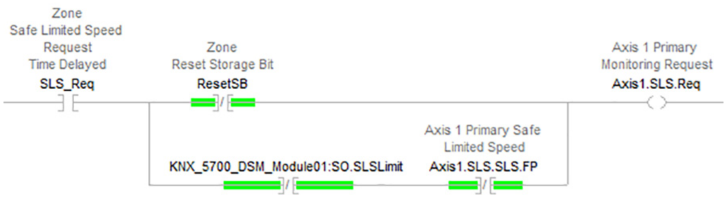


Table 10 - SLS Instruction

Parameter	Description
MOV	Actual Speed visual for the programmer to see the Actual Speed from the SFX.
SLS	Safely-Limited Speed instruction Speed below Active Limit. This parameter can be programmatically changed. Feedback SFX is the SFX being monitored. SLS Active, Limit, Fault values sent to the drive for pass-through standard tags.

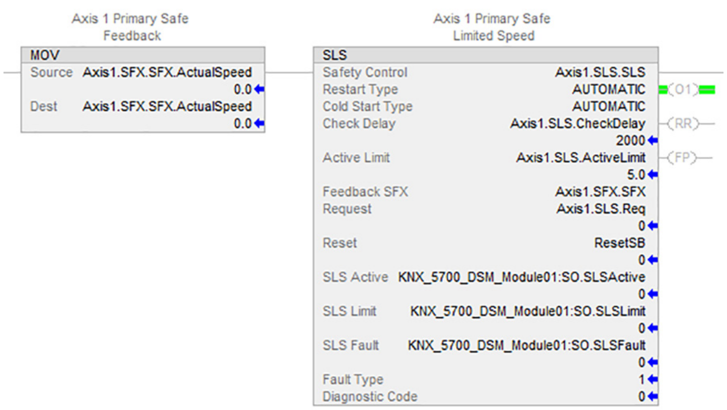
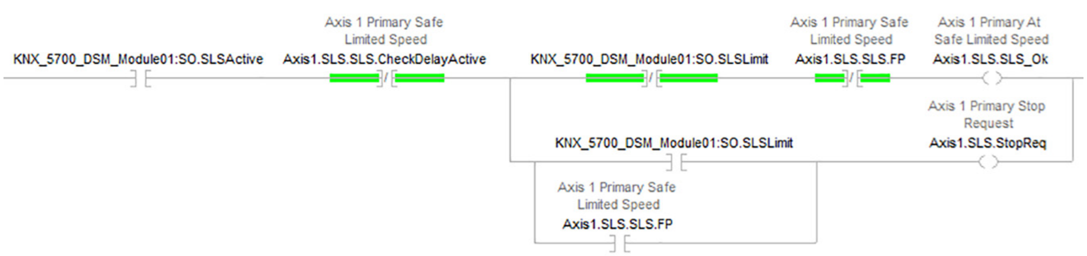


