

GuardLogix Safety Application Instruction Set

1756 GuardLogix Safety, 1769 GuardLogix Safety, 5069 Compact GuardLogix Safety

Publication 1756-RM095K-EN-P

Rockwell Automation

Reference Manual

Original Instructions

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.

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The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This manual includes new and updated information. Use these reference tables to locate changed information.

Global changes

The Legal noticeshave been updated.

New or enhanced features

This table contains a list of topics changed in this version, the reason for the change, and a link to the topic that contains the changed information.

Topic Name	Reason
Dual Channel Input Stop with Test (DCST)	In the Fault Codes and Corrective Actions table, updated Fault Code numbers 16#4001 16385, 16#4002 16386, and 16#4003 16387. In the Diagnostic Code and Corrective Actions table, updated Diagnostic Code numbers 16#4000 16384 and 16#4001 16385.
Dual-channel Input Start (DCSRT)	In the Fault Codes and Corrective Actions table, updated Fault Code numbers 16#4000 16384, 16#4001 16385, 16#4002 16386, and 16#4003 16387. In the Diagnostic Code and Corrective Actions table updated Diagnostic Code numbers 16#4000 16384.
Dual Channel Input Stop with Test and Lock (DCSTL) wiring and programming example	In the programming diagram, updated Note 1 to correct the parenthetical reference to the falling edge of the Test Request input, changing it from (0->1) to (1->0).

Chapter 2

Metal Form Instructions

Chapter 3

Drive Safety

RSLogix 5000 Software, Version 14 and Later, Safety Application Instructions

Chapter 4

Common Attributes for Safety Instructions

Chapter 5

Index

This reference manual is intended to describe the Rockwell Automation GuardLogix Safety Application Instruction Set, which is type-approved and certified for safety-related function in applications up to and including Safety Integrity Level (SIL) 3 according to IEC61508, and Performance Level, PLe (Cat.4), according to ISO13849-1.

The timing diagrams that are presented in the manual are for illustrative purposes only. The actual response times are determined by the performance characteristics of your application.

Use this manual if you are responsible for designing, programming, or troubleshooting safety applications that use GuardLogix controllers.

You must have a basic understanding of electrical circuitry and familiarity with relay ladder logic. You must also be trained and experienced in the creation, operation, programming and maintenance of safety systems.

The term Logix5000 controller refers to any controller that is based on the Logix5000 operating system.

GuardLogix Controller Operation

The GuardLogix safety controllers are part of a de-energize to trip system, which means that all of its outputs are set to zero when a fault is detected.

Certified Instructions

The table below lists the instructions that are certified for use in GuardLogix systems. For the latest information, see our safety certificates and revision release lists at http://www.rockwellautomation.com/global/certification/safety.page?

Studio 5000 Logix Designer®Software Version 31 and Later Drive Safety Instructions

Instruction Abbreviation	Instruction Name	Certification
SBC	Safe Brake Control	TÜV
SDI	Safe Direction	TÜV
SFX	Safely Feedback Interface	TÜV
SLP	Safely-Limited Position	TÜV
SLS	Safely-Limited Speed	TÜV
SOS	Safe Operating Stop	TÜV
SS1	Safe Stop 1	TÜV
SS2	Safe Stop 2	TÜV

RSLogix 5000 Software Version 17 and Later Metal Form and Safety Instructions.

Instruction Abbreviation	Instruction Name	Certification
AVC	Auxiliary Valve Control	TÜV

Instruction Abbreviation	Instruction Name	Certification
CBCM	Clutch Brake Continuous Mode	DGÜV[1] TÜV
CBIM	Clutch Brake Inch Mode	DGÜV[1] TÜV
CBSSM	Clutch Brake Inch Mode	DGÜV[1] TÜV
CPM	Crankshaft Position Monitor	DGÜV[1] TÜV
CROUT	Configurable Redundant Output	DGÜV[1] TÜV
CSM	Configurable Redundant Output	DGÜV[1] TÜV
DCM	Dual Channel Input Monitor	DGÜV[1] TÜV
DCS	Dual Channel Input Stop	DGÜV[1] TÜV
DCSRT	Dual Channel Input Start	DGÜV[1] TÜV
DCST	Dual Channel Input Stop with Test	DGÜV[1] TÜV
DCSTL	Dual Channel Input Stop with Test	DGÜV[1] TÜV
DCSTM	Dual Channel Input Stop with Test	TÜV
DCA	Dual Channel Input Stop with Test	TÜV
DCAF	Dual Channel Analog Input - floating point version	TÜV
EPMS	Eight Position Mode Selector	DGÜV[1] TÜV
FSBM	Four Sensor Bidirectional Muting	TÜV
MMVC	Four Sensor Bidirectional Muting	DGÜV[1] TÜV
MVC	Four Sensor Bidirectional Muting	DGÜV[1] TÜV
SMAT	Four Sensor Bidirectional Muting	TÜV
THRSe	Four Sensor Bidirectional Muting	DGÜV[1] TÜV
TSAM	Four Sensor Bidirectional Muting	TÜV
TSSM	Four Sensor Bidirectional Muting	TÜV

[1] At the time of publication, these instructions are not DGUV-certified for use with Compact GuardLogix 5370 controllers, and are certified only for firmware versions 17...21 for GuardLogix and 1768 Compact GuardLogix controllers.

RSLogix 5000 Software Version 14 and Later Metal Form and General Instructions.

Instruction Abbreviation	Instruction Name	Certification
DIN	Diverse Input	TÜV
ENPEN	Enable Pendant	TÜV
ESTOP	Emergency Stop	TÜV
FPMS	Five-position Mode Selector	TÜV
LC	Light Curtain	TÜV
RIN	Redundant Input	TÜV
ROUT	Redundant Output	TÜV
THRS	Two-hand Run Station	TÜV

Terminology

In this manual, 'programming software' refers to both the Studio 5000 Logix Designer application and RSLogix 5000 software. The following table defines abbreviations that are used in this manual .

Abbreviation	Description
AOPD	Active Opto-electronic Protective Device
BCAM	Brake Cam
BDDC	Bottom Dead Center
CVT	Circuit Verification Test
DCAM	Dynamic Cam
ESPE	Electro-sensitive Protective Equipment
TCAM	Takeover Cam

Additional resources

These documents contain additional information concerning related Rockwell Automation products.

Resource	Description
GuardLogix® 5570 Controllers User Manual, publication 1756-UM022.	Provides information on how to install, configure, and program the GuardLogix 5570 controllers in the Logix Designer application.
GuardLogix 5570 Controllers Reference Manual, publication 1756-RM099.	Contains detailed requirements for how to achieve and maintain SIL 3 with the GuardLogix 5570 controller system in a Logix Designer application.
GuardLogix 5570 Controllers User Manual, publication 1756-UM020.	Provides information on how to install, configure, and program the GuardLogix 5560 controllers in RSLogix 5000 software.
GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093.	Contains detailed requirements for how to achieve and maintain SIL 3 with the GuardLogix 5560 controller and the 1768 Compact GuardLogix® system in RSLogix 5000 software.
CompactLogix™ Controllers Installation Instructions, publication 1768-IN004.	Provides information on how to install 1768 Compact GuardLogix controllers.
1768 Compact GuardLogix Controllers User Manual, publication 1768-UM002.	Provides information on how to configure and program the 1768 Compact GuardLogix controller.

Resource	Description
CompactBlock, Guard I/O, DeviceNet Safety Module Installation Instructions, publication 1791DS-IN002.	Provides information on how to install CompactBlock Guard I/O™ DeviceNet Safety modules.
Guard I/O DeviceNet Safety Modules User Manual, publication 1791DS-UM001.	Provides information on using Guard I/O DeviceNet Safety Modules.
Guard I/O EtherNet/IP Safety Modules Installation Instructions, publication 1791ES-IN001.	Provides information on how to install CompactBlock Guard I/O EtherNet/IP Safety modules.
Guard I/O EtherNet/IP Safety Modules User Manual, publication 1791ES-UM001.	Provides information on using Guard I/O Safety modules.
POINT Guard I/O Safety Modules User Manual, publication 1734-UM013.	Provides information on using POINT Guard I/O Safety modules
Using ControlLogix® in SIL2 Applications Safety Reference Manual, publication 1756-RM001.	Describes requirements for using ControlLogix controllers, and GuardLogix standard tasks, in SIL2 safety control applications.
Logix Controllers Instructions Reference Manual, publication 1756-RM009.	Provides information on the Logix5000™ instruction set that includes general, motion, and process instructions.
Logix Common Procedures Programming Manual, publication 1756-PM001.	Provides information on programming Logix5000 controllers, including how to manage project files, organize tags, program and test routines, and handle faults.
ControlLogix System User Manual, publication 1756-UM001.	Provides information on using ControlLogix in nonsafety applications.
DeviceNet™ Modules in Logix5000 Control Systems User Manual, publication DNET-UM004.	Provides information on using the 1756-DNB module in a Logix5000 control system
EtherNet/IP™ Modules in Logix5000 Control Systems User Manual, publication ENET-UM001.	Provides information on using the 1756-ENBT module in a Logix5000 control system.
ControlNet™ Modules in Logix5000 Control Systems User Manual, publication CNET-UM001.	Provides information on using the 1756-CNB module in Logix5000 control systems.
Logix5000 Controllers Execution Time and Memory Use Reference Manual, publication 1756-RM087.	Provides information on how to estimate the execution time and memory use for instructions.
Logix Import Export Reference Manual, publication 1756-RM084.	Provides information on using RSLogix 5000 Import/Export utility
Product Certifications website, http://ab.rockwellautomation.com.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

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The software included in this product contains copyrighted software that is licensed under one or more open source licenses. Copies of those licenses are included with the software. Corresponding Source code for open source packages included in this product are located at their respective web site(s).

Alternately, obtain complete Corresponding Source code by contacting Rockwell Automation via the Contact form on the Rockwell Automation website: http://www.rockwellautomation.com/global/about-us/contact/contact.page
Please include "Open Source" as part of the request text.

A full list of all open source software used in this product and their corresponding licenses can be found in the OPENSOURCE folder. The default installed location of these licenses is `C:\Program Files (x86)\Common Files\Rockwell\Help\FactoryTalk Services Platform\Release Notes\OPENSOURCE\index.htm`.

Safety Instructions

Safety Instructions

In the controller organizer, you can recognize safety programs by the red bar that is incorporated into the icons. The red bar indicates the program will execute in safety memory.

The buttons for instructions that function as part of a safety program, or are supported by a safety program, have a red triangle in the right corner of each button.

Available Instructions

Ladder Diagram

FSBM	TSAM	TSSM	FPMS	ESTOP	ROUT	RIN	ENPEN
DIN	LC	THRS	DCS	DCST	DCSTL	DCSTM	DCSRT
DCM	SMAT	THRSe	CROUT	DCA			

Function Block

Not available

Structured Text

Not available

Safety application instructions are intended for use within a safety system that has a controller and I/O modules. These instructions are intended for Safety Integrity Level (SIL) 3, PLe/Category (CAT) 4 applications.

If you want to	Use this instruction
Provide an interface from a programmable controller to a three-to-five position selector switch used in SIL3/CAT4 safety applications.	FPMS
Emulate the input functionality of a safety relay in a software programmable environment which is intended for use in SIL3/CAT4 safety applications.	ESTOP
Emulate the output functionality of a safety relay in a software programmable environment which is intended for use in SIL3/CAT4 safety applications.	ROUT

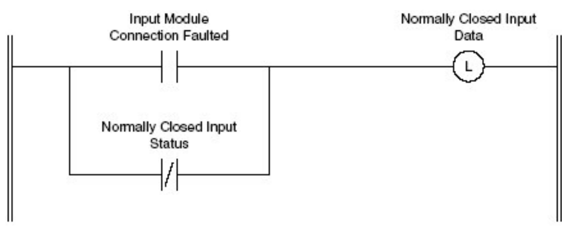
If you want to	Use this instruction
Emulate the input functionality of a safety relay in a software programmable environment that is intended for use in SIL3/CAT4 safety applications.	RIN
Emulate the input functionality of a safety relay in a software programmable environment that is intended for use in SIL3/CAT4 safety applications.	ENPEN
Emulate the input functionality of a safety relay in a software programmable environment that is intended for use in SIL3/CAT4 safety applications.	DIN
Provide a manual and an automatic circuit reset interface from a programmable controller to a light curtain used in SIL3/CAT4 safety applications.	LC
Provide a method to incorporate two diverse input buttons used as a single operation start button into a software programmable environment that is intended for use in SIL3/CAT4 safety applications.	THRS
Monitor dual-input safety devices whose main purpose is to provide a stop function, such as an E-stop, light curtain, or gate switch.	DCS
Monitor dual-input safety devices whose main purpose is to provide a stop function, such as an E-stop, light curtain, or gate switch. It includes the added capability of initiating a functional test of the stop device.	DCST
Monitors dual-input safety devices whose main purpose is to stop a function, such as an E-stop, light curtain, or gate switch. It includes the added capability of initiating a functional test of the stop device and can monitor a feedback signal from a safety device and issue a lock request to a safety device.	DCSTL
Monitor dual-input safety devices whose main purpose is to provide a stop function, such as an E-stop, light curtain, or gate switch. It includes the added capability of initiating a functional test of the stop device and the ability to mute the safety device.	DCSTM
Energize dual-input safety devices whose main function is to start a machine safely, for example an enable pendant.	DCSRT
Monitor dual-input safety devices.	DCM
Indicate whether or not the safety mat is occupied.	SMAT
Provide temporary, automatic disabling of the protective function of a light curtain, using two muting sensors arranged asymmetrically.	TSAM
Provide temporary, automatic disabling of the protective function of a light curtain, using two muting sensors arranged symmetrically.	TSSM
Provide temporary, automatic disabling of the protective function of a light curtain, using four sensors arranged sequentially before and after the light curtain's sensing field.	FSBM
Monitor two diverse safety inputs, one from a right-hand push button and one from a left-hand push button, to control a single output.	THRSe
Control and monitor redundant outputs.	CROUT
Monitor two analog input channels originating from an analog input module. (Integer version)	DCA
Monitor two analog input channels originating from an analog input module. (Floating Point version)	DCAF

The Safety controller is part of a De-Energize to Trip system. This means that all of its outputs are set to zero when a fault is detected.

IMPORTANT The following sections are only applicable to these instructions:
- ESTOP
- RIN
- DIN
- ENPEN
- THRS
- LC
- ROUT
- FPMS

De-energize to Trip System

In addition, the Safety controller automatically sets any input values associated with faulty input modules to zero. As a result, any inputs being monitored by one of the diverse input instructions (DIN or THRS) should have the normally closed input conditioned by logic as shown here:



The exact ladder logic depends on your specific system requirements, and the functionality of the Safety input module. The result, however, should be the same: to create a Safe state of one for the normally closed input of the diverse input instructions. This example logic actually overrides the input value in the input tag.

The normally closed input of the diverse input instruction should be placed in a Safe state whenever the connection to the input module is lost, or the normally closed input point is faulted.

The input value should remain intact to represent the actual state of the field device when there is a connection and the normally closed input point is not faulted.

Failure to implement this type of logic does not create an unsafe condition, but it does result in the instruction latching an Inputs Inconsistent fault, requiring a clear fault operation to be performed.

System Dependencies

The safety application instructions depend on the safety I/O modules, controller operating system, and the ladder logic to perform portions of the safety functions.

Input and Output Line Conditioning

Safety I/O modules provide pulse test and monitoring capabilities. If the module detects a failure, it sets the offending input or output to the Safe state and reports the failure to the controller.

The failure indication is made via the input or output point status, and is maintained for a configurable amount of time, or until the failure is repaired, which ever comes last.

IMPORTANT	Ladder logic must be included in the application program to latch these I/O point failures and ensure proper restart behavior.

For more information on Safety I/O modules, refer to the following:

- DeviceNet Safety I/O User Manual, publication 1791DS-UM001
- Guard I/O EtherNet/IP Safety modules User Manual, publication 1791ES-UM001
- POINT Guard I/O Safety Modules User Manual, publication 1734-UM013.

I/O Module Connection Status

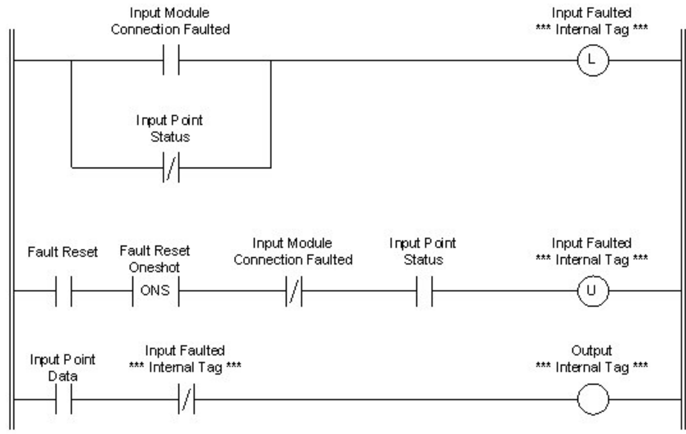
A CIP Safety™ system provides connection status for each I/O device in the safety system. If an input connection failure is detected, the operating system sets all associated inputs to the de-energized (Safe) state, and reports the failure to the ladder logic. If an output connection failure is detected, the operating system can only report the failure to the ladder logic.

IMPORTANT	Ladder logic must be included in the application program to latch these I/O point failures and ensure proper restart behavior.

How to Latch and Reset Faulted I/O

The following diagrams provide examples of the ladder logic required to latch and reset an I/O module connection or point failure. The first image shows the ladder logic for an input point, and the second shows the ladder logic for an output point.

IMPORTANT	Both of these diagrams are examples, and are for illustrative purposes only. The suitability of this logic depends upon your specific system requirements.



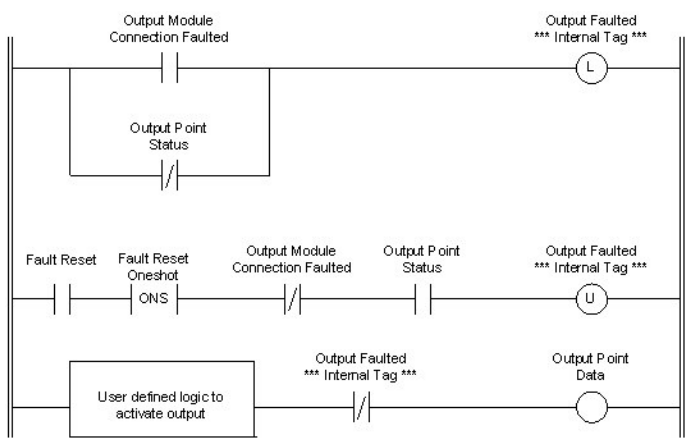
The first rung latches an internal indication that either the module connection or the specific input point has failed.

The second rung resets the internal indication, but only if the fault has been repaired, and only on the rising edge of the Fault Reset signal. This prevents the safety function from automatically restarting if the Fault Reset signal gets stuck on.

The third rung shows the input point data used in combination with the internal fault indication to control an output.

The output is internal data that may be used in combinational logic later to drive an actual output. If an actual output is used directly, it may or may not require logic similar to that shown in Figure 1.3 for latching and resetting output connection failures.

The Fault Reset contact shown in these examples is typically activated as a result of operator action. The Fault Reset could be derived as a result of combinational logic or directly from an input point (in which case it may or may not require conditioning of its own).



The ladder logic in the output example has the same latch and reset concept as that shown in the input example.

The first rung latches an internal indication that either the module connection or the specific output point has failed.

The second rung resets the internal indication, but only if the fault has been repaired, and only on the rising edge of the Fault Reset signal. This prevents the safety function from automatically restarting if the Fault Reset signal gets stuck on.

The third rung includes application-specific logic to drive the state of an output point. This logic is conditioned by the output faulted internal indicator.

False Rung State Behavior

The information provided in this manual regarding the GuardLogix Safety application instructions depicts the "True Rung State" (Ladder Diagram Logic) behavior of the instructions.