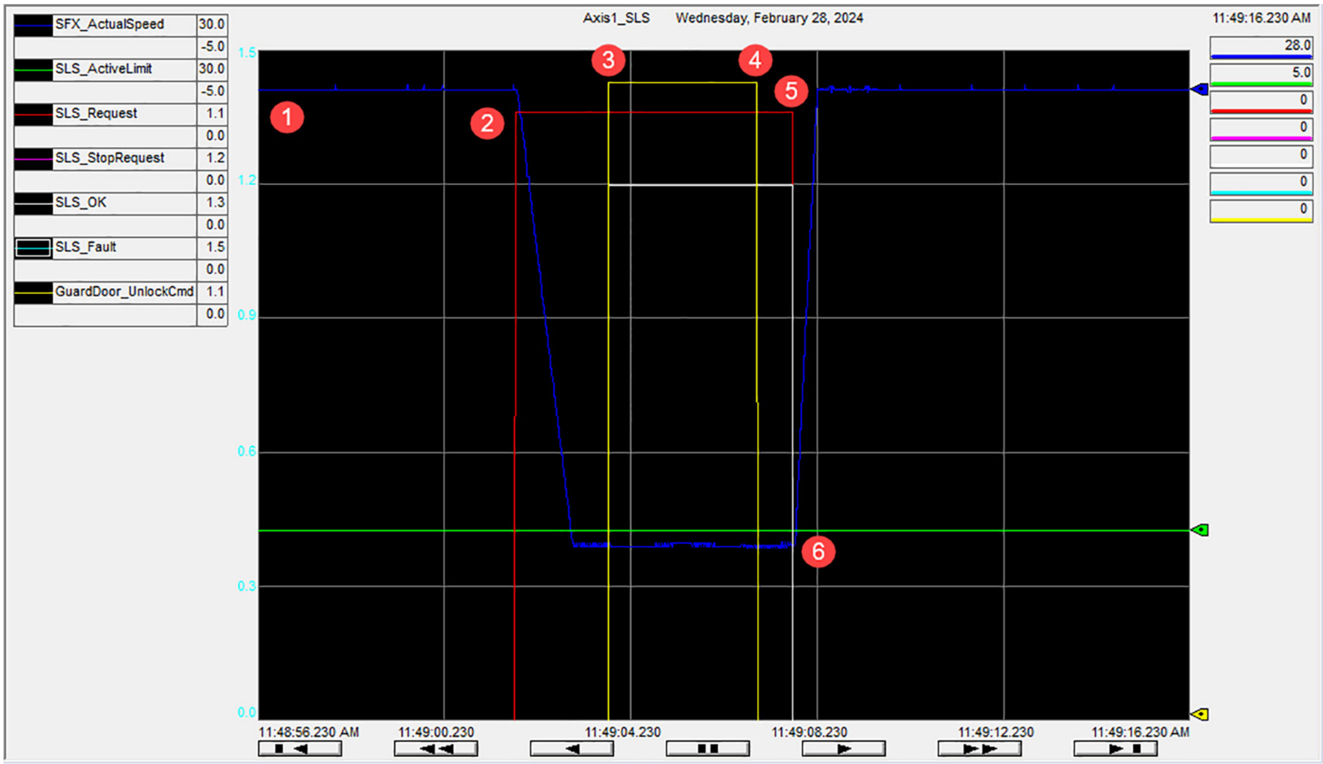
Table 11 - SLS Output Status

Parameter	Description
Ok	IF SLS is Active, check delay expired, not at limit, no SLS fault THEN SLS is OK. SLS Limit is the key variable for SLS above the active limit. SLS does not fault when exceeding the active limit.
StopReq	IF SLS is Active, check delay expired, and (limit or SLS fault) THEN SLS Stop Request. Safe stop the application due to SLS malfunction or above the active limit. In this example, initiate Safe Stop 1.



Example of Safely-Limited Speed Monitoring

This example shows the key elements of a Safely-Limited Speed monitor for guard door unlock control.



1. The axis is running at normal speed.
2. With an SLS_Req active, an SLS_Request is sent to the SLS instruction.
3. After SLS.CheckDelay, SLS_Ok initiates a GuardDoor_UnlockCommand, which unlocks the guard door.
4. The removal of SLS_Req removes the GuardDoor_UnlockCommand, which locks the guard door.
5. SLS_TMR provides time for the guard door to lock and the closed and locked feedback to be received before turning off the SLS_Request.
6. The axis ramps back to normal speed.

A trend can be used to verify timing of the safety functions. Understanding sequential logic timing is important to allow time for a system to respond and help prevent nuisance tripping.

Programming - Logic L10_Logic

The main logic contains reset logic, device status summary, and the main run permissive.

Rung 3

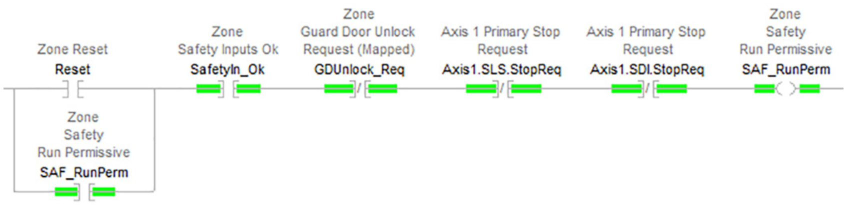
Table 12 - Safety Input Summary

Parameter	Description
GuardDoor_Cls	Guard Door Closed Status
GuardDoor_Lk	Guard Door Locked Status
SLS_Ok	SLS actively monitoring allows the guard door to be unlocked and open.
SDI_OK	SDI actively monitoring allows the guard door to be unlocked and open.

Rung 4

Table 13 - Drive Run Permissive

Parameter	Description
SafetyIn_Ok	Input summary from the previous rung.
GDUnlock_Req	Guard door unlock request mapped from standard.
SLS.StopReq	SLS malfunction or out of limit remove run permissive.
SDI.StopReq	SDI malfunction or out of limit remove run permissive.
SAF_RunPerm	On loss of safe run permissive a Safe Stop 1 (SS1) is executed.



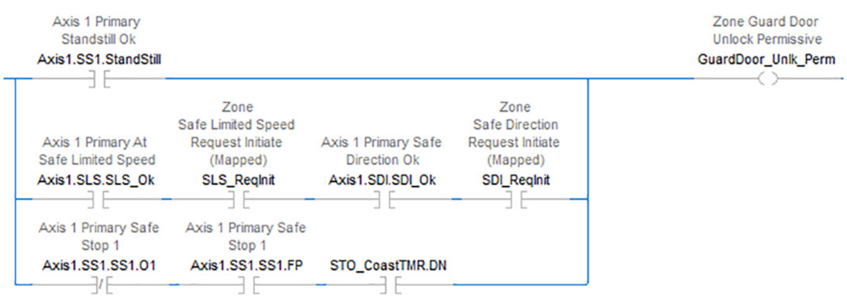
Programming - Output 001_GuardDoor_Unlock

The output guard door unlock routine contains logic controlling the guard door lock and unlock functions.

Rung 0

Table 14 - Guard Door Unlock Permissive

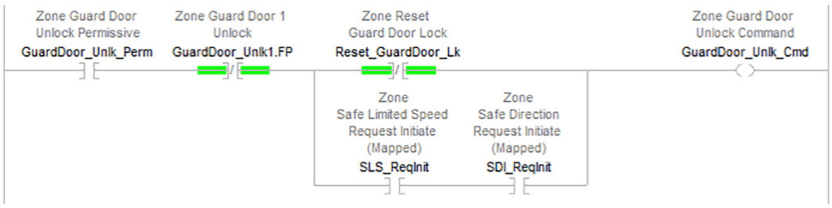
Parameter	Description
SS1.Standstill	SS1 instruction has detected that the axis is at Standstill.
SLS.SLS_OK	SLS Actively monitoring allows the guard door to be unlocked and open.
SLS_ReqInit	SLS function requested.
SDI.SDI_OK	SDI Actively monitoring allows the guard door to be unlocked and open.
SDI_ReqInit	SDI function requested
SS1.SS1.01	SS1.01 transitions to OFF when the SS1 is not actively monitoring due to it having reached standstill or the instruction has detected a fault.
SS1.SS1.FP	SS1.FP transition to ON when the SS1 instruction detects a fault.
STO_CoastTMR.DN	Timer used to unlock the gate when torque has been removed long enough to coast to a stop. This parameter cannot be used for vertical axes or overhauling loads.
GuardDoor_Unlk_Perm	On loss of unlock permissive the unlock command will be removed.



Rung 1

Table 15 - Guard Door Unlock Command

Parameter	Description
GuardDoor_Unlk_Perm	Unlock Permissive summary from the previous rung.
GuardDoor_Unlk1.FP	SLS Actively monitoring allows the guard door to be unlocked and open.
Reset_GuardDoor_Lk	Removes the unlock command to allow restart when safety is reset.
SLS_ReqInit	SLS function requested.
SDI_ReqInit	SDI function requested.
GuardDoor_Unlk_Cmd	On loss of unlock command, the door will be locked if it is closed. It the door is open, a safe stop 1 (SS1) is executed.



Rung 2

Guard door solenoid and lock monitoring.

Table 16 - I/O Status Summary

Parameter	Description
InputStatus	Summarize the input status of the inputs before the CROUT.
OutputStatus	Summarize the output status of the outputs before the CROUT.

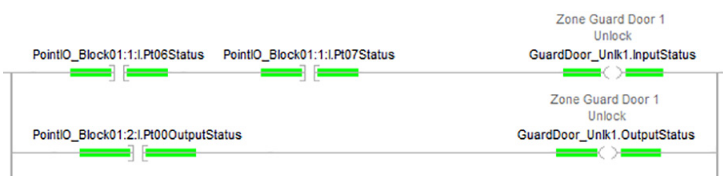


Table 17 - Active Lock Feedback Monitoring

Parameter	Description
CROUT	Configurable Redundant Output instruction for controlling the locking outputs and monitoring two locked feedback inputs and associated I/O status. Provides continuous monitoring of locked feedback relationship to commanded unlock output.
raC_Dvc_CROUT	The optional raC_Dvc_CROUT AOI connects CROUT to the HMI faceplate. (ME, SE, PV5000) To find this information, go to rok.auto/pcdc, and search for Safety Device Library.

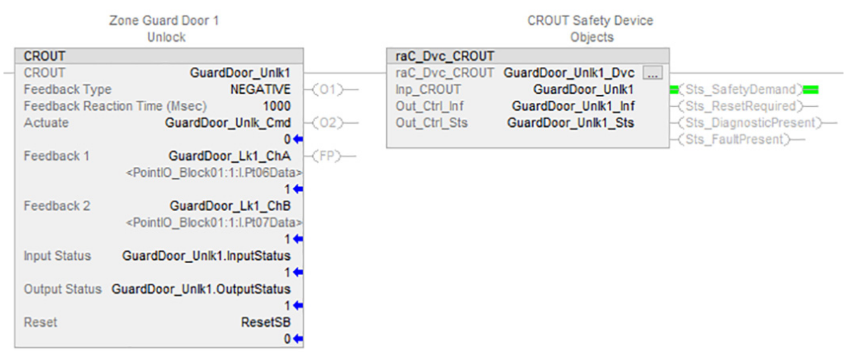
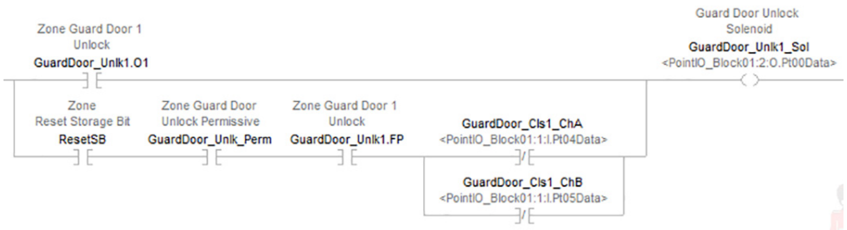
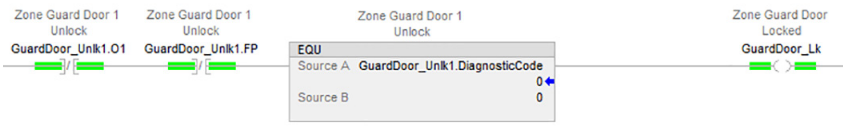


Table 18 - Solenoid Output

Parameter	Description
CROUT.01	Actuates the guard door unlock solenoid.
ResetSB	The reset branch allows recovery of an unlock feedback input faults by allowing the solenoids to be cycled independently of the CROUT under latched fault conditions. Guard Door unlock permissive must be on for safety.



Guard Door Lock Status for Use in Safety Task



Programming - Output 010_Ax1_SS1

The Output SS1 routine performs the Safe Stop 1 (SS1) safety function.

Rung 0

SS1 Request on loss of run permissive and no SS1 fault.

Rung 1

Table 19 - SS1 Instruction

Parameter	Description
MOV	Actual Speed visual for the programmer to see the Actual Speed from the SFX.
SS1	Safe Stop 1 instruction Stop Monitor Delay time after request to start monitor decel ramp. Stop Delay is used to build the X-axis of the decel monitor ramp, and maximum allowed time to reach standstill. Standstill Speed is the speed that standstill is declared and STO request is made. Decel Ref Speed used to build the Y-axis of the decel monitor ramp. Decel Speed Tolerance is the tolerance shift between actual ramp and fault point. Feedback SFX is the SFX being monitored. SS1 Active, Fault values sent to the drive for pass through standard tags.