The "False Rung State" behavior is exactly the same (internal state machines continue to run and change states based on the inputs) except that all outputs, including prompts and fault indicators, are set to zero when the instructions are disabled or on a false rung.

I/O Point Mapping

Input

The following table identifies the mapping between the Safety I/O module's Input points and the controller tags when the Safety I/O module's Input Status module definition is configured for Point Status or Combined Status.

Note that *moduleName* is the name you assign to the I/O module.

	Controller Tag Reference		
I/O Module Point	**Data**	**Point Status**	**Combined Status**
IN 0	*moduleName*:I.Pt00Data	*moduleName*:I.Pt00InputStatus	*moduleName*:I.InputStatus
IN 1	*moduleName*:I.Pt01Data	*moduleName*:I.Pt01InputStatus	
IN 2	*moduleName*:I.Pt02Data	*moduleName*:I.Pt02InputStatus	
…	…	…	
IN n	*moduleName*:I.PtnData	*moduleName*:I.PtnInputStatus	

Output

The following table identifies the mapping between the Safety I/O module's Output points and the controller tags when the Safety I/O module's Input Status module definition is configured for Point Status or Combined Status.

Note that *moduleName* is the name you assign to the I/O module.

	Controller Tag Reference		
I/O Module Point	**Data**	**Point Status**	**Combined Status**
OUT 0	*moduleName*:O.Pt00Data	*moduleName*:I.Pt00OutputStatus	*moduleName*:I.OutputStatus
OUT 1	*moduleName*:O.Pt01Data	*moduleName*:I.Pt01OutputStatus	
OUT 2	*moduleName*:O.Pt02Data	*moduleName*:I.Pt02OutputStatus	
…	…	…	
OUT n	*moduleName*:O.PtnData	*moduleName*:I.PtnOutputStatus	

See also

Execution Times for Safety Application Instructions on page 526

Status and Safety input and output for dual channel safety instructions

The following I/O status information is relevant for all safety instructions.

Connection Status

Connection status (.ConnectionFaulted) is the status of the safety connection between the safety controller and safety I/O module. When the connection is operating properly, the bit is LO (0). When the connection is not operating properly, the bit is HI (1). When the connection status is not operating properly, all module defined tags are LO, and have invalid data.

Point Status

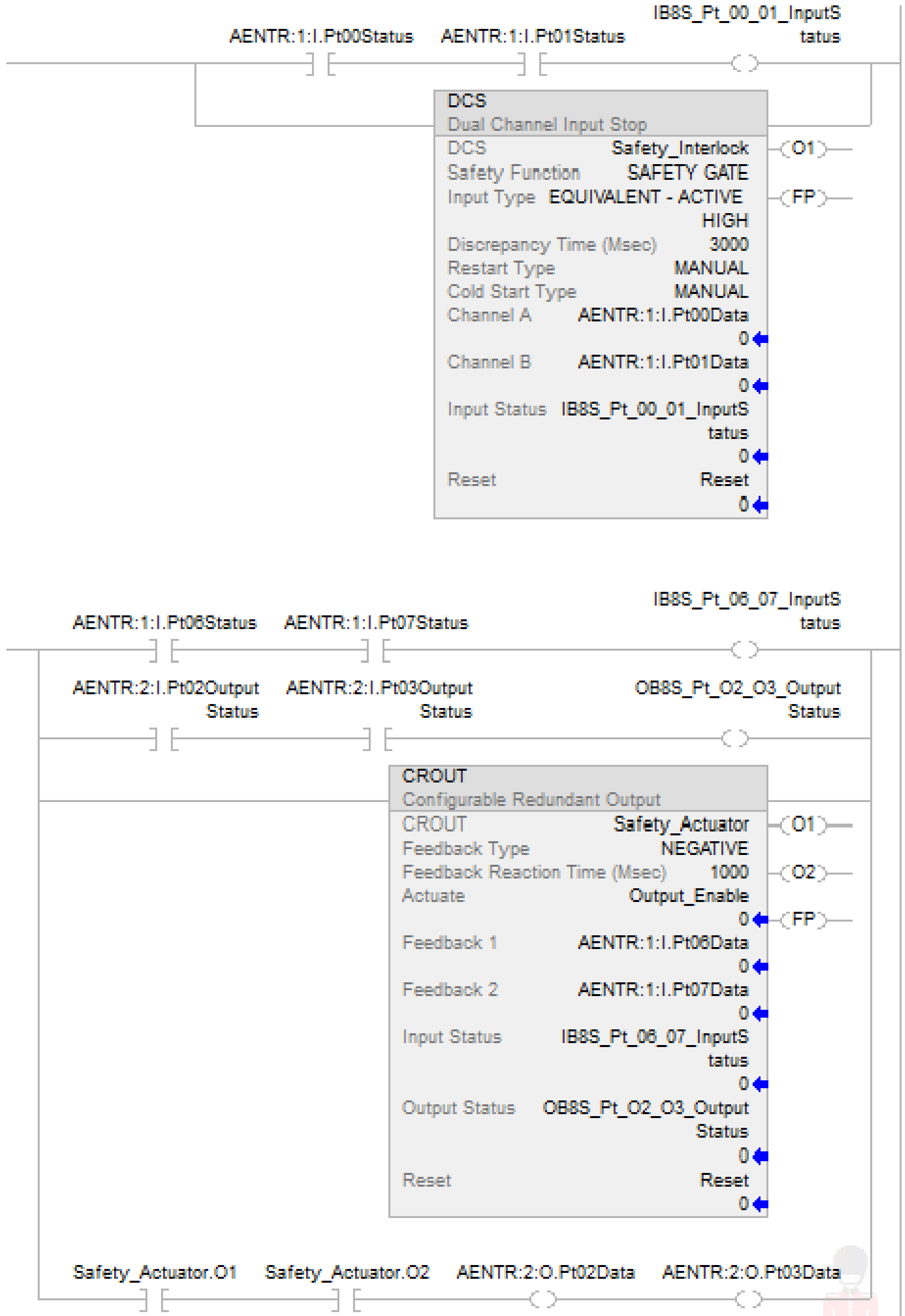
Point Status is available for safety inputs (.PtxxInputStatus) and safety outputs (.PtxxOutputStatus). When a point status tag is HI (1), it indicates that the individual channel is functioning and wired correctly. It also indicates the safety connection between the safety controller and the safety I/O module on which this channel resides is operating properly.

Combined Status

Combined Status is available for safety inputs (.CombinedInputStatus) and safety outputs (.CombinedOutputStatus). When the combined status tag is HI (1), it indicates that all input or output channels on the module are functioning and wired correctly. It also indicates that the safety connection between the safety controller and the safety I/O module on which these channels reside is operating properly.

Whether combined status or point status is used depends on the application. Point status provides more granular status.

The dual channel safety instructions have built-in safety I/O status monitoring. Input and Output statuses are parameters for the safety input and output instructions. All dual channel safety instructions have input status for input channels A and B. The CROUT instruction has input status for Feedbacks 1 and 2, and output status for the output channels driven by the CROUT outputs O1 and O2. The status tags used in these instructions must be HI (1) for the safety instruction output tag(s) with O1 for input instructions and O1/O2 to energize the CROUT instruction.



IMPORTANT	Interrogate Safety I/O status when using instructions such as XIC and OTE. Verify safety input channel status is HI (1) before using a safety input channel as an interlock. Verify safety output channel status is HI (1) before energizing a safety output channel.

See also

Safety Instructions on page 15

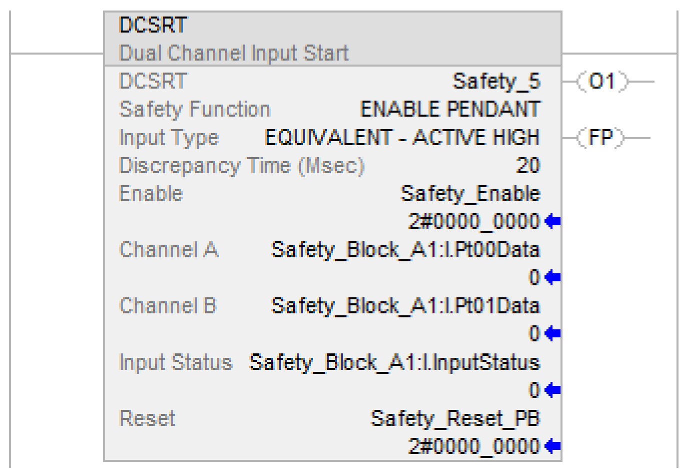
Dual-channel Input Start (DCSRT)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual-channel Input Start instruction is for safety devices whose main function is to start a machine safely, for example, an enable pendant. This instruction energizes its output (O1) only if the Enable input is ON (1), and both safety inputs, Channel A and Channel B, transition to the active state within the Discrepancy Time.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

IMPORTANT Make sure safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or Ple (Cat. 4) safety functions.

IMPORTANT If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operand used to configure the instruction. This operand cannot be changed at runtime.

Operand	Data Type	Format	Description
DCSRT	DCI_START	Tag	DCSRT structure
Safety Function	DINT	list item	This operand provides a text name for how this instruction is being used. Choices include enable pendant (20), start button (21), and user-defined (100). This operand does not affect instruction behavior. It is for information/documentation purposes only.
Input Type	DINT	list item	This operand selects input channel behavior. **Equivalent - Active High (0)**: Inputs are in the active state when Channel A and Channel B inputs are 1. **Complementary (2)**: Inputs are in the active state when Channel A is 1 and Channel B is 0.
Discrepancy Time (ms)	DINT	immediate	The amount of time that the inputs can be in an inconsistent state before an instruction fault is generated. The inconsistent state depends on the Input Type. Equivalent: Inconsistent state is when either is true: Channel A = 0 and Channel B =1 Channel A =1 and Channel B =0 Complementary: Inconsistent state is when either is true: Channel A = 0 and Channel B =0r Channel A =1 and Channel B =1 The valid range is 5...3000 ms.

The following table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Enable	BOOL	tag	This input enables or disables the instruction. ON (1): The instruction is enabled. Output 1 is energized when Channel A and Channel B transition to the active state within the Discrepancy Time. OFF (0): The instruction is disabled. Output 1 is not energized.
Channel A[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Channel B[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	tag	This input clears the instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset.

[1] If the input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

The following table explains instruction outputs. The outputs can be used to drive external tags (safety output modules) or internal tags for use in other logic routines.

Operand	Data Type	Description
Output 1 (01)	BOOL	This output is energized when the input conditions have been satisfied. The output becomes de-energized when: • Either Channel A or Channel B transitions to the safe state. • The Input Status input is OFF(0). • The Enable input turns OFF(0)
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section for a list of fault codes. This operand is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section below for a list of diagnostic codes. This operand is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

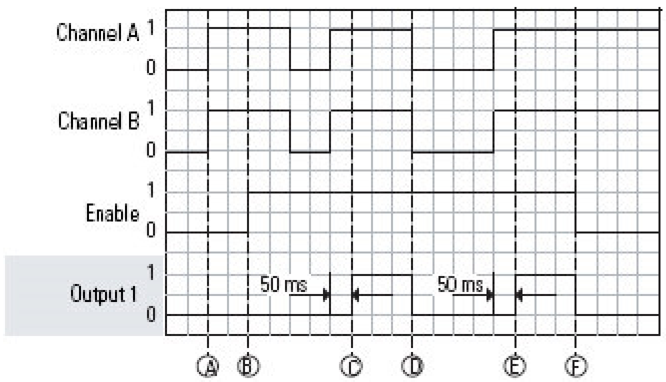
Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01 and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Normal operation section.
Postscan	Same as Rung-condition-in is false.

Operation

Normal

The timing diagram illustrates the normal operation for a start device, for example, an enable pendant. At (A), Output 1 is not energized because the Enable input is OFF (0). At (B), Output 1 is not energized because the transition of the Enable signal ON (1) can never enable Output 1. At (C), Output 1 is energized 50 ms after the safety inputs transition through the safe state and to the active state with the Enable input ON (1). At (D), Output 1 is de-energized when either one of the safety inputs transition to the safe state. At (E), Output 1 is energized 50 ms after the safety inputs return to the active state. At (F), Output 1 is de-energized because the Enable input has transitioned to OFF (0).

Normal (Equivalent Inputs)



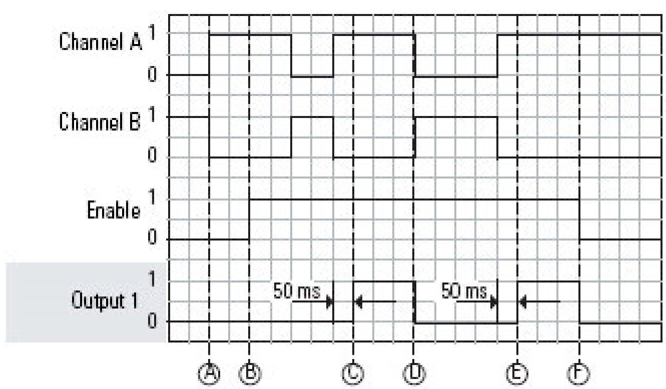
Input Type = Equivalent - Active High

Discrepancy Time = 250 ms

If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

This diagram demonstrates the same behavior as in the previous timing diagram except that the Input Type is Complementary.

Normal (Complementary Inputs)



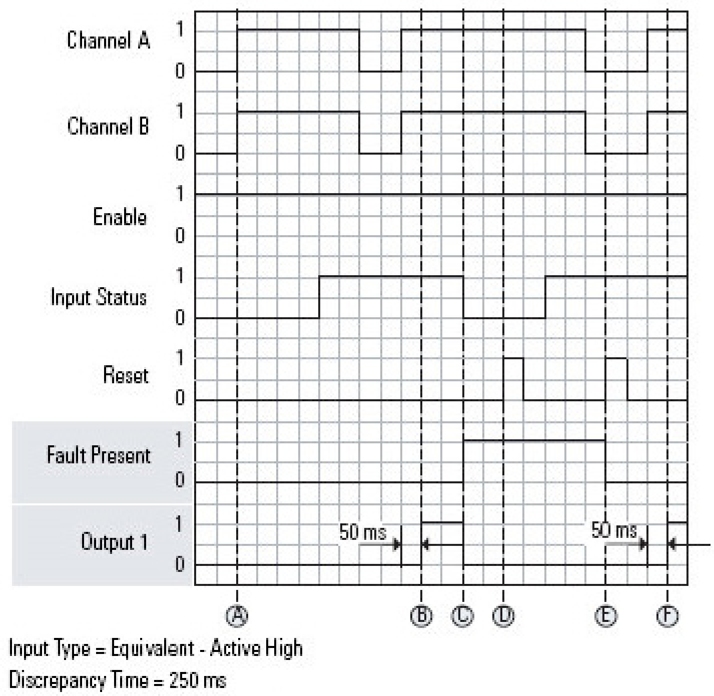
Input Type = Complementary.

Discrepancy Time = 250 ms. If the Input Status input is not shown, it is assumed that the input status is valid (ON =1) for the entire timing diagram.

Input Status Fault Operation

The timing diagram illustrates fault behavior when the Input Status becomes invalid. At (A), Output 1 is not energized because the Input Status has not become active for the first time. At (B), with the Input Status active, and after a 50 ms delay, Output 1 is energized because the safety inputs have transitioned through the safe state to the active state. At (C), the Input Status becomes invalid, which immediately de-energizes Output 1 and generates a fault. At (D), the fault cannot be reset because the Input Status is still inactive.

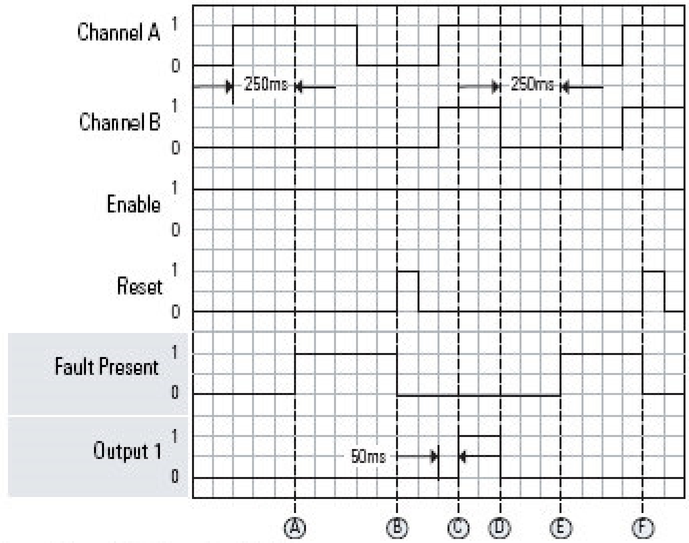
At (E), the fault is reset because the Input Status is now active and a reset is triggered. At (F), Output 1 is active.



Discrepancy Fault Operation

The timing diagram illustrates a discrepancy fault occurring when Channel A and Channel B are in an inconsistent state for longer than the Discrepancy Time configuration operand. At (A), a fault is generated when the safety inputs are in an inconsistent state for longer than the Discrepancy Time, for example, 250 ms. At (B), the fault is cleared because both safety inputs are inactive and the reset went active. At (C), Output 1 is energized 50 ms after both safety inputs transition to the active state together within the Discrepancy Time. At (D), Output 1 is de-energized when Channel B transitions to the safe state. At (E), a fault is generated because the safety inputs are again in an inconsistent state for longer than the Discrepancy

Time. At (F), the fault is cleared, but Output 1 is not energized until both safety inputs transition to the active state together.



Input Type = Equivalent - Active High
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Alarms

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.
16#4000 16384	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the active state. Channel B was in the safe state.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state). • Reset the fault.
16#4001 16385	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the safe state. Channel B was in the active state.	

Fault Code	Description	Corrective Action
16#4002 16386	Channel A went to the safe state and back to the active state while Channel B remained active.	
16#4003 16387	Channel B went to the safe state and back to the active state while Channel A remained active.	

Diagnostic Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status was OFF(0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.
16#4000 16384	The device is not in a safe state at start-up.	Release the start device (put Channel A and Channel B in a safe state).
16#4060 16480	The device is not enabled.	Enable the device (set Enable to 1).

See also

Dual-channel Input Start (DCSRT) wiring and programming example on page 30

Index Through Arrays on page 540

Status and Safety input and output for dual channel safety instructions on page 21

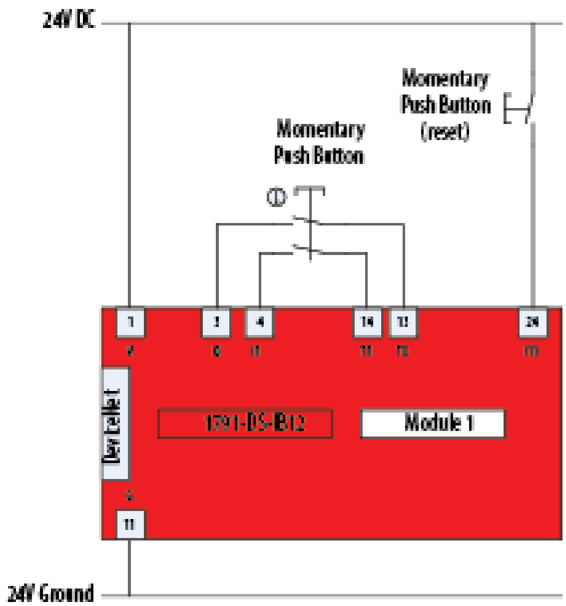
Dual-channel Input Start (DCSRT) wiring and programming example

This topic demonstrates how to wire the Guard I/O module and program the instruction in the safety control portion of an application

This application example complies with ISO 13849-1, Category 4 operation.