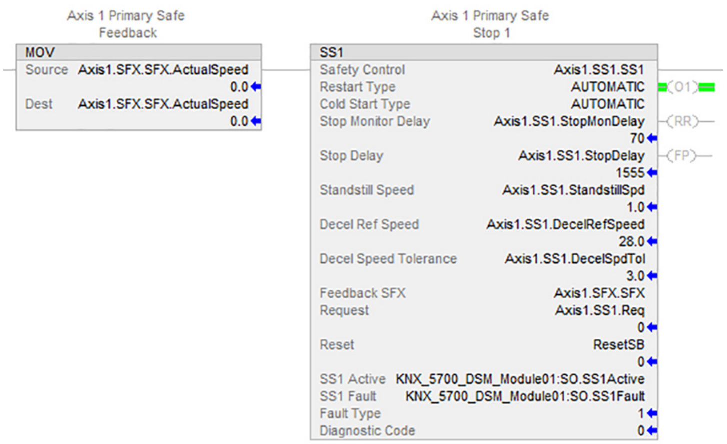
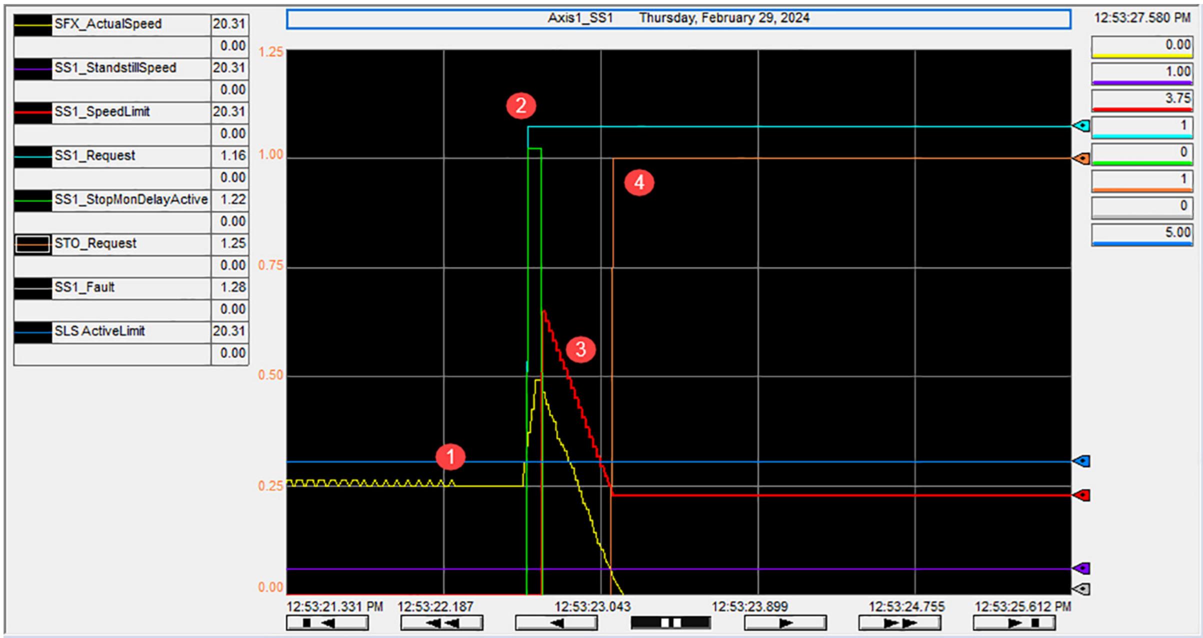


Table 20 - SS1 Output Status

Parameter	Description
Standstill	When SS1.01 goes off and there is no SS1 fault, SS1 has passed through standstill. This standstill is based on STO, which results in no additional motion. Not valid for overdriving loads or gravitational loads that may move after motor torque has been removed.
STO_Request	This bit is used with the 020_STO logic to request an STO.

Example of Safe Stop 1

This example shows the key elements of a Safe Stop 1.



1. SLS is monitoring speed below the active limit.
2. While SLS is monitoring, the speed is increased above the SLS active Limit, which causes the SLS.StopReq to trigger an SS1 Request.
3. SS1_StopMonDelayActive provides time for the drive to begin decelerating repeatably. When the SS1_StopMonDelayActive goes off, then the SS1_SpeedLimit monitors the deceleration.
4. When SFX_ActualSpeed crosses SS1_StandstillSpeed, STO_Request is made.

Safe Stop 1 must be configured for the application. A trend can be used to verify the load deceleration response and timing that is required for the safety function. The system dynamics must be understood to configure the SS1 to repeatably monitor deceleration without nuisance faulting.

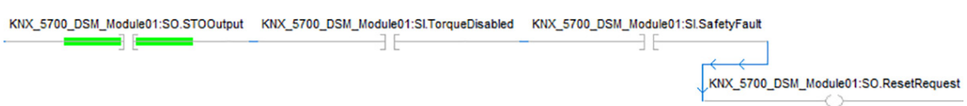
Programming - Output 020_STO

The output STO routine contains drive safety reset logic, device status summary, and the main run permissive.

Rung 0

Table 21 - Drive Safety Reset Request

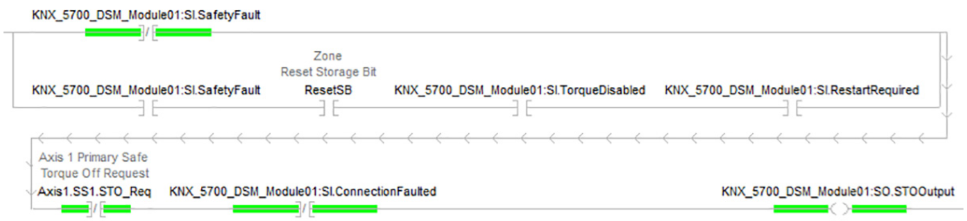
Parameter	Description
STO Output	Must be on to reset drive safety



Rung 1

Table 22 - STO Output - ON is Drive Enabled

Parameter	Description
No Safety Fault	Follow the SS1.STO_Req.
Safety Fault	Turn on STO when reset and all conditions are met.



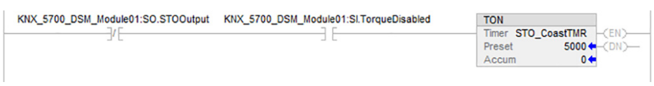
Rung 2

STO reset required indication.

Rung 3

Table 23 - STO Coast Timer

Parameter	Description
SO.STOOutput	Output to allow drive to produce torque. Must be OFF to start the timer.
SI.TorqueDisabled	Feedback from drive indicating that the drive is being prevented from producing torque. Must be ON to start timer
STO_CoastTMR	Timer used to unlock guard door to permit entry when torque has been disabled. Timer present must be long enough to ensure axis has come to a complete stop. This cannot be used for vertical axes or overhauling loads.



Calculation of the Performance Level

When properly implemented, these safety functions can achieve a safety rating of Performance Level d (PLd), according to ISO 13849-1: 2023, as calculated by using the SISTEMA software PL calculation tool.

IMPORTANT To calculate the PL of your entire safety function, you must include the specific subsystems that you chose. Depending on the devices you choose, the overall safety rating of your system differs.

The SISTEMA file that is referenced in this safety function application technique is attached to this publication. For instructions on how to access the attachments, see Use Sample Project Files on page 4.

The PFH for electromechanical systems may be calculated differently based on the version of ISO 13849 supported by SISTEMA. The maximum MTTFd of 2500 years is supported starting in version 2.0.3 of SISTEMA. As a result, the same SISTEMA data file that is opened in different versions of SISTEMA can yield different calculated results.

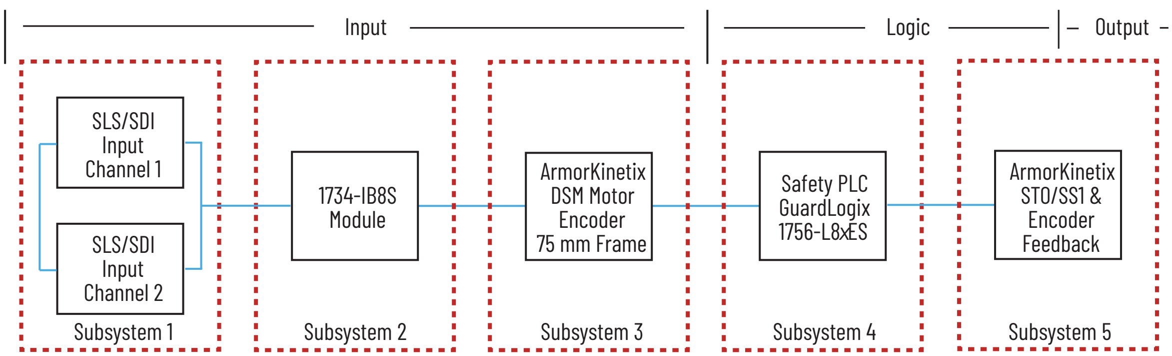
✔ SB	Safety PLC: GuardLogix 1756-L8xES	d	n.a.	6.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	Compact GuardLogix 5380, SIL 2, Category 3	d	n.a.	7.2E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled

Safe Direction

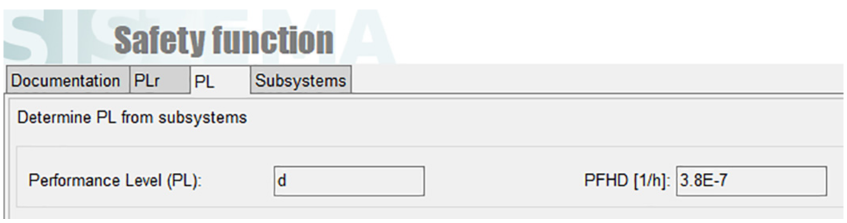
Assuming the use of the following subsystem choices, the overall Performance Level that is achieved is shown in the graphic.

Status	Name	Ref. des.	PL	PL-Software	PFHD [1/h]	CCF score	DCavg [%]	MTTFD [a]	Category	Requirements of the category
✔SB	SLS Mode Select Key Switch	01	e	n.a.	2.5E-8	80 (fulfilled)	99 (High)	100 (High)	3	fulfilled
✔SB	POINT Guard I/O: 1734-IB8S Series B	02	d	d	1.2E-10	*not relevant*	*not relevant*	*not relevant*	4	fulfilled
✔SB	ArmorKinetix (DSM) Encoder Module - 75mm Frame	03	d	d	3.5E-7	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔SB	Safety PLC: GuardLogix 1756-L8xES	04	d	d	6.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔SB	ArmorKinetix DSM - STO/SS1 and monitoring	05	d	d	3.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled

The Safe Direction Monitoring safety function can be modeled as follows:



IMPORTANT	The PFH for this complete safety function, with the keyswitch, sensor, logic, and actuator subsystems, is 3.8E-7. The PL for the complete safety function is PLd.