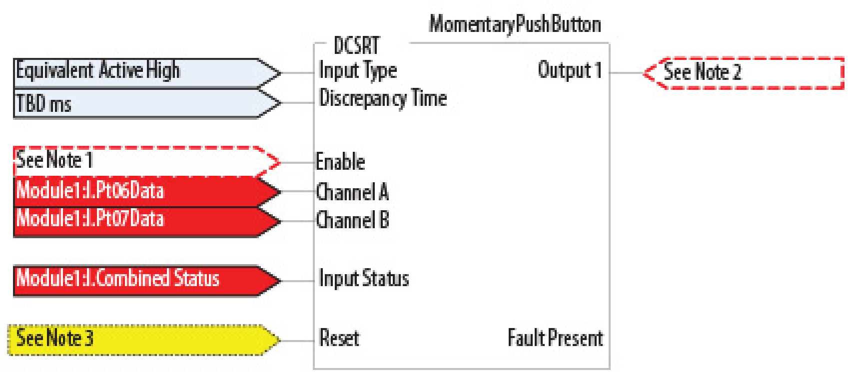
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram



Programming Diagram

This programming diagram shows the instruction with inputs and test outputs.

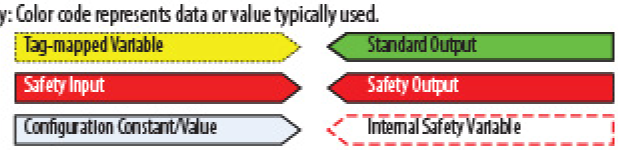


Note 1: This tag is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.

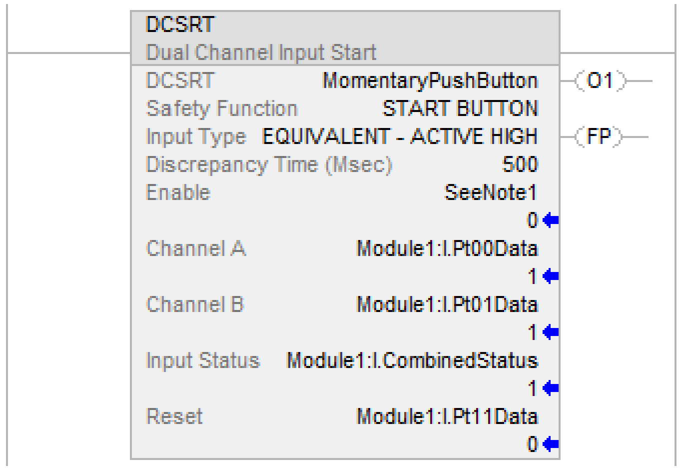
Note 2: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.

Note 3: The source can be mapped or safety data.

Key: Color code represents data or value typically used.



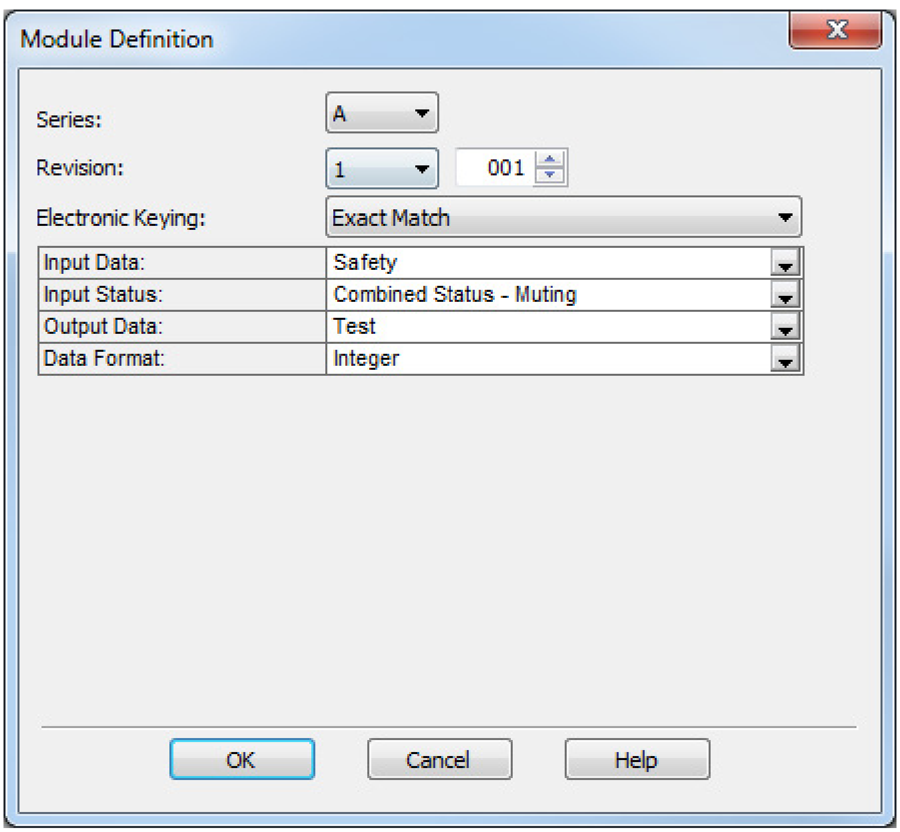
Ladder Diagram



Tip: The tag in the preceding diagram is an internal Boolean tag that has a value determined by other parts of the user application that are not shown in this example.

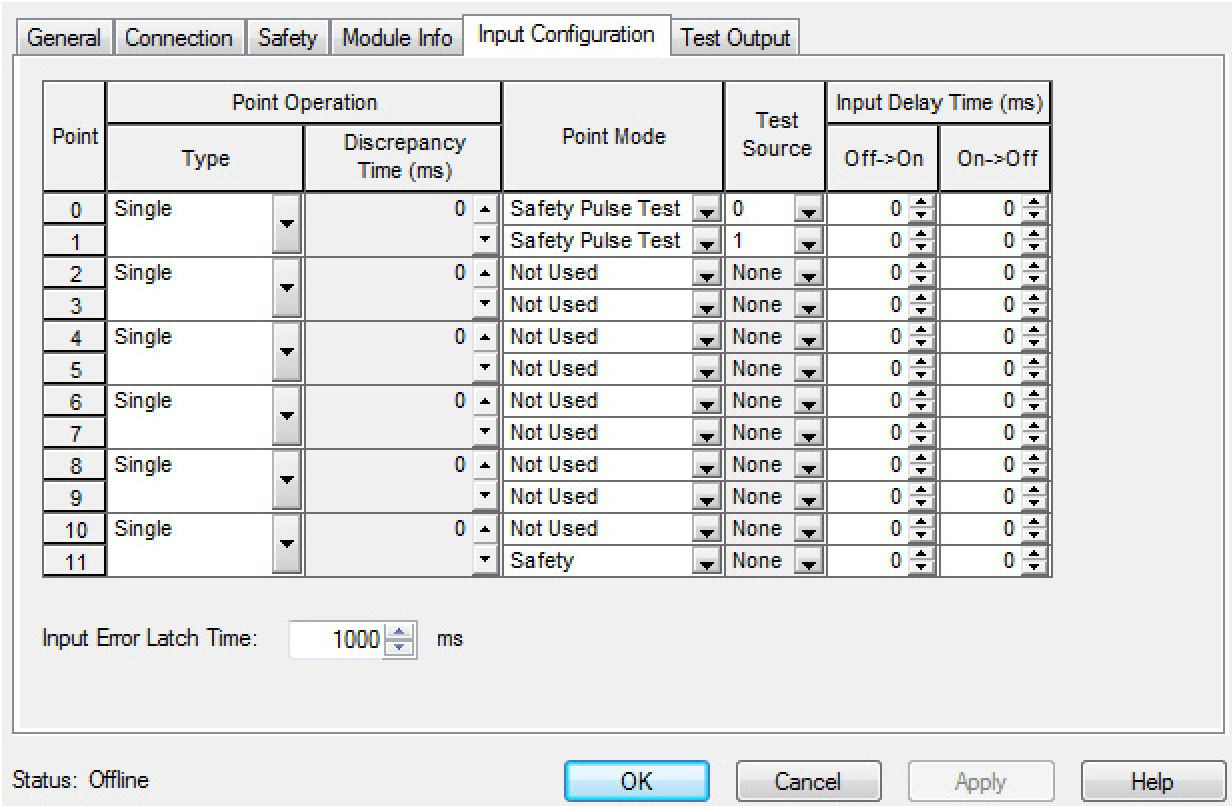
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.

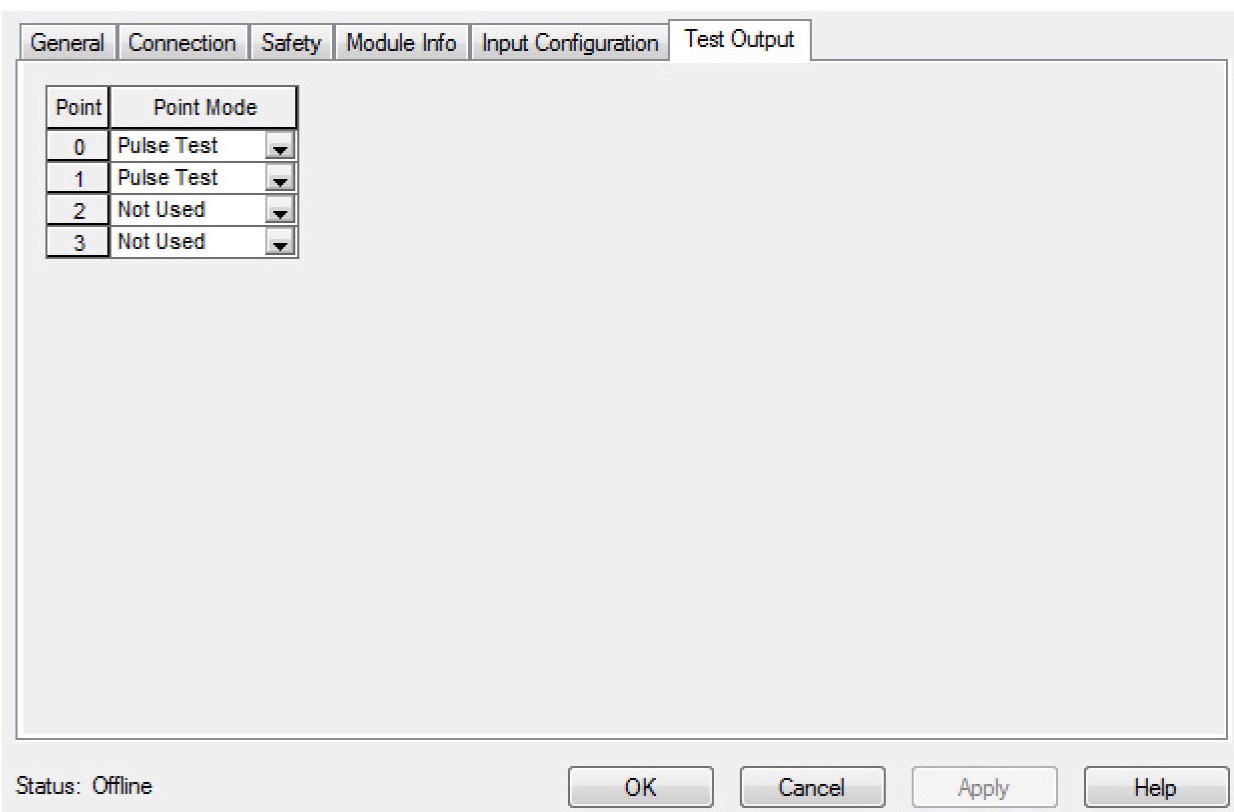


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

Module Input Configuration



Module Test Output Configuration



See also

Dual-channel Input Start (DCSRT) on page 23

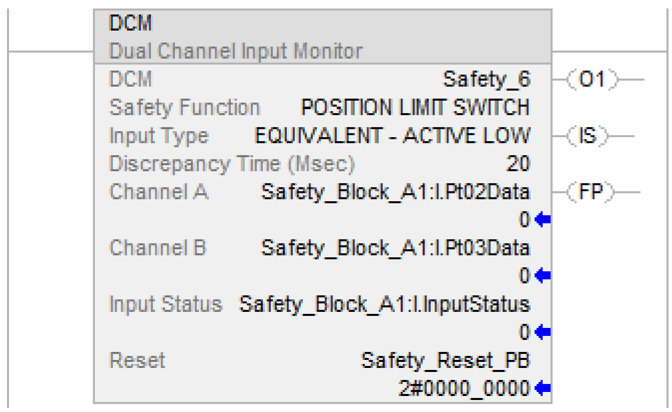
Dual Channel Input Monitor (DCM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual Channel Input Monitor instruction monitors dual-input safety devices and sets O1 (Output 1) based on the Input Type operand and the combined state of Channel A and Channel B.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT	Unexpected operation may occur if: • Output tag operands are overwritten. • Members of a structure operand are overwritten. • Structure operands are shared by multiple instructions.

IMPORTANT Make sure safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or Ple (Cat. 4) safety functions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands that are used to configure the instruction. These operands cannot be changed at runtime.

Operand	**Data Type**	**Format**	**Description**
DCM	DCI_MONITOR	tag	DCM structure
Safety Function	DINT	Drop Down	This operand provides a text name for how this instruction is being used. Choices include cam switch (40), position limit switch (41), and user-defined (100). This operand does not affect instruction behavior. It is for information/documentation purposes only.
Input Type	DINT	Drop Down	This operand selects input channel behavior. **Equivalent - Active High (0)**: Inputs are in the active state when Channel A and Channel B inputs are 1. **Equivalent - Active Low (1)**: Inputs are in the active state when Channel A and Channel B inputs are 0. **Complementary (2)**: Inputs are in the active state when Channel A is 1 and Channel B is 0.
Discrepancy Time (ms)	DINT	immediate	The amount of time that the inputs can be in an inconsistent state before an instruction fault is generated. The inconsistent state depends on the Input Type. Equivalent: Inconsistent state is when either is true: Channel A = 0 and Channel B =1 Channel A =1 and Channel B =0 Complementary: Inconsistent state is when either is true: Channel A = 0 and Channel B =0 Channel A =1 and Channel B =1 If this operand is 0, the Discrepancy Time checking is disabled (0 = infinite). The allowable range is 0…3000 ms.

The following table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Channel A[1]	BOOL	tag	This input is one of the two inputs being monitored. When either input is in the safe state, Output 1 is de-energized.
Channel B[1]	BOOL	tag	This input is one of the two inputs being monitored. When either input is in the safe state, Output 1 is de-energized.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	tag	This input clears the instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset.

[1] If the input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

The following table explains instruction outputs. The outputs may be external tags (safety output modules) or internal tags for use in other logic routines.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output is energized (1) when the input conditions are satisfied. The output becomes de-energized (0) when: • Either Channel A or Channel B transitions to the safe state. • The Input Status is OFF (0).
Instruction Status (IS)	BOOL	This output is ON (1) when Output 1 of this instruction is valid (no faults or diagnostics are present).
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.

Operand	Data Type	Description
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section below for a list of fault codes. This operand is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes for a list of diagnostic codes. This operand is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

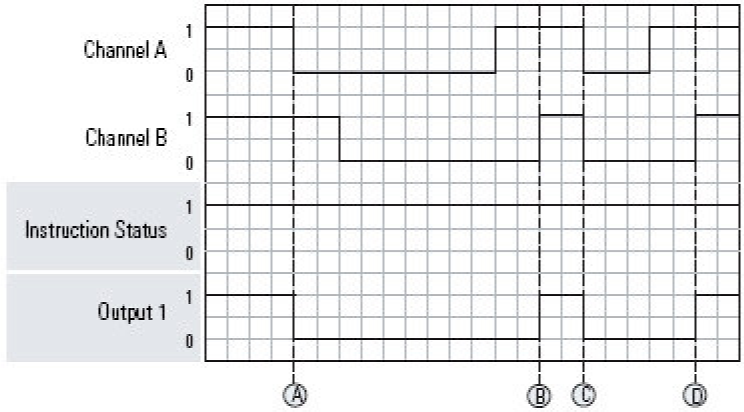
Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01, .IS, and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the operation section.
Postscan	Same as Rung-condition-in is false.

Operation

Normal Operation

The timing diagram illustrates the normal monitoring of a dual-channel input with the Input Type configured as Equivalent - Active High. Output 1 is ON (1) initially because the safety inputs are in the active state. At (A), Channel A transitions to the safe state, which causes Output 1 to go to the safe state. At (B), both of the safety inputs have transitioned to the active state, which energizes Output 1. At (C), Output 1 is de-energized and energized again at (D).

The Instruction Status is ON (1) the entire time because no faults or diagnostics occur.



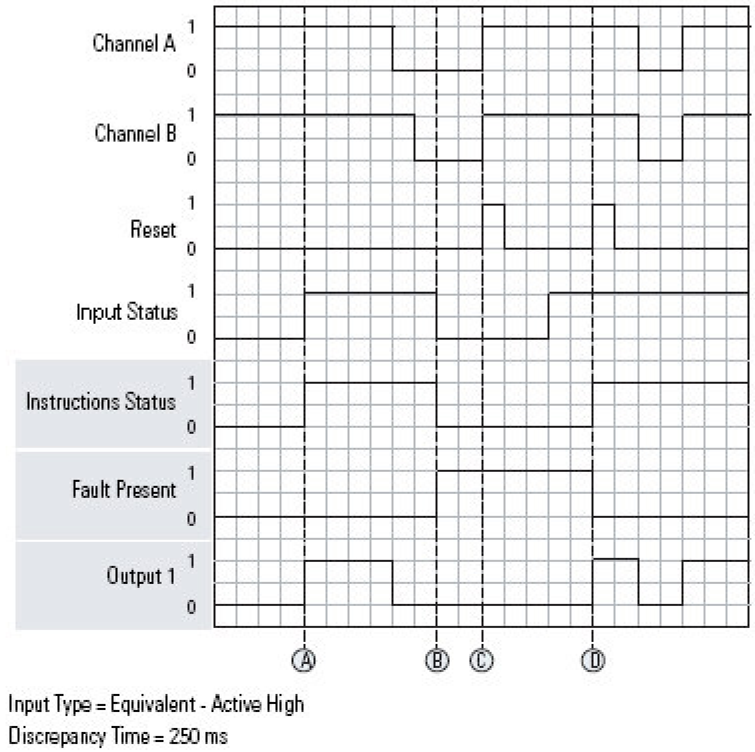
Input Type = Equivalent - Active High

Discrepancy Time = 250 ms

If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

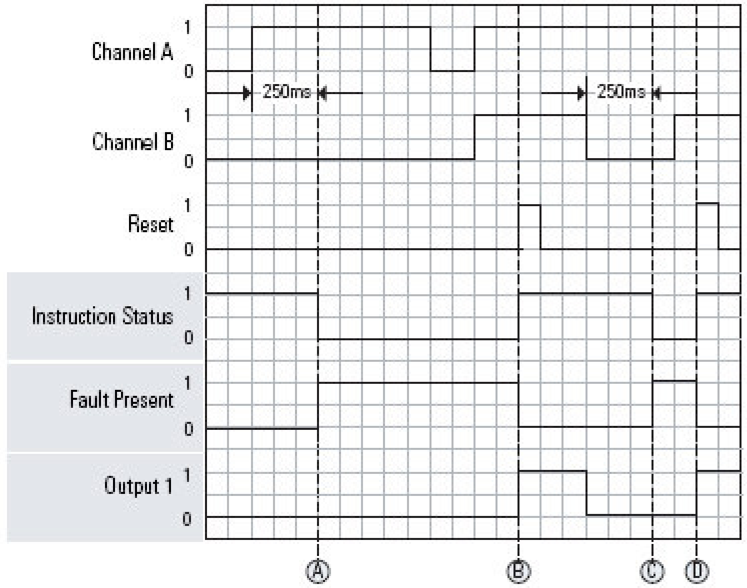
Input Status Fault Operation

The timing diagram illustrates instruction behavior with fault conditions. At (A), Output 1 turns ON (1) when the Input Status becomes valid. This also energizes Output 1 because the safety inputs are in the active state. At (B), a fault is generated when the Input status becomes invalid. This also turns OFF (0) the Instruction Status output. At (C), the fault cannot be reset because the Input Status is still invalid. At (D), the fault is cleared when a reset is triggered with the Input Status being valid. This also turns the Instruction Status output ON (1).