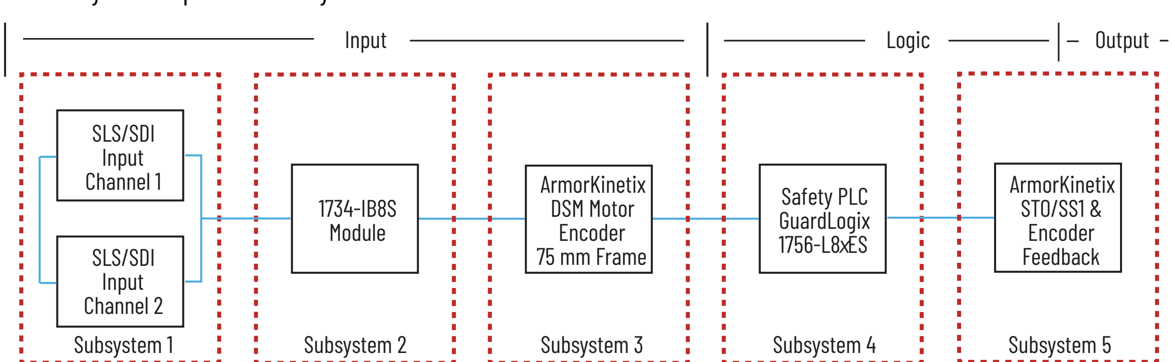


Safely-Limited Speed

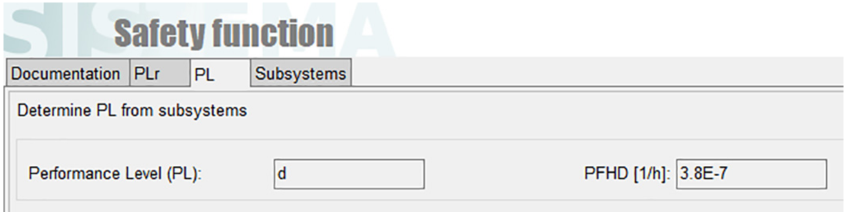
Assuming the use of the following subsystem choices, the overall Performance Level that is achieved is shown in the graphic.

Status	Name	Ref. des.	PL	PL-Software	PFHD [1/h]	CCF score	DCavg [%]	MTTFD [a]	Category	Requirements of the category
✔SB	SLS Mode Select Key Switch	01	e	n.a.	2.5E-8	80 (fulfilled)	99 (High)	100 (High)	3	fulfilled
✔SB	POINT Guard I/O: 1734-IB8S Series B	02	d	d	1.2E-10	*not relevant*	*not relevant*	*not relevant*	4	fulfilled
✔SB	ArmorKinetix (DSM) Encoder Module - 75mm Frame	03	d	d	3.5E-7	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔SB	Safety PLC: GuardLogix 1756-L8xES	04	d	d	6.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔SB	ArmorKinetix DSM - STO/SS1 and monitoring	05	d	d	3.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled

The safely limited position safety function can be modeled as follows:



IMPORTANT	The PFH for this complete safety function, with the keyswitch, logic, and actuator subsystems, is 3.8E-7. The PL for the complete safety function is PLd.

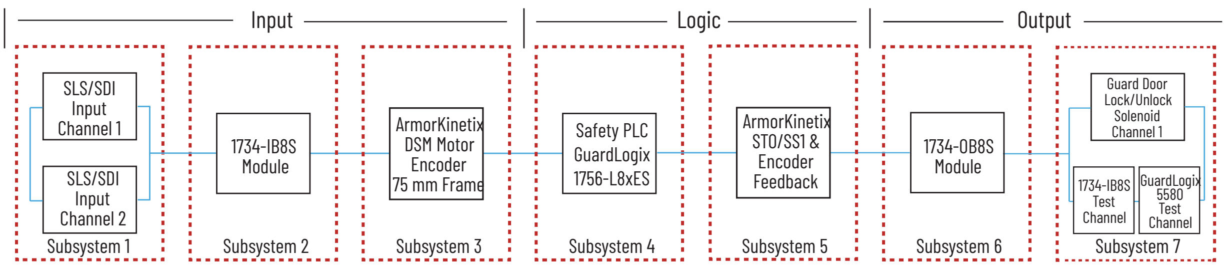


Guard Door Unlock: Safely-Limited Speed with Safe Direction

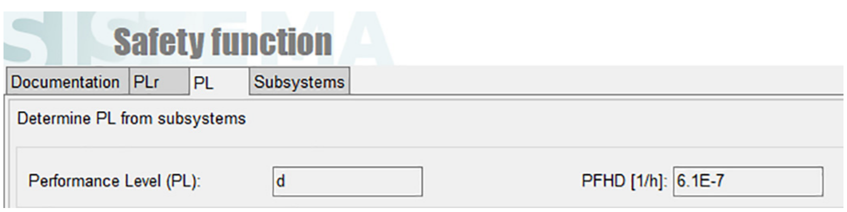
Assuming the use of the following subsystem choices, the overall Performance Level that is achieved is shown in the graphic.