Discrepancy Fault Operation

The timing diagram illustrates a discrepancy fault occurring when Channel A and Channel B are in an inconsistent state for longer than the Discrepancy Time. At (A), a fault is generated when the safety inputs are in an inconsistent state for longer than the Discrepancy Time. This also turns Output 1 OFF (0). At (B), the fault is cleared because a Reset is triggered when the safety inputs are no longer in an inconsistent state. At (C), the fault is generated when the safety inputs are again in an inconsistent state for longer than the Discrepancy Time. At (D), the fault is reset.



Input Type = Equivalent - Active High

Discrepancy Time = 250 ms

If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.
16#4000 16384	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the active state. Channel B was in the safe state.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state). • Reset the fault.

Fault Code	Description	Corrective Action
16#4001 16385	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the safe state. Channel B was in the active state.	
16#4002 16386	Channel A went to the safe state and back to the active state while Channel B remained active.	
16#4003 16387	Channel B went to the safe state and back to the active state while Channel A remained active.	

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status was OFF(0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.

See also

Dual Channel Input Monitor (DCM) wiring and programming example on page 41

Safety Instructions on page 15

Index Through Arrays on page 540

Status and Safety input and output for dual channel safety instructions on page 21

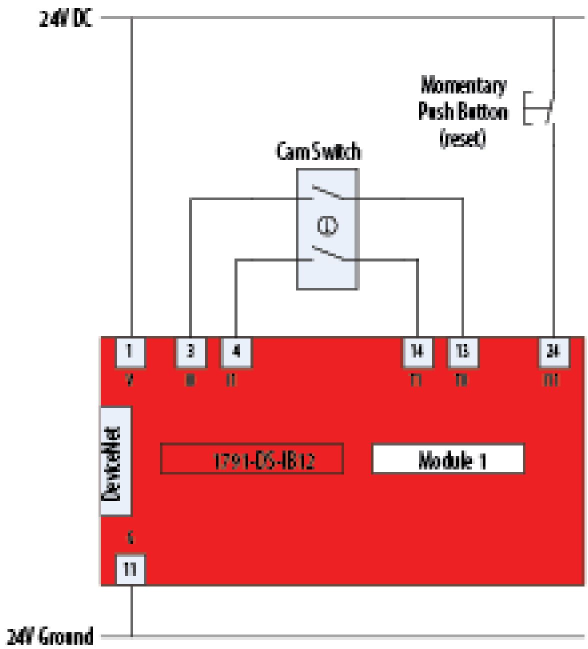
Dual Channel Input Monitor (DCM) wiring and programming example

This section demonstrates how to program the instruction in the safety control portion of an application.

This application example complies with ISO 13849-1, Category 4 operation.

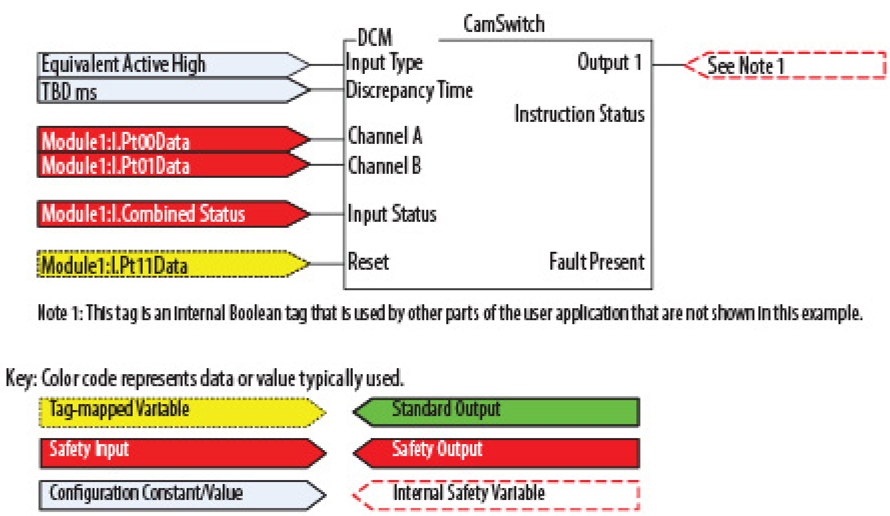
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram

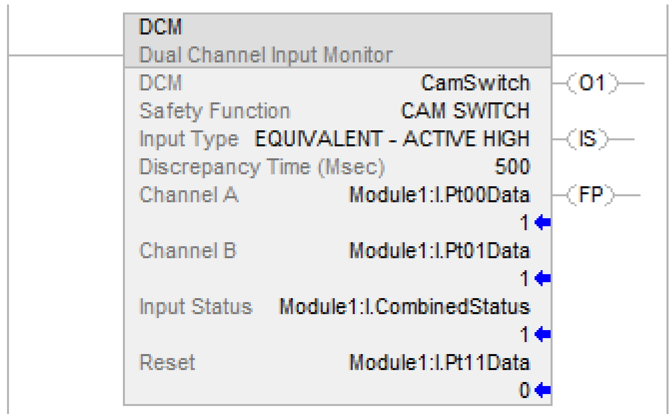


Programming Diagram

This programming diagram shows the Dual Channel Input Monitor (DCM) instruction with inputs and outputs.

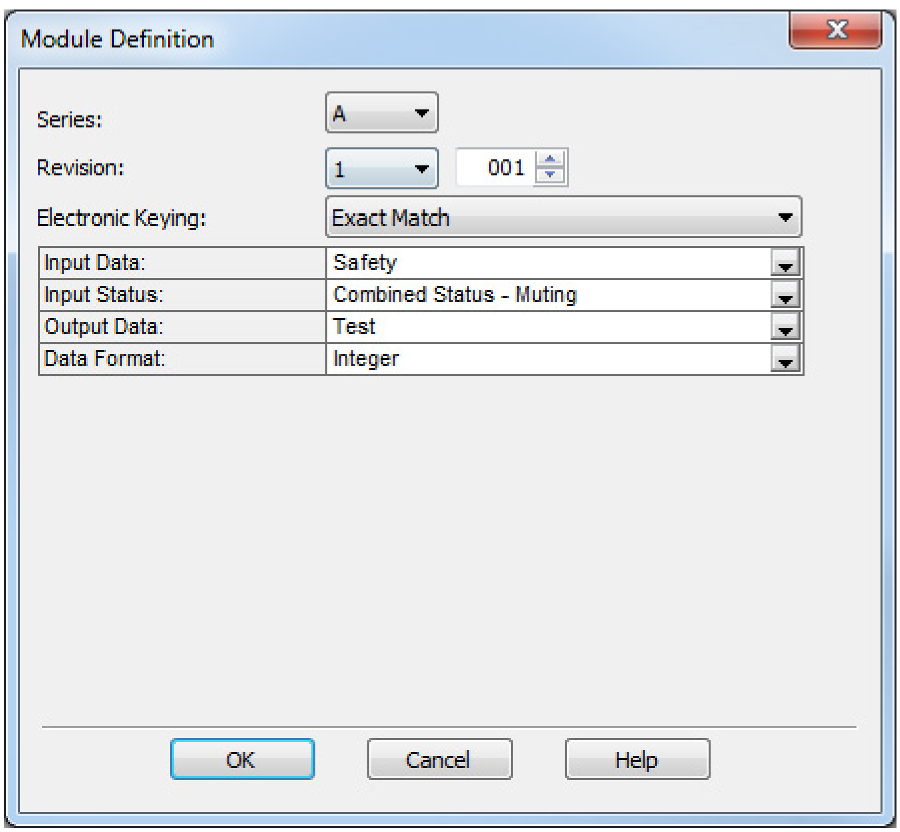


Ladder Diagram



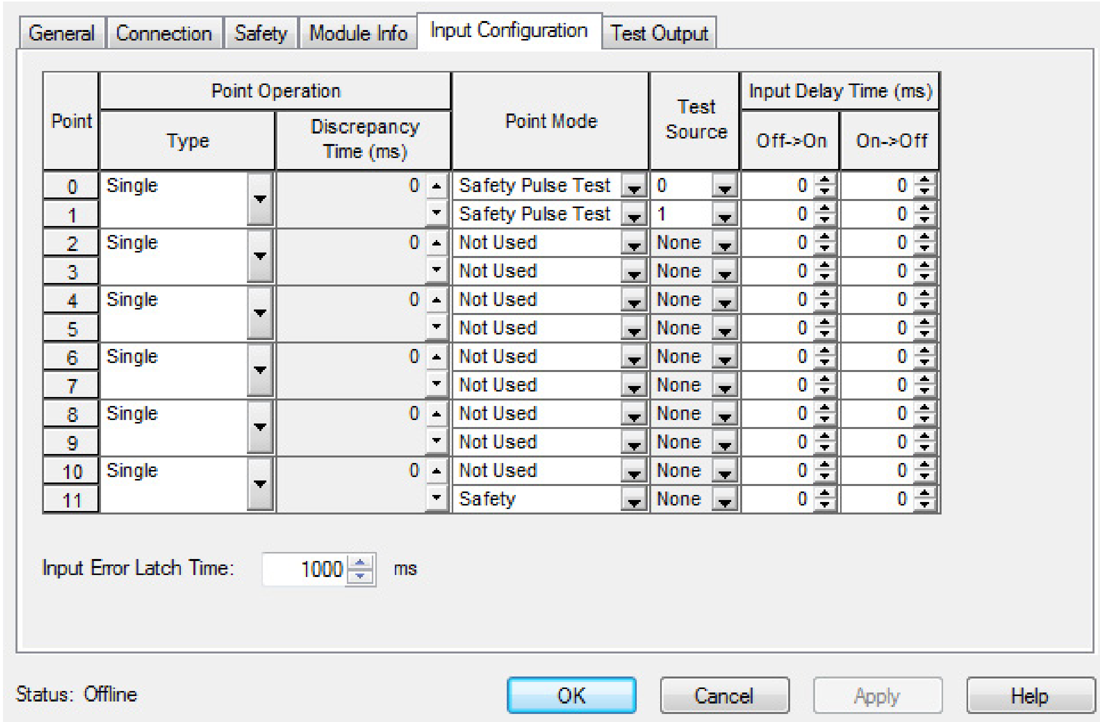
The programming software is used to configure the input and output operands of the Guard I/O module, as illustrated.

Module Definition

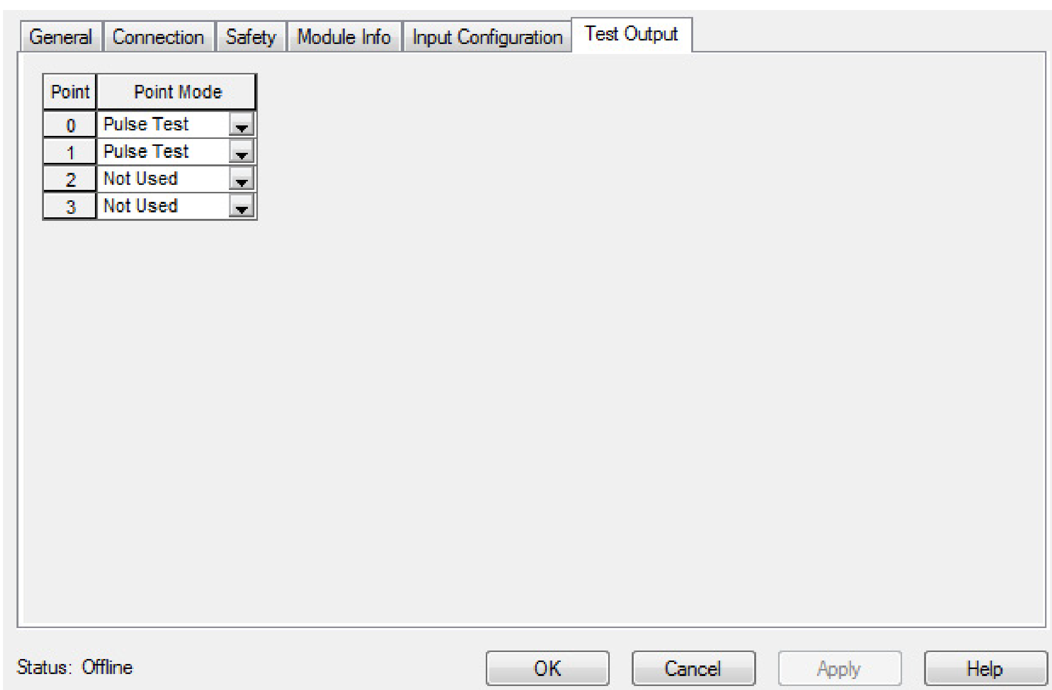


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

Module Input Configuration



Module Test Output Configuration



See also

Dual Channel Input Monitor (DCM) on page 34

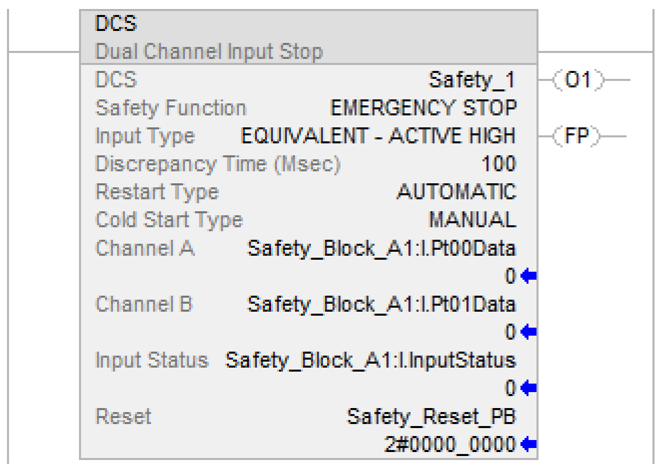
Dual Channel Input Stop (DCS)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual Channel Input Stop instruction monitors dual-input safety devices whose main function is to stop a machine safely, for example, an E-stop, light curtain, or safety gate. This instruction can only energize O1 (Output 1) when both safety inputs, Channel A and Channel B, are in the active state as determined by the Input type parameter, and the correct reset actions are carried out.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT	Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstance.

IMPORTANT	Make sure that your safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or Ple (Cat. 4) safety functions.

ATTENTION: If you change instructions parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameters that are used to configure the instruction. These parameters cannot be changed at runtime.

Operand	Type	Format	Description
DCS	DCI_STOP	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.
Safety Function	DINT	name	This parameter provides a text name for how this instruction is being used. Choices include E-stop, safety gate, light curtain, area scanner, safety mat, cable (rope) pull switch, and user-defined. This parameter does not affect instruction behavior. It is for information/documentation purposes only.
Input Type	DINT	name	This parameter selects input channel behavior. **Equivalent (0):** Active High: Inputs are in the active state when Channel A and Channel B inputs are 1. **Complementary (2):** Inputs are in the active state when Channel A is 1 and Channel B is 0.
Discrepancy Time (ms)	DINT	immediate	The amount of time that the inputs can be in an inconsistent state before an instruction fault is generated. The inconsistent state depends on the Input Type. Equivalent: Inconsistent state is when: • Channel A = 0 and Channel B =1, or • Channel A =1 and Channel B =0 Complementary: Inconsistent state is when: • Channel A = 0 and Channel B =0, or • Channel A =1 and Channel B =1 The range is 5...3000 ms.
Restart Type	List	name	This input configures Output 1 for either Manual or Automatic Restart. **Manual (0):** A transition of the Reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1 **Automatic (1):** Output 1 is energized 50 ms after all enabling conditions are met. **ATTENTION:** Automatic restart may only be used in application situations where you can prove that no unsafe conditions can occur as a result of its use, or the reset function is being performed elsewhere in the safety circuit (for example, output function).

Operand	Type	Format	Description
Cold Start Type	BOOL	name	This parameter specifies the Output 1 behavior when applying controller power or mode change to Run. **Manual (0):** Output 1 is not energized when the Input status becomes valid or when the Input Status fault is cleared. The device must be tested before Output 1 can be energized. **Automatic (1):** Output 1 is energized immediately when the Input status becomes valid or when the Input Status fault is cleared and both inputs are in their active state.

This table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Channel A[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Channel B[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	tag	If Restart Type = Manual, this input is used to energize Output 1 once Channel A and Channel B are both in the active state. If Restart Type = Automatic, this input is not used to energize Output 1. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset.

[1] If the input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to your reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

The following table explains instruction outputs. The outputs may be external tags (safety output modules) or internal tags for use in other logic routines.

Operand	Data Type	Description
Output 1 (01)	BOOL	This output is energized when the input conditions have been satisfied. The output becomes de-energized when: • Either Channel A or Channel B transitions to the safe state. • The Input Status is in the safe state.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section for a list of fault codes. This parameter is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section for a list of diagnostic codes. This parameter is not safety-related.

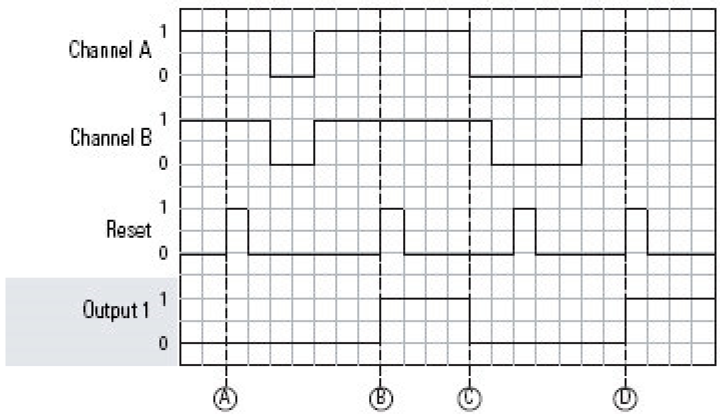
IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Operation

The timing diagram illustrates normal operation with Restart Type configured for Manual and Cold Start Type configured for Manual. At (A), Output 1 will not be energized because the safety inputs have not been through the safe state (0 in this case). At (B), Output 1 is energized because the safety inputs have been cycled through the safe state and are in the active state when the reset is triggered. At (C), Output 1 is de-energized because one of the safety inputs (Channel A) has transitioned to a safe state. At (D), Output 1 is once again energized when a reset is triggered with both safety inputs in the active state.

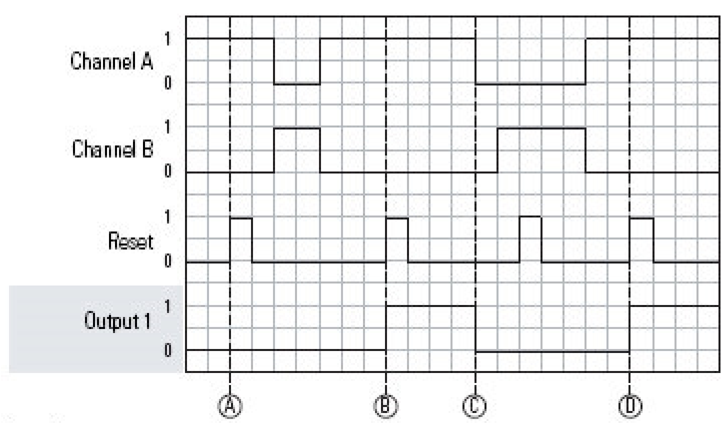
Normal Operation (Manual Restart, Manual Cold Start)



Input Type = Equivalent - Active High
Restart Type = Manual
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Normal Operation (Manual Restart, Manual Cold Start, Complementary)

The same behavior is demonstrated below as in the previous timing diagram except that the Input Type is Complementary.

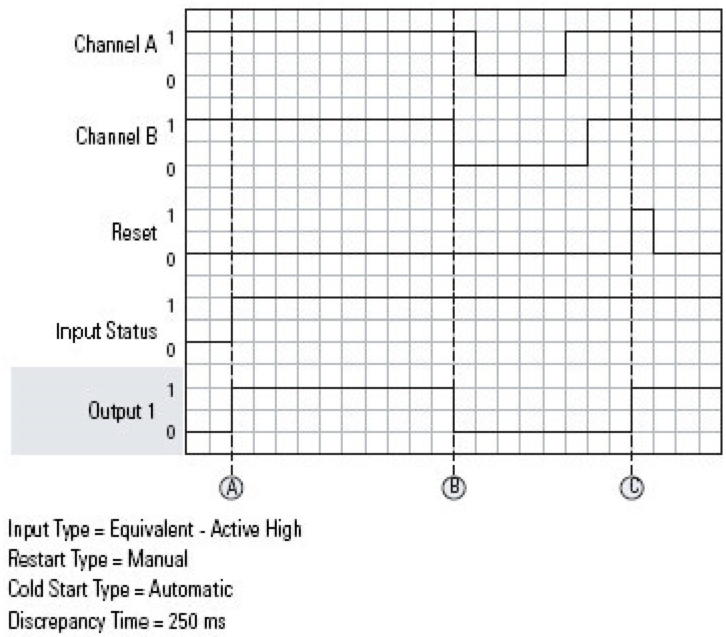


Input Type = Complimentary
Restart Type = Manual
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Normal Operation (Manual Restart, Automatic Cold Start)

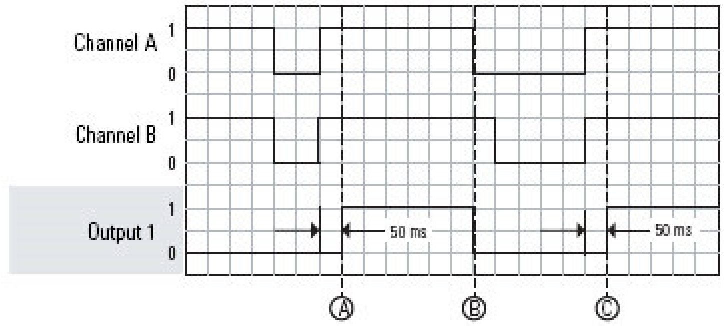
The timing diagram illustrates normal operation with Cold Start Type configured for Automatic. When Cold Start Type is automatic, Output 1 is energized as soon as the Input Status becomes valid (OFF (0) to ON (1) transition) for the first time such as when power is applied to a PLC controller. At (A), Output 1 is energized when the Input Status becomes valid with the safety inputs in the active state. At (B), Output 1 is de-energized when one of the safety inputs transitions to the safe state. Output 1 is not energized again until (C), when the reset is triggered with the safety inputs in the active state.

The Automatic Cold Start only has effect the first time the Input Status becomes valid.



Normal Operation (Automatic Restart, Manual Cold Start)

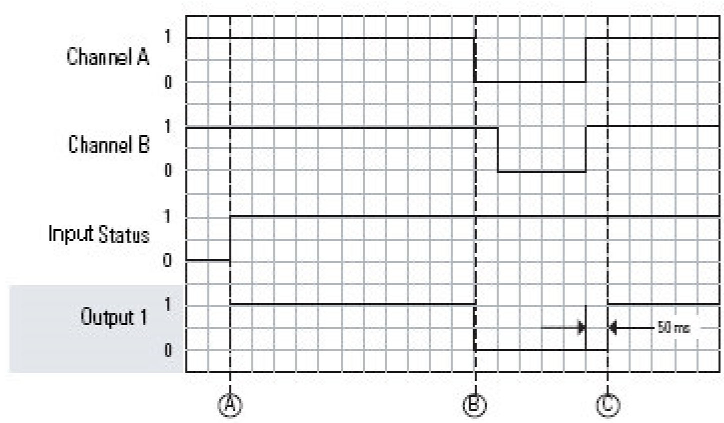
The timing diagram illustrates normal operation with Automatic Restart and manual cold start. Because Cold Start Type is manual, both safety inputs must go through the safe state before Output 1 can be energized. At (A), Output 1 is energized automatically 50 ms after the safety inputs transition to the active state (1 in this case). At (B), Output 1 is de-energized when one of the safety inputs transitions to the safe state. At (C), Output 1 is automatically energized 50 ms after both safety inputs transition back to the active state.



Input Type = Equivalent - Active High
Restart Type = Automatic
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.
There is always a 50 ms delay before energizing Output 1 when it is configured to be energized automatically (Restart Type = Automatic).

Normal Operation (Automatic Restart, Automatic Cold Start)

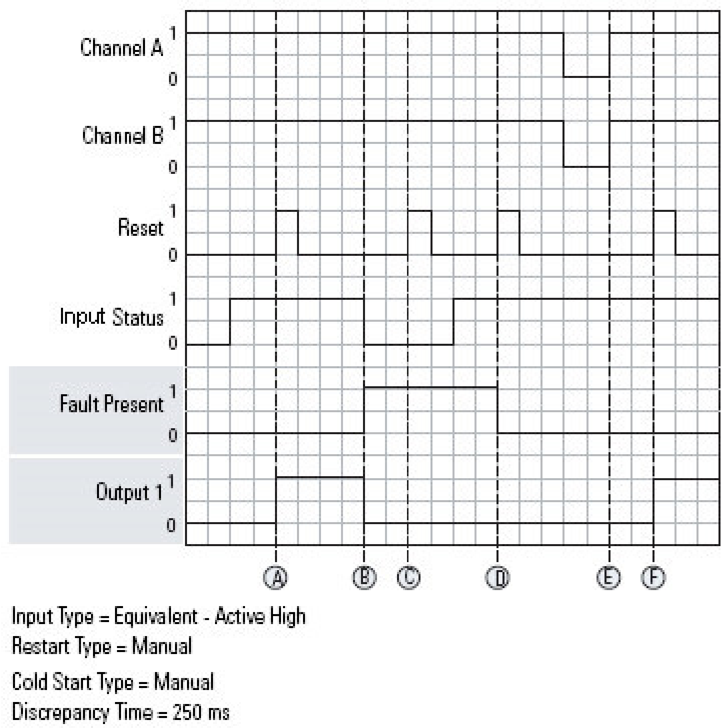
The timing diagram illustrates normal operation with Automatic Restart and Automatic Cold Start. Here the instruction does not have to wait for the safety inputs to go through the safe state. At (A), Output 1 is energized immediately after the Input Status becomes valid for the first time with the safety inputs in the active state.



Input Type = Equivalent - Active High
Restart Type = Automatic
Cold Start Type = Automatic
Discrepancy Time = 250 ms
There is always a 50 ms delay before energizing Output 1 when it is configured to be energized automatically (Restart Type = Automatic).

Input Status Fault (Manual Cold Start)

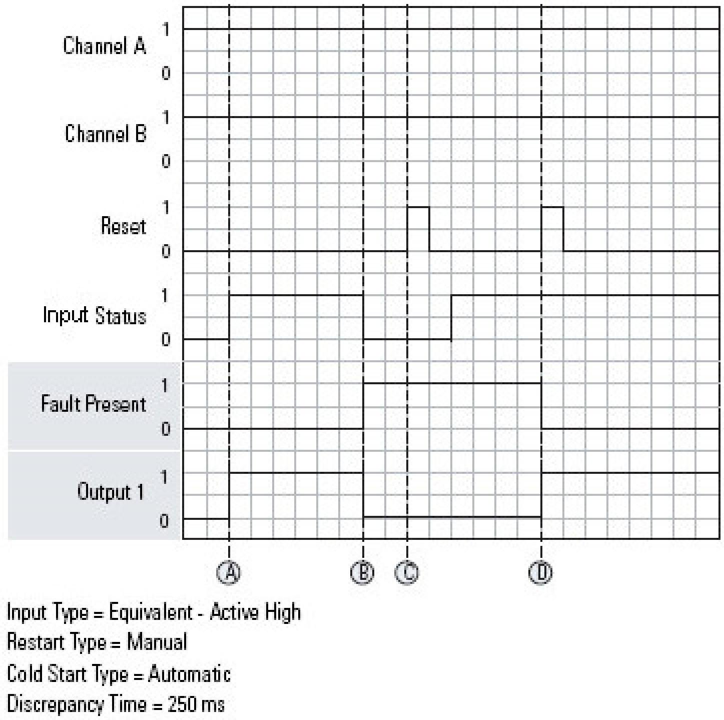
The timing diagram illustrates a fault occurring when the Input Status becomes invalid. When Cold Start Type is configured for manual, the safety inputs must go through the safe state after a fault has been cleared. At (A), Output 1 is energized when a reset is triggered with the safety inputs in the active state. At (B), a fault occurs because the Input Status becomes invalid, which de-energizes Output 1. At (C), the fault cannot be cleared because the Input Status is still invalid. At (D), the fault is cleared, but Output 1 cannot yet be energized because the safety inputs must transition through the safe state when Cold Start Type is manual. At (E), the safety inputs have gone through the safe state. At (F), Output 1 is once again energized when the Reset is triggered.



Input Status Fault (Automatic Cold Start)

The timing diagram illustrates a fault occurring when the Input Status becomes invalid. When Cold Start Type is configured for automatic, the safety inputs are not required to go through the safe state after a fault has been cleared. At (A), Output 1 is energized when the Input Status becomes valid because the Cold Start Type is automatic. At (B), a fault occurs because the Input Status becomes invalid, which de-energizes Output 1. At (C), the fault cannot be cleared because the Input Status is still invalid. At (D), the fault is cleared because the Input Status is valid and a reset occurred. Output 1 is then energized because the Cold Start Type is automatic.

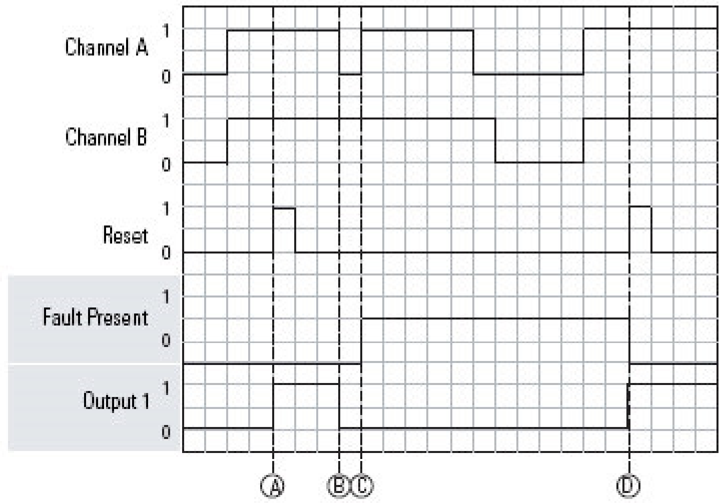
It is not necessary for the Safety Inputs to go through the safe state after an Input Status fault is cleared when the Cold Start Type is Automatic.



If the input Status input is not shown, it is assumed that the input status is valid (=1) for the entire timing diagram.

Cycle Inputs Fault

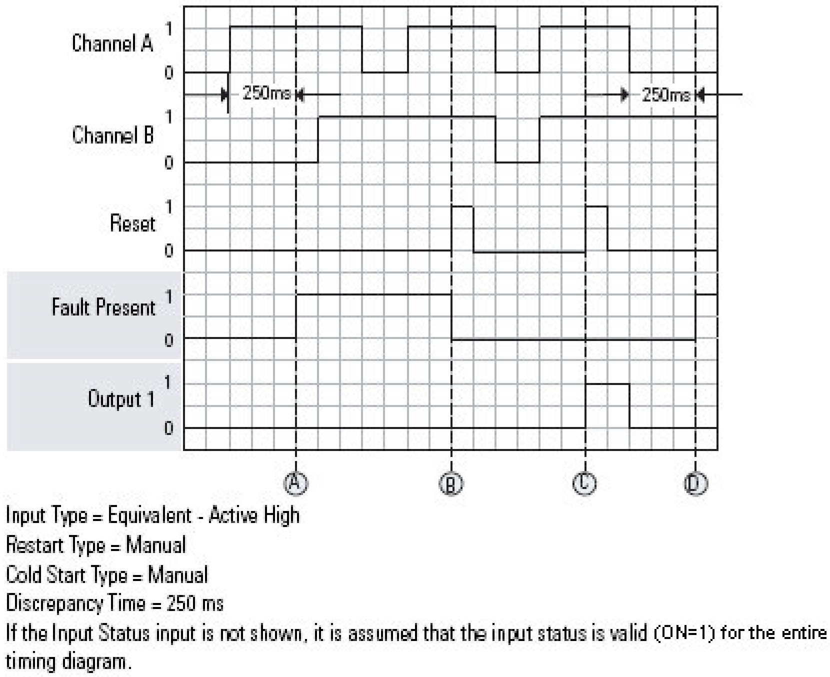
The timing diagram illustrates one of the two safety inputs transitioning to the safe state and back to the active state while Output 1 is energized. At (A), Output 1 is energized in the normal way. At (B), Channel A transitions to the safe state, which immediately de-energizes Output 1. At (C), Channel A transitions back to the active state before the 250 ms Discrepancy Time causes a fault. At (D), Output 1 is energized because the safety inputs have cycled through the safe state, and a reset has been triggered.



Input Type = Equivalent - Active High
Restart Type = Manual
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Discrepancy Fault

The timing diagram illustrates a fault occurring when Channel A and Channel B are in an inconsistent state for longer than the Discrepancy Time parameter. At (A), a discrepancy fault occurs because Channel A has been in the active state and Channel B has been in the safe state for 250 ms (Discrepancy Time parameter). At (B), the fault is reset, but Output 1 is not energized because the safety inputs must cycle through the safe state after a discrepancy fault is cleared, energize Output 1. At (C), Output 1 is energized because the safety inputs have transitioned through the safe state and a reset has been triggered. At (D), another discrepancy fault occurs when the safety inputs are again in an inconsistent state for longer than 250 ms.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	• None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.
16#4000 16384	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the active state. Channel B was in the safe state.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state). • Reset the fault.

Fault Code	Description	Corrective Action
16#4001 16385	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the safe state. Channel B was in the active state.	
16#4002 16386	Channel A went to the safe state and back to the active state while Channel B remained active.	
16#4003 16387	Channel B went to the safe state and back to the active state while Channel A remained active.	

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
00	No fault	None
16#05 5	The Reset input is held ON (1).	Set the Reset input to OFF (0).
16#20 32	The Input Status was OFF(0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.
16#4000 16384	The device has not been functionally tested at startup.	Perform a functional test of the inputs (put Channel A and Channel B in a safe state).
16#4001 16385	The device has not been functionally tested after a fault occurs.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state).

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01 and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung-condition-in is false.

See also

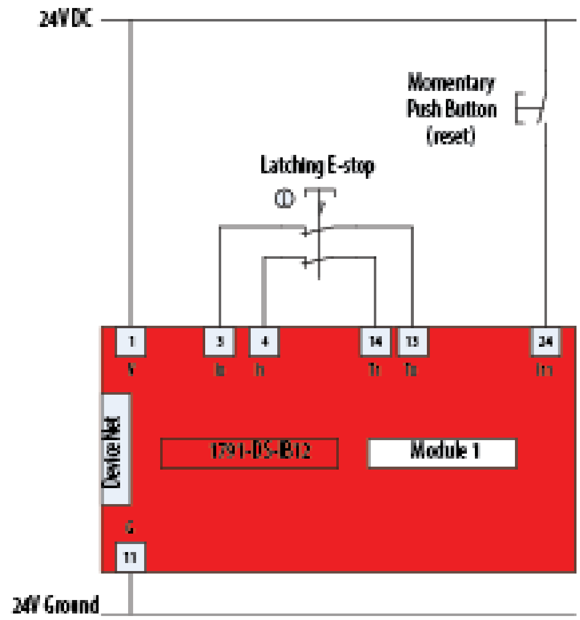
Common Attributes on page 529

Dual Channel Input Stop (DCS) wiring and programming example on page 57

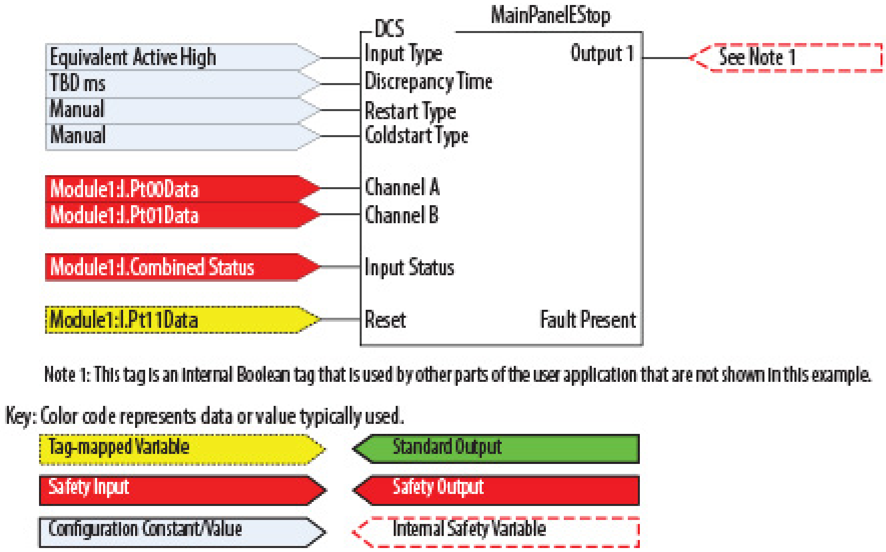
Status and Safety input and output for dual channel safety instructions on page 21

Dual Channel Input Stop (DCS) wiring and programming example

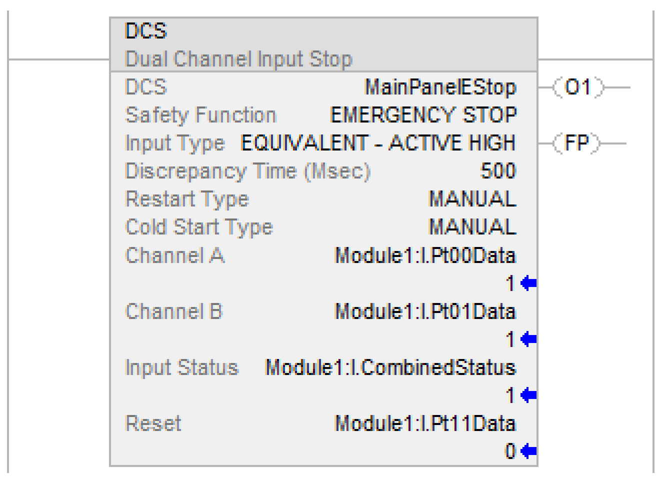
This example complies with ISO 13849-1, Category 4 operation. The standard control portion of the application is not shown.



This programming diagram shows the Dual Channel Input Stop (DCS) instruction with inputs and test outputs.