Status	Name	Ref. des.:	PL	PL-Software	PFHD [1/h]	CCF score	DCavg [%]	MTTFD [a]	Category	Requirements of the category
✔ SB	SLS Mode Select Key Switch	01	e	n.a.	2.5E-8	80 (fulfilled)	99 (High)	100 (High)	3	fulfilled
✔ SB	POINT Guard I/O: 1734-IB8S Series B	02	d	d	1.2E-10	*not relevant*	*not relevant*	*not relevant*	4	fulfilled
✔ SB	ArmorKinetix (DSM) Encoder Module - 75mm Frame	03	d	d	3.5E-7	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	Safety PLC: GuardLogix 1756-L8xES	04	d	d	6.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	ArmorKinetix DSM - STO/SS1 and monitoring	05	d	d	3.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	POINT Guard I/O: 1734-OB8S Series B	06	d	d	4.6E-10	*not relevant*	*not relevant*	*not relevant*	2	fulfilled
✔ SB	Guard Door Lock	07	d	n.a.	2.3E-7	100 (fulfilled)	99 (High)	100 (High)	2	fulfilled

The Guard Door Unlock: Safely-Limited Speed with Safe Direction safety function can be modeled as follows:



IMPORTANT The PFH for this complete safety function, with the keyswitch, sensor, logic, and actuator subsystems, is 6.1E-7. The PL for the complete safety function is PLd.

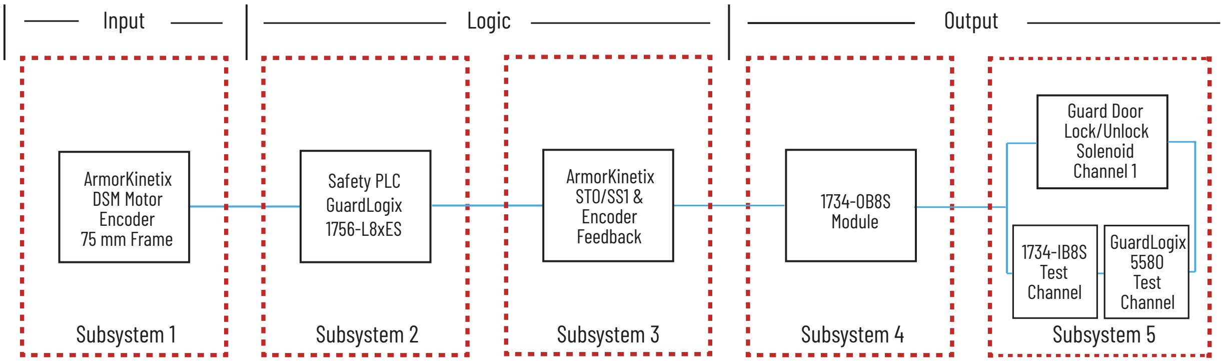


Guard Door Unlock: Zero Speed (SS1 and Standstill Monitoring)

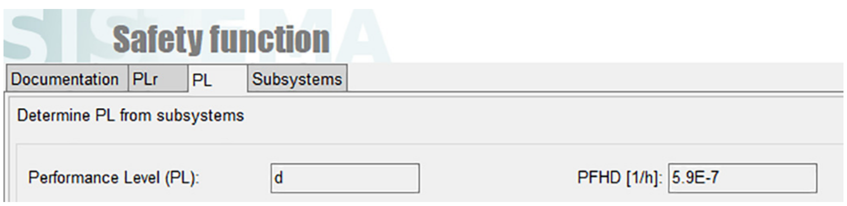
Assuming the use of the following subsystem choices, the overall Performance Level that is achieved is shown in the graphic.

Status	Name	Ref. des.:	PL	PL-Software	PFHD [1/h]	CCF score	DCavg [%]	MTTFD [a]	Category	Requirements of the category
✔ SB	ArmorKinetix (DSM) Encoder Module - 75mm Frame	01	d	d	3.5E-7	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	Safety PLC: GuardLogix 1756-L8xES	02	d	d	6.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	ArmorKinetix DSM - STO/SS1 and monitoring	03	d	d	3.4E-9	*not relevant*	*not relevant*	*not relevant*	3	fulfilled
✔ SB	POINT Guard I/O: 1734-OB8S Series B	04	d	d	4.6E-10	*not relevant*	*not relevant*	*not relevant*	2	fulfilled
✔ SB	Guard Door Lock	05	d	n.a.	2.3E-7	100 (fulfilled)	99 (High)	100 (High)	2	fulfilled

The Guard Door Unlock or Open: Zero Speed safety function can be modeled as follows:



IMPORTANT The PFH for this complete safety function, with the sensor, logic, and actuator subsystems, is 5.9E-7. The PL for the complete safety function is PLd.

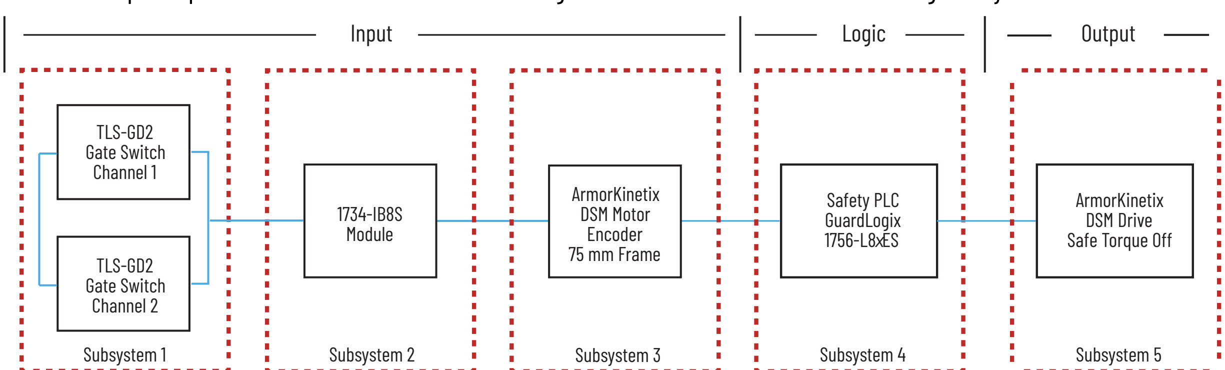


Safe Stop and Prevention of Hazardous Motion using Guard Door Lock/Position Monitoring