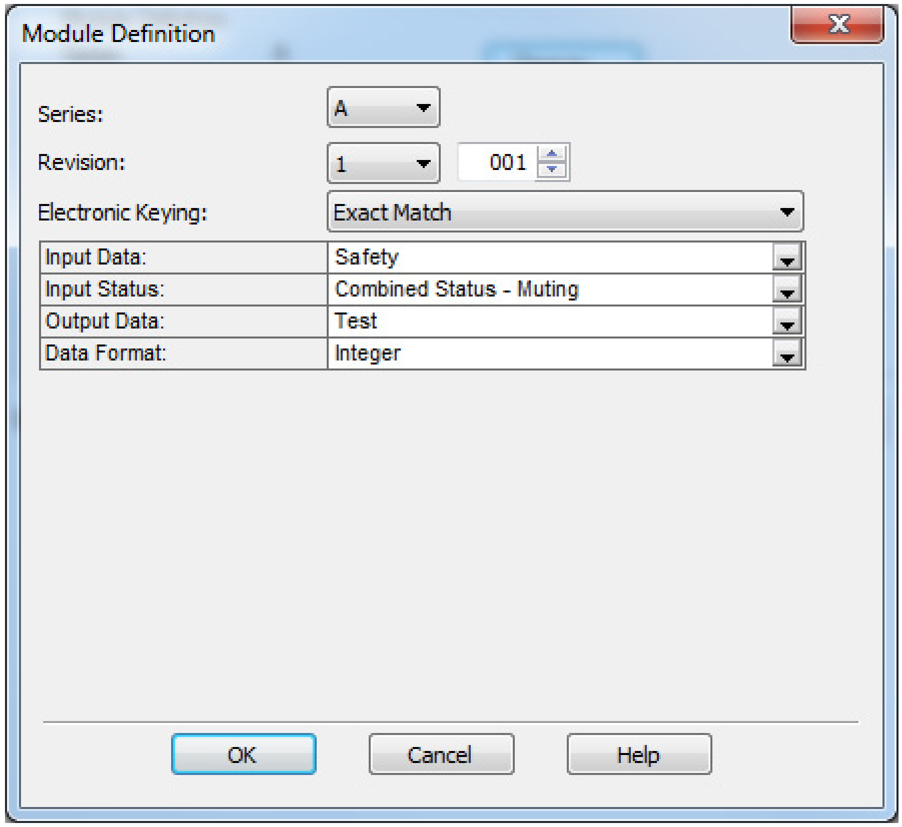


Ladder Diagram



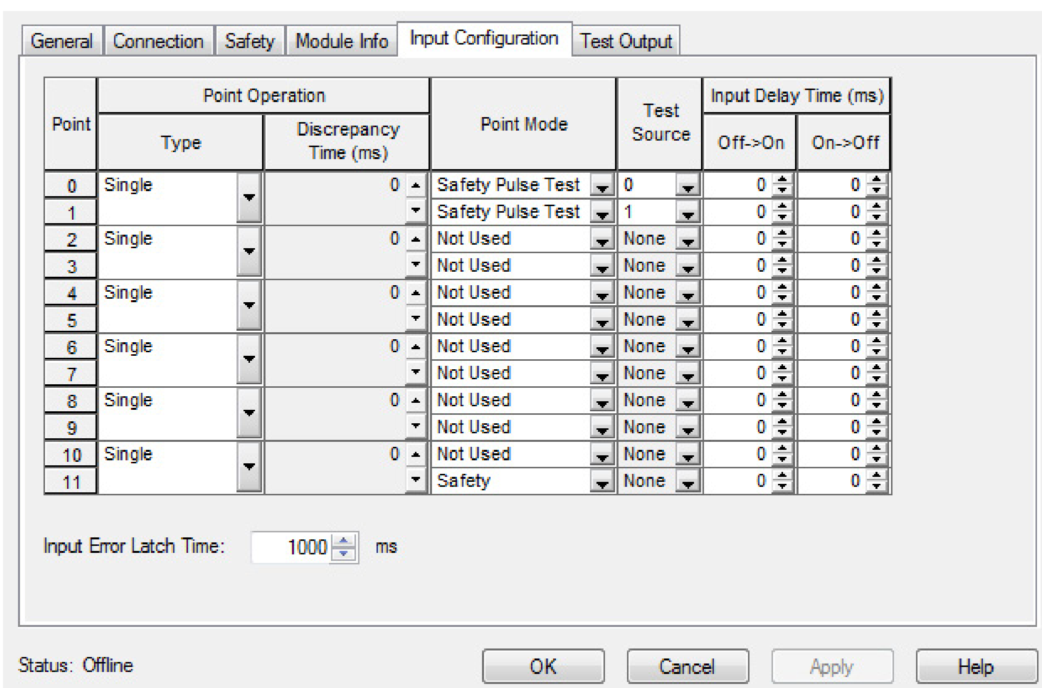
The programming software is used to configure the input and output parameters of the Guard I/O module, as illustrated.

Module Definition

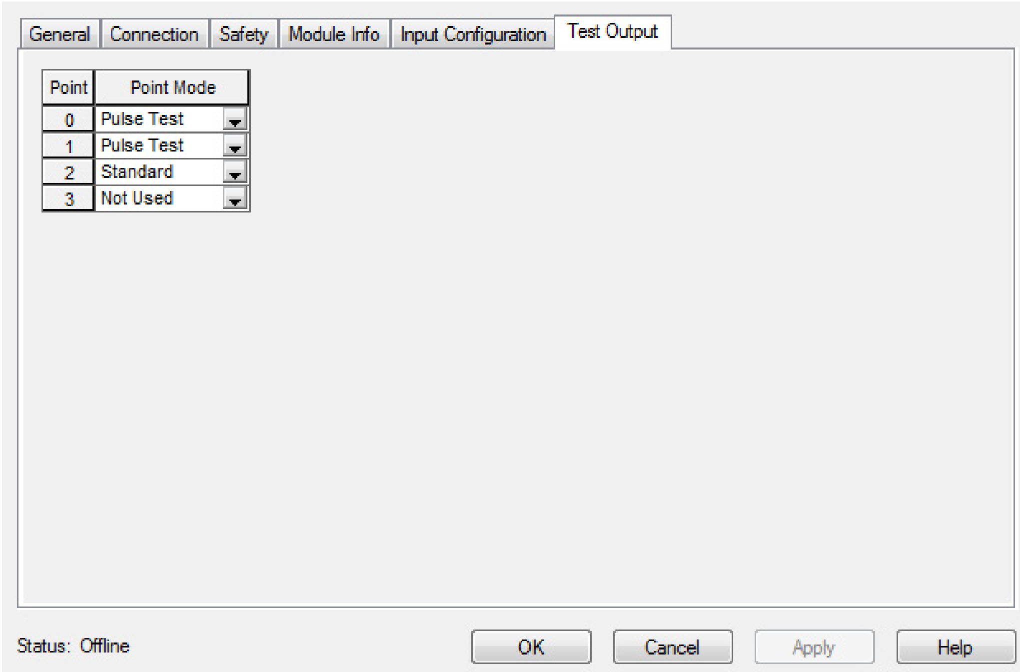


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. You can also select **Compatible Match**.

Module Input Configuration



Module Test Output Configuration



See also

Dual Channel Input Stop (DCS) on page 45

Dual Channel Input Stop with Test (DCST)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual-Channel Input Stop with Test instruction monitors dual-input safety devices whose main function is to stop a machine safely, for example, an E-stop, light curtain, or safety gate. This instruction can only energize Output 1 when both safety inputs, Channel A and Channel B, are in the active state as determined by the Input Type operand, and the correct reset actions are carried out.

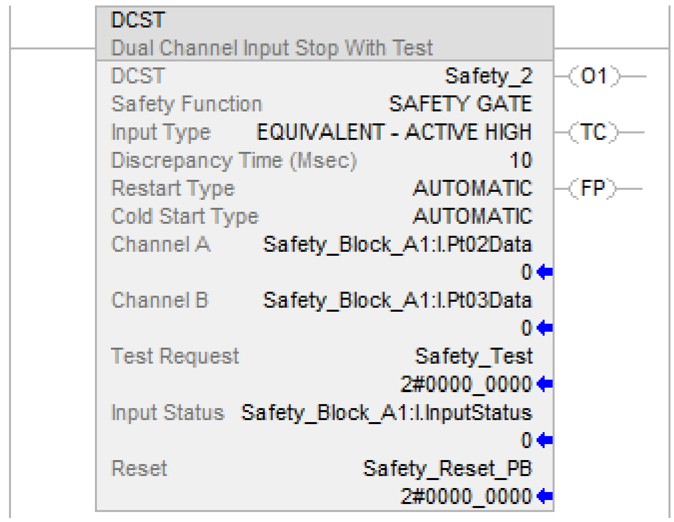
In addition, this instruction has the ability to force a functional test of the stop device upon request.

The timing diagrams from the Dual-Channel Input Stop (DCS) instruction are applicable to this instruction as well.

DCST operation diagrams in this instruction, highlight the features of the test-related operands such as Test Request and Test Command.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

IMPORTANT Make sure safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands that are used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
DCST	DCI_STOP_TEST	tag	DCST structure
Safety Function	DINT	list item	This operand provides a text name for how this instruction is being used. Choices include E-stop, safety gate, light curtain, area scanner, safety mat, cable (rope) pull switch, and user-defined. This operand does not affect instruction behavior. It is for information/documentation purposes only.
Input Type	DINT	list item	This operand selects input channel behavior. **Equivalent - Active High (0):** Inputs are in the active state when Channel A and Channel B inputs are 1. **Complementary (2):** Inputs are in the active state when Channel A is 1 and Channel B is 0.
Discrepancy Time (ms)	DINT	immediate	The amount of time that the inputs can be in an inconsistent state before an instruction fault is generated. The inconsistent state depends on the Input Type. Equivalent: Inconsistent state is when: Channel A = 0 and Channel B =1, or Channel A =1 and Channel B =0 Complementary: Inconsistent state is when: Channel A = 0 and Channel B =0, or Channel A =1 and Channel B =1 The range is 5...3000 ms.
Restart Type	BOOL	immediate	This input configures Output 1 for either manual or automatic restart. **Manual (0): -** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1 **Automatic (1): -** Output 1 is energized 50 ms after all of the enabling conditions are met. **Important:** Automatic restart may only be used in application situations where no unsafe conditions can occur as a result of its use, or the reset function is being performed elsewhere in the safety circuit (for example, output function).

Operand	Data Type	Format	Description
Cold Start Type	BOOL	list item	This operand specifies the Output 1 behavior when applying controller power or mode change to Run. **Manual (0): -** Output 1 is not energized when the Input Status becomes valid or when the Input Status fault is cleared. (The device must be tested before Output 1 can be energized.) **Automatic (1): -** Output 1 is energized immediately when the Input Status becomes valid or when the Input Status fault is cleared and both inputs are in their active state.

The following table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Channel A[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Channel B[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Test Request	BOOL	tag	This signal forces a functional test to occur. ON (1) -> OFF (0): Triggers a functional test. Output 1 is de-energized and the Test Command output is energized, which prompts for a functional test to be performed. The functional test is complete and the Test Command output is de-energized when Channel A and Channel B go to the safe state.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	tag	If Restart Type = Manual, this input is used to energize Output 1 once Channel A and Channel B are both in the active state. If Restart Type = Automatic, this input is used to energize Output 1. This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset.

[1] If the input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to the

reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

The following table explains the instruction outputs. The outputs can be external tags (safety output modules) or internal tags for use in other logic routines.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output is energized when the input conditions have been satisfied. The output becomes de-energized when: • Either Channel A or Channel B transitions to the safe state. • The Input Status is OFF (0). • A functional test is requested (Test Request > OFF (0).
Test Command (TC)	BOOL	This output is energized when a functional test must be carried out. The operand is not safety-related.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section below for a list of fault codes. This operand is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section below for a list of diagnostic codes. This operand is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

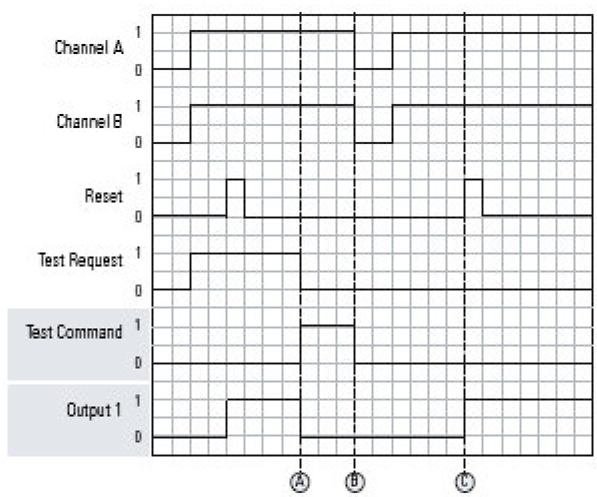
Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .TC and .FP are cleared to false.

Condition/State	Action Taken
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in is false.

Operation

Functional Test Operation (Manual Restart)

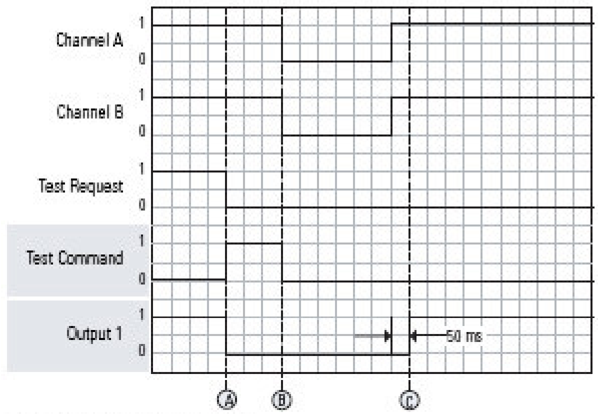
The timing diagram illustrates a manual functional test being performed on a safety device, for example, a safety gate, with the instruction configured for manual restart. At (A), a manual functional test is requested because the Test Request input transitions from ON (1) to OFF (0). This immediately de-energizes Output 1 and energizes the Test Command output, which prompts for a test of the device to be performed. At (B), the functional test is complete, so the Test Command output is de-energized. At (C), Output 1 is energized again when a reset is triggered.



Input Type = Equivalent - Active High
Restart Type = Manual
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Functional Test Operation (Automatic Restart)

The timing diagram illustrates a manual function test being performed with Restart Type equal to Automatic. At (A), Output 1 is de-energized because the Test Request transitions from ON (1) to OFF (0). The Test Command output is also energized at this point. At (B), the Test Command output is de-energized because the functional test is complete. At (C), Output 1 is automatically energized 50 ms after the safety inputs enter the active state because the restart type is automatic.



Input Type = Equivalent - Active High
Restart Type = Automatic
Cold Start Type = Automatic
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.
There is always a 50 ms delay before energizing Output 1 when it is configured to be energized automatically (Restart Type = Automatic).

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

Fault Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.
16#4000 16384	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the active state. Channel B was in the safe state.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state). • Reset the fault.
16#4001 16385	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the safe state. Channel B was in the active state.	
16#4002 16386	Channel A went to the safe state and back to the active state while Channel B remained active.	
16#4003 16387	Channel B went to the safe state and back to the active state while Channel A remained active.	

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
00H	No fault.	None.
16#05 5	The Reset input is held ON (1)	Set the Reset input to OFF (0)
16#20 32	The Input Status was OFF(0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.
16#4000 16384	The device has not been functionally tested at startup.	Perform a functional test of the inputs (put Channel A and Channel B in a safe state).
16#4001 16385	The device has not been functionally tested after a fault occurs.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state).
16#4030 16432	Waiting for the manual functional test to occur.	Perform a functional test of the device (put Channel A and Channel B in a safe state).

See also

Dual Channel Input Stop with Test (DCST) wiring and programming example on page 67

Index Through Arrays on page 540

Status and Safety input and output for dual channel safety instructions on page 21

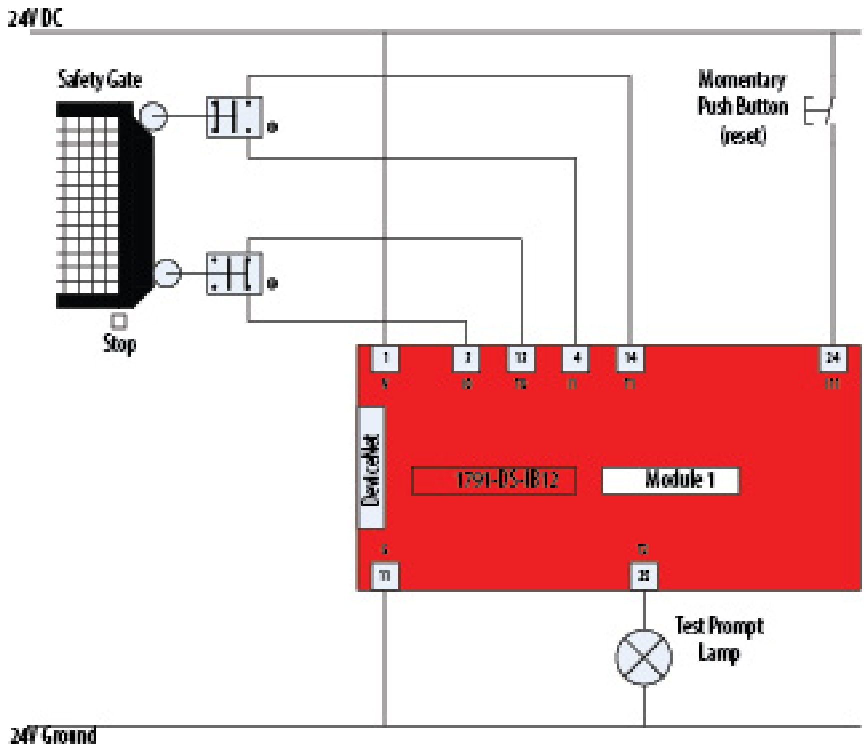
Dual Channel Input Stop with Test (DCST) wiring and programming example

This topic demonstrates how to wire the Guard I/O and program the instruction in the safety control portion of an application

This application example complies with ISO 13849-1, Category 4 operation.

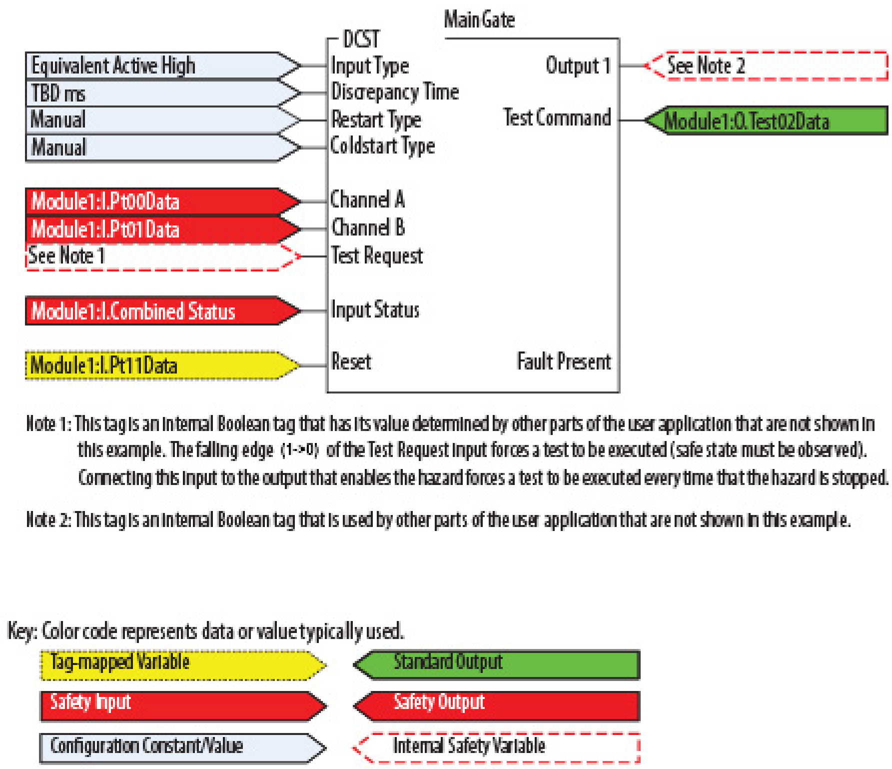
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram

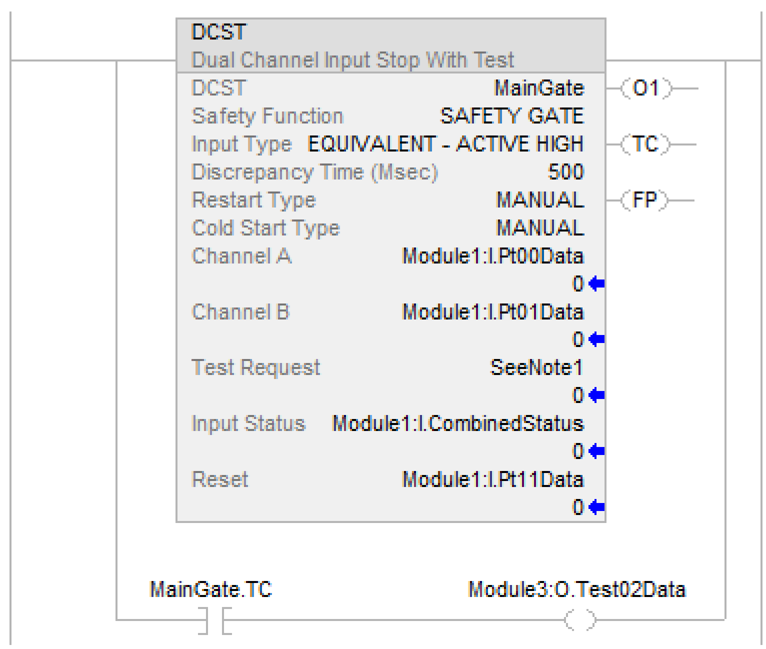


Programming Diagram

This programming diagram shows the Dual Channel Input Stop with Test (DCST) instruction with inputs and test outputs.