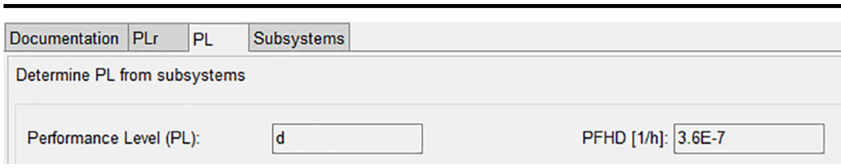
Assuming the use of the following subsystem choices, the overall Performance Level that is achieved is shown in the graphic.

Status	Name	Ref. des.	PL	PL-Software	PFHD [1/h]	CCF score	DCavg [%]	MTTFD [a]	Category	Requirements of the category
✔SB	Gate Switch1	01	e	n.a.	9.9E-10	65 (fulfilled)	99 (High)	2,283.1 (High)	4	fulfilled
✔SB	POINT Guard I/O: 1734-IB8S Series B	02	d	d	1.2E-10	not relevant	not relevant	not relevant	4	fulfilled
✔SB	ArmorKinetix (DSM) Encoder Module - 75mm Frame	03	d	d	3.5E-7	not relevant	not relevant	not relevant	3	fulfilled
✔SB	Safety PLC: GuardLogix 1756-L8xES	04	d	d	6.4E-9	not relevant	not relevant	not relevant	3	fulfilled
✔SB	ArmorKinetix DSM - Integrated STO	05	d	d	3.4E-9	not relevant	not relevant	not relevant	3	fulfilled

The Safe Stop and prevention of hazardous motion using Guard Door Lock/Position Monitoring safety function can be modeled as follows:



IMPORTANT The PFH for this complete safety function, with the sensor, logic, and actuator subsystems, is 3.6E-7. The PL for the complete safety function is PLd.



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 validating the GuardLogix Safety System, confirm that the safety system and safety application program have been designed in accordance with the controller safety reference manuals that are listed in Additional Resources and the GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095.

For a validation checklist, see the attached spreadsheet. For instructions on how to access the attachments, see Use Sample Project Files on page 4.

Additional Resources

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

Resource	Description
Machinery SafeBook 5 – Safety related control systems for machinery, publication SAFEBK-RM002	Provides the principles, standards, and implementation of safety-related control systems for machinery.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012	Describes the GuardLogix 5580 and Compact GuardLogix 5380 controller system. Provides instructions on how to develop, operate, or maintain a controller-based safety system that uses the Studio 5000 Logix Designer application.
ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication 1756-UM543	Provides information on how to install, configure, and program the GuardLogix 5580 controllers in the Logix Designer application.
CompactLogix 5380 and Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001	Provides information on how to install, configure, and program the Compact GuardLogix 5380 controllers in the Logix Designer application.
GuardLogix Safety Application Instruction Set 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.
POINT Guard I/O Safety Modules User Manual, publication 1734-UM13	Provides information on how to install and operate the Point I/O safety modules.
ArmorKinetix System Safe Monitor Functions Reference Manual, publication 2198-RM007	Explains how the ArmorKinetix drives can be used in up to Safety Integrity Level (SIL 3), Performance Level (PLe) applications. Provides information to configure and troubleshoot the ArmorKinetix drives with safe-stopping and safe-monitoring functions.
Light Curtain and GuardLogix Controller Safety Function Application Technique, publication SAFETY-AT191	Explains how to wire, configure, and program a GuardLogix controller and a 450L-ENETR CIP Safety™ network interface module to monitor a GuardShield™ 450L light curtain.
Rockwell Automation Functional Safety Data Sheet, publication SAFETY-SR001	Provides functional safety data for Rockwell Automation® products.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.
Safety Automation Builder and SISTEMA Library website, rok.auto/sistema	Download Safety Automation Builder® to help simplify machine safety design and validation, and reduce time and costs. Integration with our risk assessment software provides you with consistent, reliable, and documented management of the Functional Safety Lifecycle. The SISTEMA tool, also available for download from the Safety Automation Builder page, automates calculation of the attained Performance Level from the safety-related parts of a machine's control system to (EN) ISO 13849-1.

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

Safety Function Capabilities

Visit rok.auto/safety for more information on our Safety System Development Tools, including Safety Functions.

Rockwell Otomasyon Ticaret A.Ş. Kar Plaza İş Merkezi E Blok Kat:6 34752, İçerenkÖy, İstanbul, Tel: +90 (216) 5698400 EEE YÖnetmeliğine Uygundur

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AMERICAS: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000
EUROPE/MIDDLE EAST/AFRICA: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2663 0600
ASIA PACIFIC: Rockwell Automation SEA Pte Ltd, 2 Corporation Road, #04-05, Main Lobby, Corporation Place, Singapore 618494, Tel: (65) 6510 6608
UNITED KINGDOM: Rockwell Automation Ltd., Pitfield, Kiln Farm, Milton Keynes, MK11 3DR, United Kingdom, Tel: (44)(1908) 838-800

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