Ladder Diagram

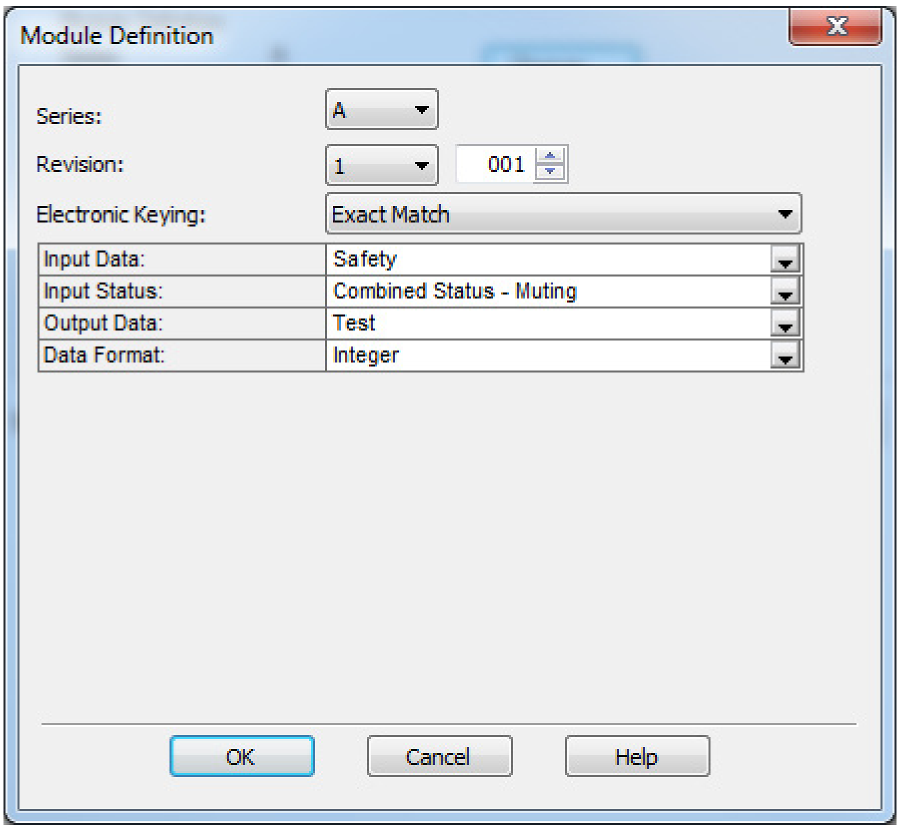


Tip: The tag in the preceding table is an internal Boolean tag that has its value determined by other parts of the user application not shown in this example. The falling edge (1->0) of the Test Request input forces a test to be executed (safe state must be observed). Connecting this input to the output that enables the hazard forces a test to be executed every time the hazard is stopped.

The programming software is used to configure the input and output operands of the Guard I/O module as illustrated.

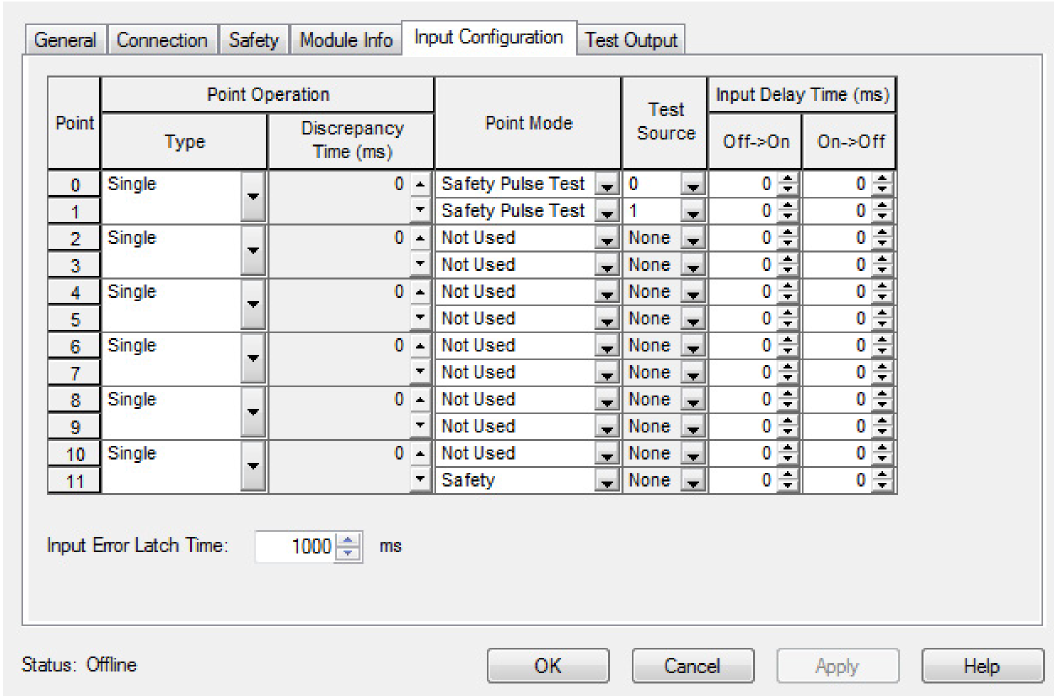
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.

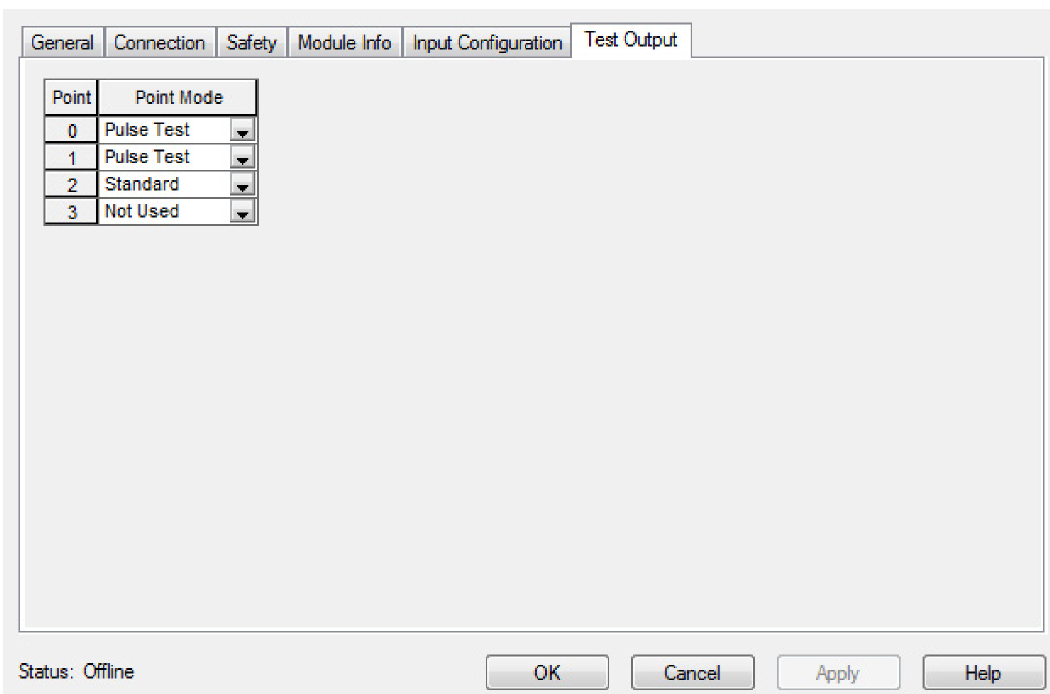


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

Module Input Configuration



Module Test Output Configuration



See also

Dual Channel Input Stop with Test (DCST) on page 60

Dual Channel Input Stop with Test and Lock (DCSTL)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual Channel Input Stop with Test and Lock (DCSTL) instruction monitors dual-input safety devices whose main function is to stop safely, for example, an E-stop, light curtain, or safety gate. This instruction can only energize Output 1 when both safety inputs, Channel A and Channel B, are in the active state as determined by the Input type operand, and the correct reset actions are carried out.

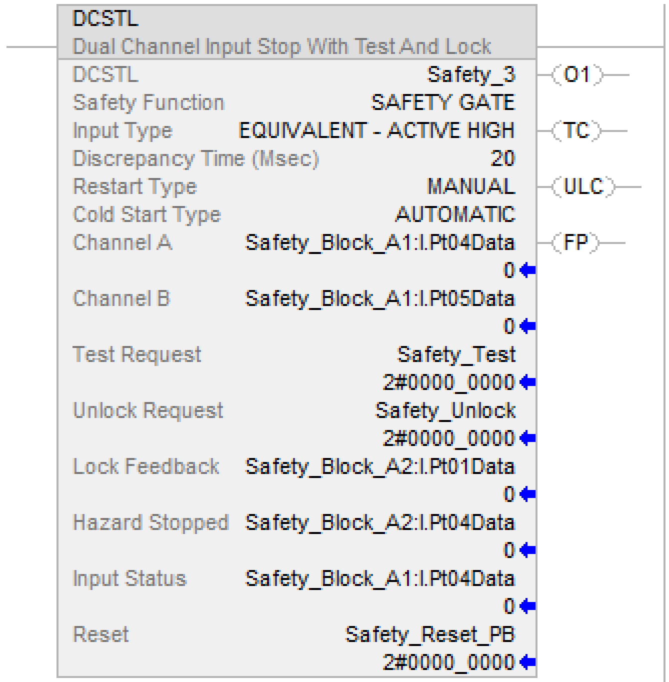
In addition, this instruction has the ability to monitor a locked feedback signal from a safety device and issue a lock request to a safety device, for example a safety gate with guard locking. The Unlock Request input is used to request an electromagnetic lock or unlock. However, the hazard must not be present for the instruction to issue an unlock command. The Lock feedback input is used to determine whether or not the safety device is currently locked. To energize Output 1, the Lock Feedback input must be ON (1) in addition to the requirements of the DCST instruction.

The operation timing diagrams from the Dual Channel Input Stop (DCS) and the Dual Channel Input Stop Test (DCST) instruction are applicable to this instruction as well.

DCSTL operation diagrams, shown below, highlight the features of the lock-related operands, such as Unlock Request, Lock Feedback, Hazard Stopped, and Unlock Command.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT	Unexpected operation may occur if: • Output tag operands are overwritten. • Members of a structure operand are overwritten. • Structure operands are shared by multiple instructions.

IMPORTANT	Make sure safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or Ple (Cat. 4) safety functions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

This table provides the operands that are used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
DCSTL	DCI_STOP_TEST_LOCK	tag	DCSTL structure
Safety Function	DINT	list item	This operand provides a text name for how this instruction is being used. Choices include slide lock (6) , safety gate (1) and user-defined (100). This operand does not affect instruction behavior. It is for information/documentation purposes only.
Input Type	DINT	list item	This operand selects input channel behavior. **Equivalent - Active High (0):** Inputs are in the active state when Channel A and Channel B inputs are 1. **Complementary(2):** Inputs are in the active state when Channel A is 1 and Channel B is 0.
Discrepancy Time (ms)	DINT	immediate	The amount of time that the inputs can be in an inconsistent state before an instruction fault is generated. The inconsistent state depends on the Input Type. Equivalent: Inconsistent state is when either is true: Channel A = 0 and Channel B =1 Channel A =1 and Channel B =0 Complementary: Inconsistent state is when either is true: Channel A = 0 and Channel B =0 Channel A =1 and Channel B =1 The range is 5...3000 ms.
Restart Type	BOOL	list item	This input configures Output 1 for either manual or automatic restart. **Manual (0): -** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1 **Automatic (1): -** Output 1 is energized 50 ms when all of the enabling conditions are met. **ATTENTION:** Automatic restart may only be used in application situations where no unsafe conditions can occur as a result of its use, or the reset function is being performed elsewhere in the safety circuit (for example, output function).
Cold Start Type	BOOL	list item	This operand specifies the Output 1 behavior when applying controller power or mode change to Run. **Manual (0): -** Output 1 is not energized when the Input Status becomes valid or when the Input Status fault is cleared. The device must be tested before Output 1 can be energized. **Automatic (1): -** Output 1 is energized immediately when the Input Status becomes valid or when the Input Status fault is cleared and both inputs are in their active state.

The following table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Channel A[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Channel B[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Test Request	BOOL	tag	This signal forces a functional test to occur. See the Test Type operand for more information. ON (1) -> OFF (0): Triggers a functional test. Output 1 is de-energized and the Test Command output is energized, which prompts for a functional test to be performed. **Important:** Do not request a test when a hazard is present (Hazard Stopped = 0) because the machine stops and causes a fault in this instruction.
Unlock Request	BOOL	tag	This input is used to request a lock and unlock of electromechanical locking devices. OFF (0): Lock is requested (the Unlock command is de-energized). ON (1): Unlock is requested if the machine hazard is stopped. The Unlock command is energized if the Hazard Stopped equals 1. This signal must also be used before locking and unlocking manual locks. Otherwise, a fault can occur because of invalid sequencing.
Lock Feedback	BOOL	tag	This input is the current state of the locking device. This input must be ON (1) in order to energize Output 1. OFF (0): The safety monitoring device currently is not locked. ON (1): The safety monitoring device is currently locked.
Hazard Stopped	BOOL	tag	This input is the hazard condition feedback signal. This input must be ON (1) in order for the instruction to issue an unlock command (energize the Unlock Command output). OFF (0): The Unlock Command output cannot be energized. ON (1): The Unlock Command output can be energized.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.

Operand	Data Type	Format	Description
Reset[2]	BOOL	tag	If Restart Type = Manual, this input is used to energize Output 1 once Channel A and Channel B are both in the active state. If Restart Type = Automatic, this input is not used to energize Output 1. This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset.

[1] If the input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

This table explains instruction outputs. The outputs may be external tags (safety output modules) or internal tags for use in other logic routines

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output is energized when the input conditions have been satisfied. The output becomes de-energized when: • Either Channel A or Channel B transitions to the safe state. • The Input Status is OFF (0). • A functional test is requested (Test Request > OFF (0). • The Lock Feedback signal turns OFF (0). • An unlock is requested and the hazard stops, that is Unlock Request -> ON (1) and Hazard Stopped -> ON (1).
Test Command (TC)	BOOL	This output is energized when a functional test must be carried out. This operand is not safety-related.
Unlock Command (ULC)	BOOL	This output is an unlock signal for an electromechanical locking device or to prompt for manual unlock.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section below for a list of fault codes. This operand is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section below for a list of diagnostic codes. This operand is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

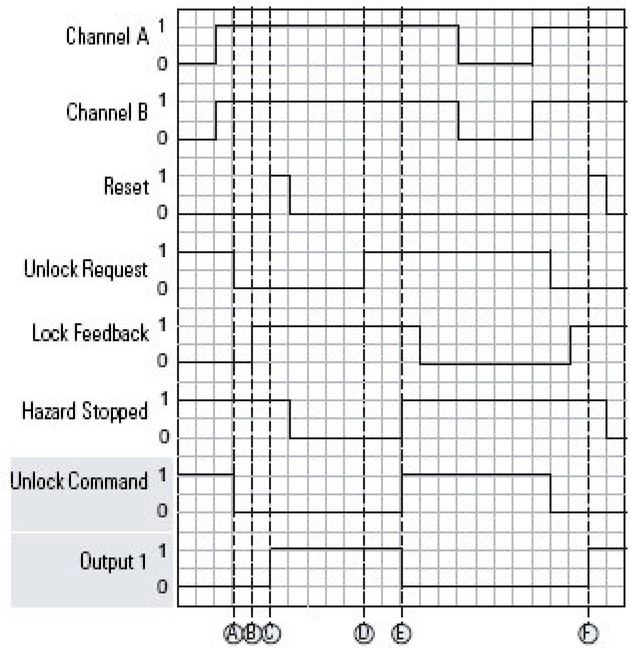
Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01, .TC , .ULC and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Operation section
Postscan	Same as Rung-condition-in is false.

Operation

Start-up Operation (Manual Cold Start)

The timing diagram illustrates Output 1 being energized when the Cold Start Type is Manual. At (A), the gate is closed and requested to lock. At (B), the gate is considered locked when the Lock Feedback transitions from OFF (0) to ON (1). At (C), Output 1 is energized when a reset is triggered. At (D), an unlock is requested when the Unlock Request signal transitions from OFF (0) to ON (1). At (E), the Unlock Command output is not energized until the Hazard Stopped input transitions from OFF (0) to ON (1). Output 1 is also de-energized at this point. At (F), Output 1 is energized again when the gate is opened, closed, and locked, and a reset is triggered.

The devices being monitored in these timing diagrams are assumed to be a safety gate with lock.

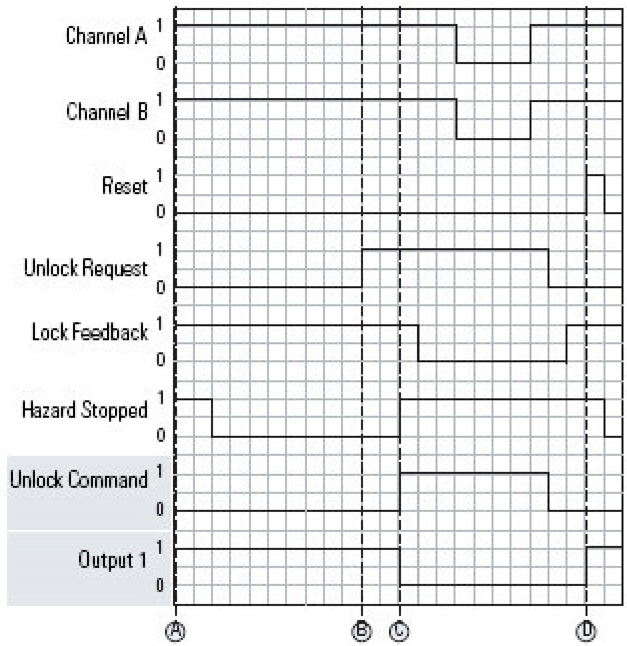


Input Type = Equivalent - Active High
Restart Type = Manual
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Start-up Operation (Automatic Cold Start)

The timing diagram illustrates the same behavior as the manual restart diagram, except that Cold Start Type is automatic. At (A), Output 1 is immediately energized when power is first applied because the gate is closed and locked, and the cold start type is automatic. At (B), an unlock is requested when the Unlock Request signal transitions from OFF (0) to ON (1). At (C), the Unlock Command output is not energized until the Hazard Stopped input transitions from OFF (0) to ON (1). Output 1 is also de-energized at this point. At (D), Output 1 is energized when the gate is opened, closed, and locked, and a reset is triggered.

The devices being monitored in these timing diagrams are assumed to be a safety gate with lock.

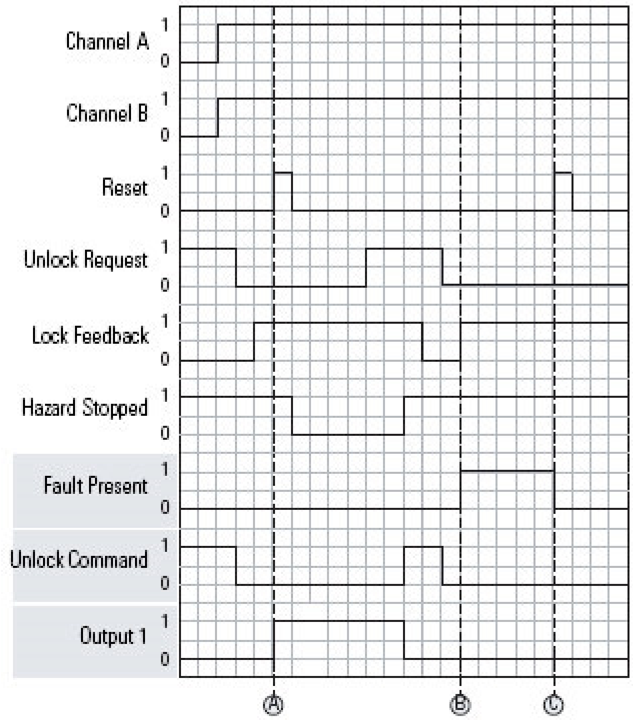


Input Type = Equivalent - Active High
Restart Type = Manual
Cold Start Type = Automatic
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Device Not Tested After Unlock Fault (Manual Cold Start)

The timing diagram illustrates how a gate must be tested each time after it is unlocked if the Cold Start type is manual. At (A), Output 1 is energized when a reset is triggered. At (B), a fault is generated when the device is unlocked and relocked without the gate being opened. At (C), the fault is cleared when a reset is triggered. Output 1 does not become energized because a functional test has not been performed on the gate.

The devices being monitored in these timing diagrams are assumed to be a safety gate with lock.



Input Type = Equivalent - Active High

Restart Type = Manual

Cold Start Type = Manual

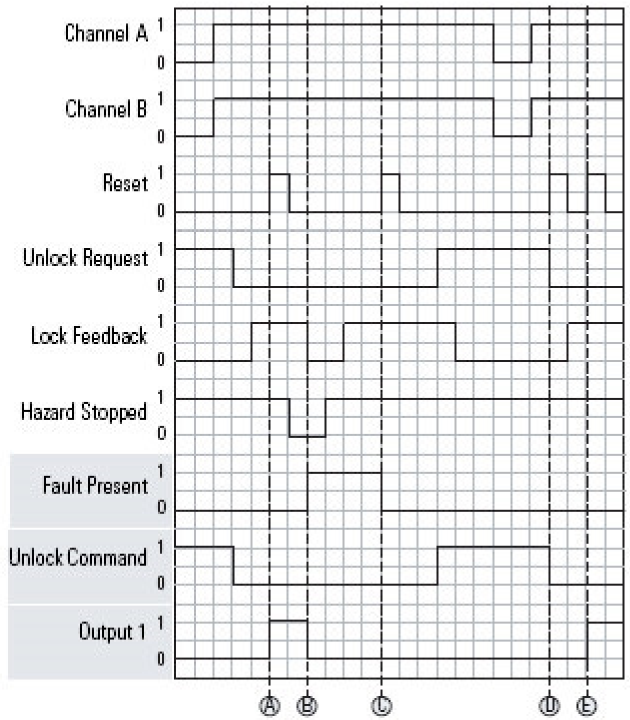
Discrepancy Time = 250 ms

If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

Functional Test after Fault Operation

The timing diagram illustrates how the gate must be functionally tested after a fault occurs. At (A), Output 1 is energized when a reset is triggered with the gate closed and locked. At (B), a fault occurs because the gate is unlocked because the Unlock Request never transitioned from OFF (0) to ON (1). At (C), the fault is reset when the reset is triggered, but Output 1 cannot be energized because the gate was not functionally tested after the fault occurred. At (D), the gate has been functionally tested and the gate is opened, unlocked, and the hazard has stopped, but Output 1 cannot be energized because the gate is not locked. At (E), Output 1 is energized when a reset is triggered with the gate now locked.

The devices being monitored in these timing diagrams are assumed to be a safety gate with lock.



Input Type = Equivalent - Active High
Restart Type = Manual
Cold Start Type = Manual
Discrepancy Time = 250 ms
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.

Fault Code	Description	Corrective Action
16#4000 16384	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the active state. Channel B was in the safe state.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state). • Reset the fault.
16#4001 16385	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the safe state. Channel B was in the active state.	
16#4002 16386	Channel A went to the safe state and back to the active state while Channel B remained active.	
16#4003 16387	Channel B went to the safe state and back to the active state while Channel A remained active.	
16#4040 16448	The device is locked in a non-active state. For example, a gate is open and locked.	• Check the wiring. • Make sure the device is unlocked. • Reset the fault.
16#4041 16449	The device is not functionally tested after being unlocked.	• Unlock the device. • Put the device in the safe state, for example, open gate. • Reset the fault.
16#4042 16450	The Lock Feedback input turned ON (1) without request. For example, the device became locked, but lock was not requested. Unlock Request = 1	• Check the wiring. • Check the mechanical lock components. • Unlock the device. • Put the device in the safe state, for example, open gate. • Reset the fault.
16#4043 16451	The Lock Feedback input turned OFF (0) without request. For example, the device became unlocked, but unlock was not requested. Unlock Request = 0	
16#4044 16452	The Hazard Stopped was OFF (0) and Output 1 was not energized.	• Make sure the hazard has stopped. • Check the wiring. • Make sure that the hazard protected by this device cannot become active without Output 1 being ON (1). • Reset the fault.
16#4045 16453	The Lock Feedback input turned OFF (0) when the hazard was present. For example, the device became unlocked, and the Hazard Stopped input was OFF (0).	• Make sure the hazard has stopped. • Check the wiring. • Make sure that the device cannot become unlocked while the hazard is running. • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None.
5	The Reset input is held ON (1)	Set the Reset input to OFF (0)
16#20 32	The Input Status was OFF(0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.
16#4000 16384	The device was functionally not tested at startup.	Perform a functional test of the device (bring Channel A and Channel B to the safe state).
16#4001 16385	The device was not functionally tested after a fault occurred.	• Check the wiring. • Perform a functional test of the device (bring Channel A and Channel B in a safe state).
16#4030 16432	Waiting for the manual functional test to occur.	Perform a functional test of the device (bring Channel A and Channel B to the safe state).
16#4040 16448	The device is unlocked. Output 1 cannot be energized until the device is locked.	• Reset the Unlock Request input to 0 or manually lock the device. • Check the wiring of the Lock Feedback input.
16#4041 16449	Waiting for the device to lock. The Unlock Request input has been set to 0, but the Lock Feedback input has not yet indicated that the device is unlocked.	• If the device has a manual lock, make sure that it has been locked. • Check the wiring of the Lock Feedback input.
16#4042 16450	Waiting for the device to unlock. The Unlock Request has been set to 1, but the Lock Feedback has not yet indicated that the device is unlocked.	
16#4043 16451	Waiting for the hazard to stop. The Unlock Request input has been set to 1, but the Unlock Command cannot be issued until the Hazard Stopped input transitions to 1.	• Make sure that any machine hazard has completely stopped. • Check the wiring of the Hazard Stopped input.
16#4044 16452	The device is not functionally tested after it was unlocked.	Perform a functional test of the device (put Channel A and Channel B in a safe state).

See also

Dual Channel Input Stop with Test and Lock (DCSTL) wiring and programming example on page 84

Index Through Arrays on page 540

Dual Channel Input Stop (DCS) on page 45

Dual Channel Input Stop with Test (DCST) on page 60

Status and Safety input and output for dual channel safety instructions on page 21

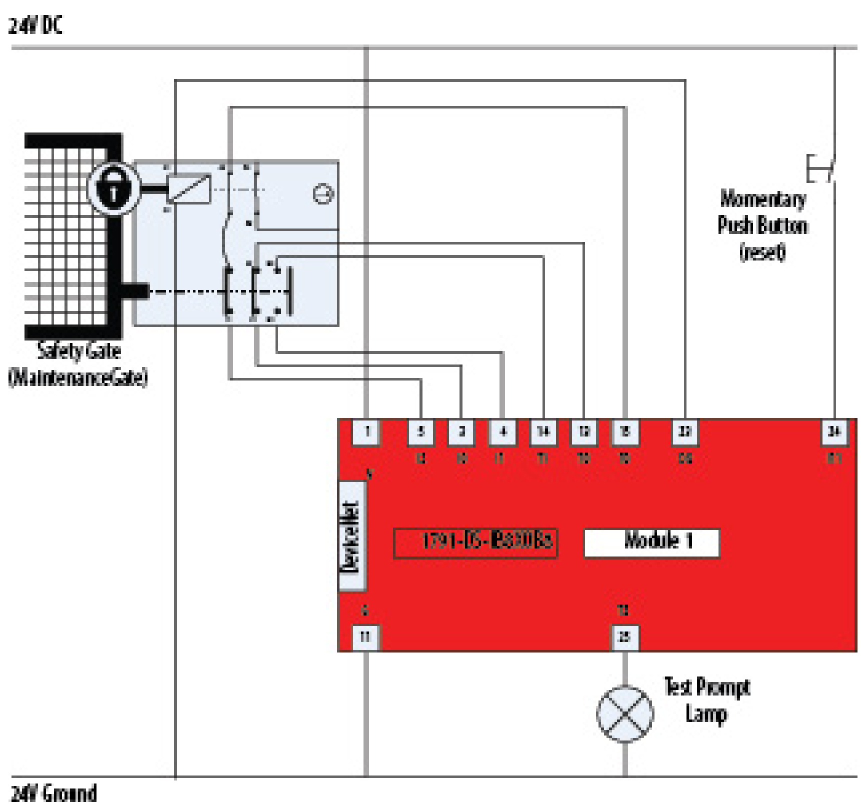
Dual Channel Input Stop with Test and Lock (DCSTL) wiring and programming example

This topic demonstrates how to wire the guard I/O and program the instruction in the safety control portion of an application

This example complies with ISO 13849-1, Category 4 operation.

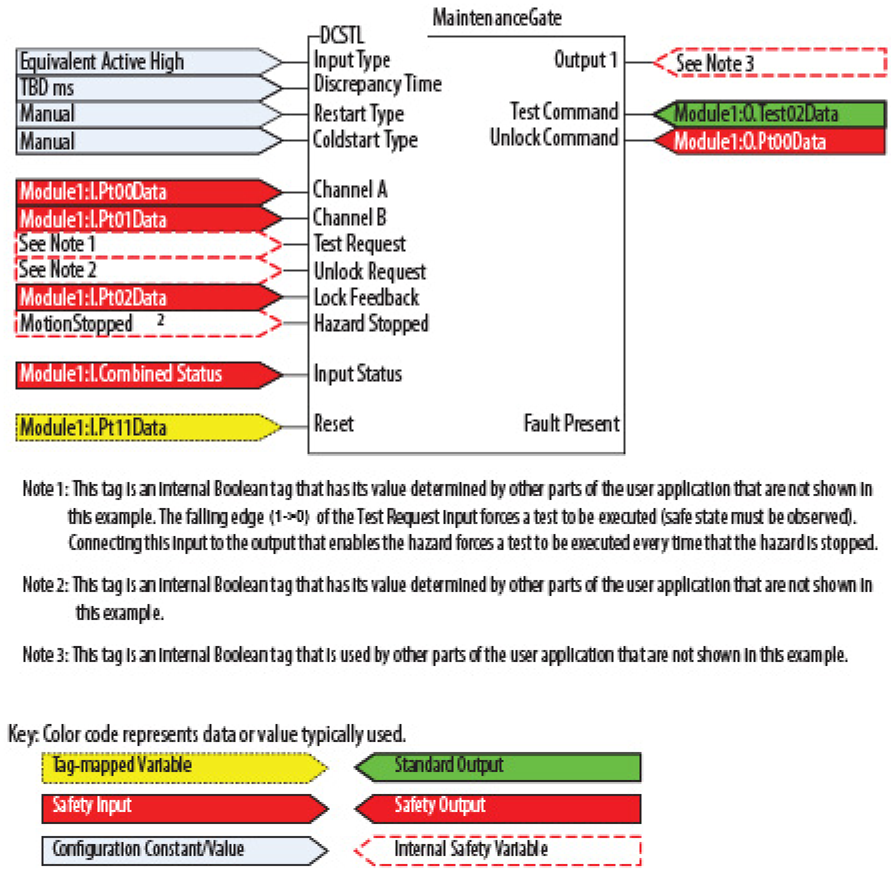
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram

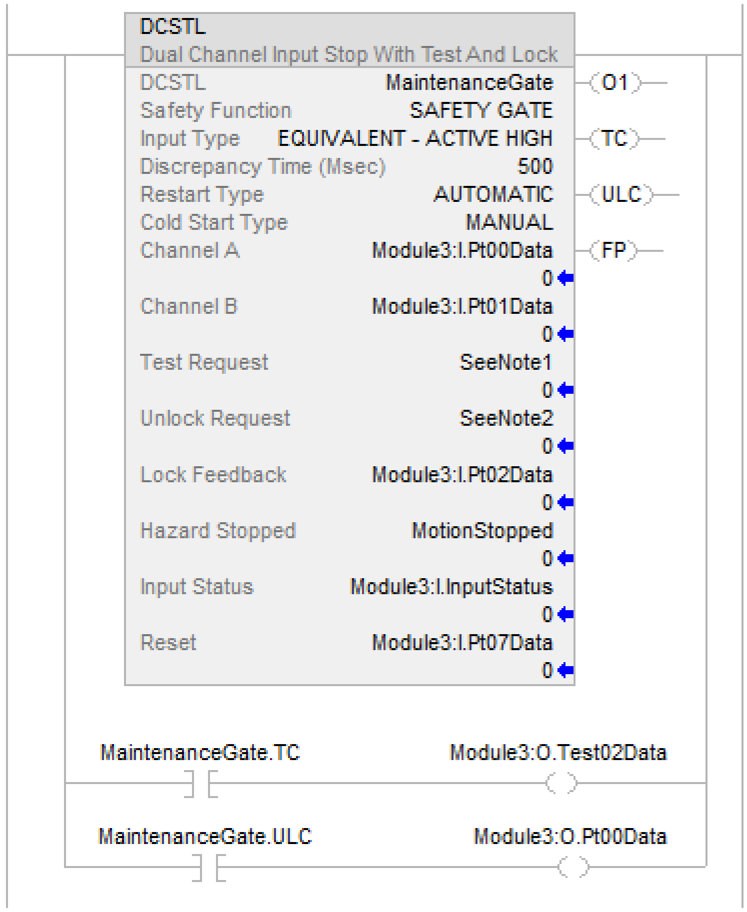


Programming Diagram

This programming diagram shows the Dual Channel Input Stop with Test and Lock (DCSTL) instruction with inputs and outputs.



Ladder Diagram

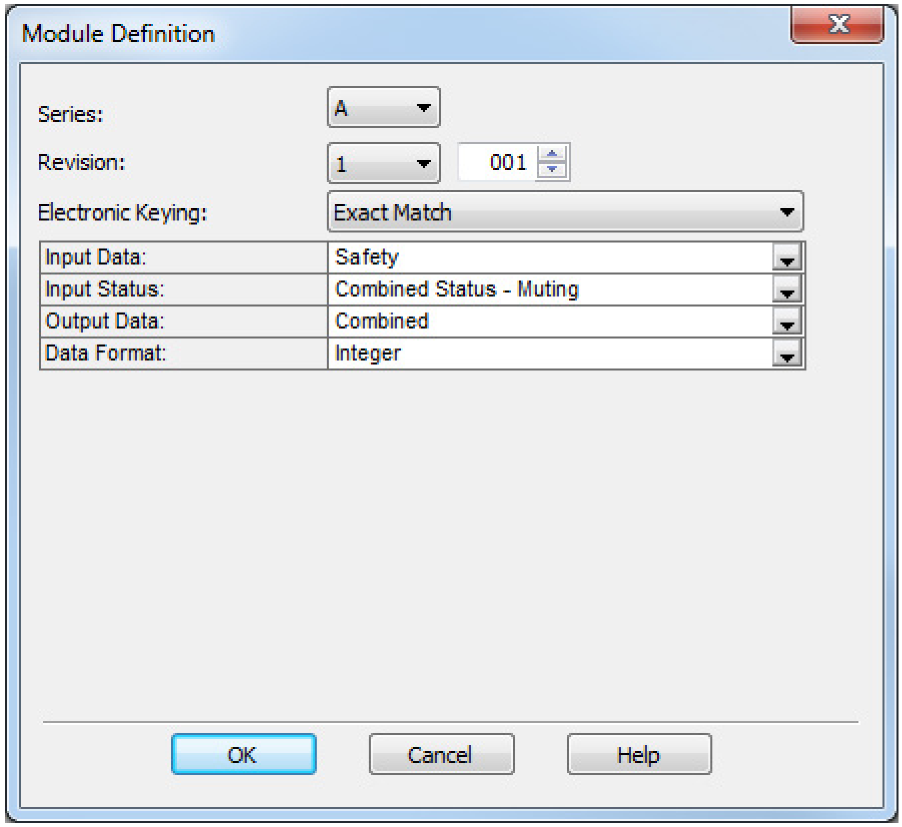


Tips:

- The tag in the preceding diagram is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example. The falling edge (1->0) of the Test Request input forces a test to be executed (safe state must be observed). Connecting this input to the output that enables the hazard forces a test to be executed every time that the hazard is stopped.
- This tag is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.

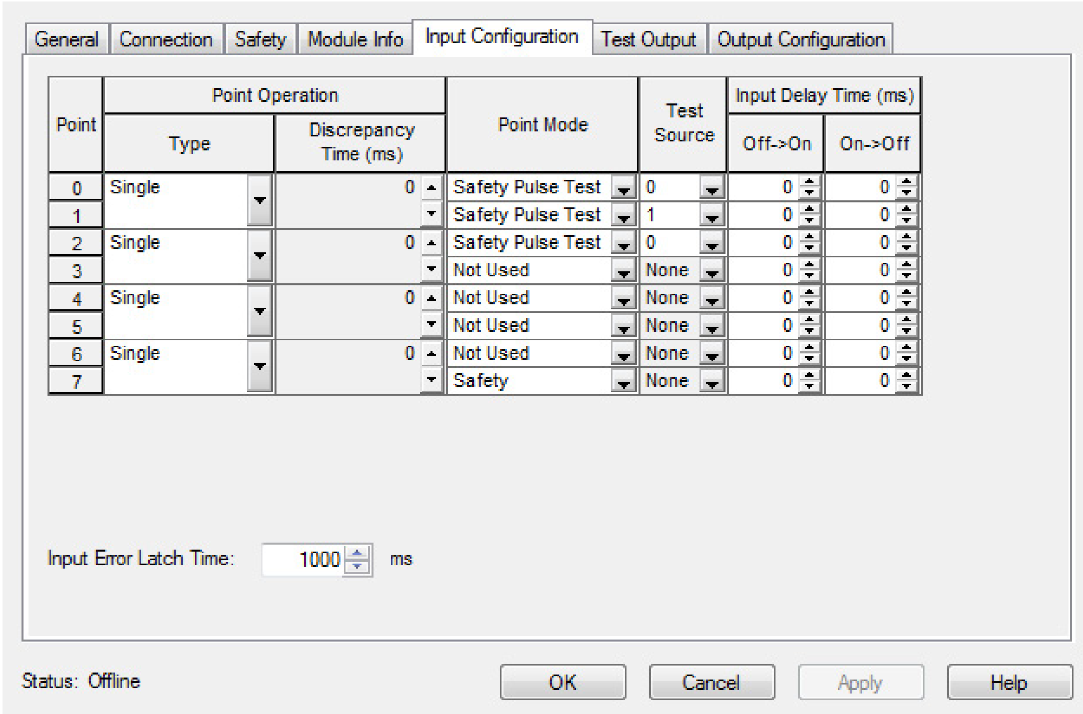
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.



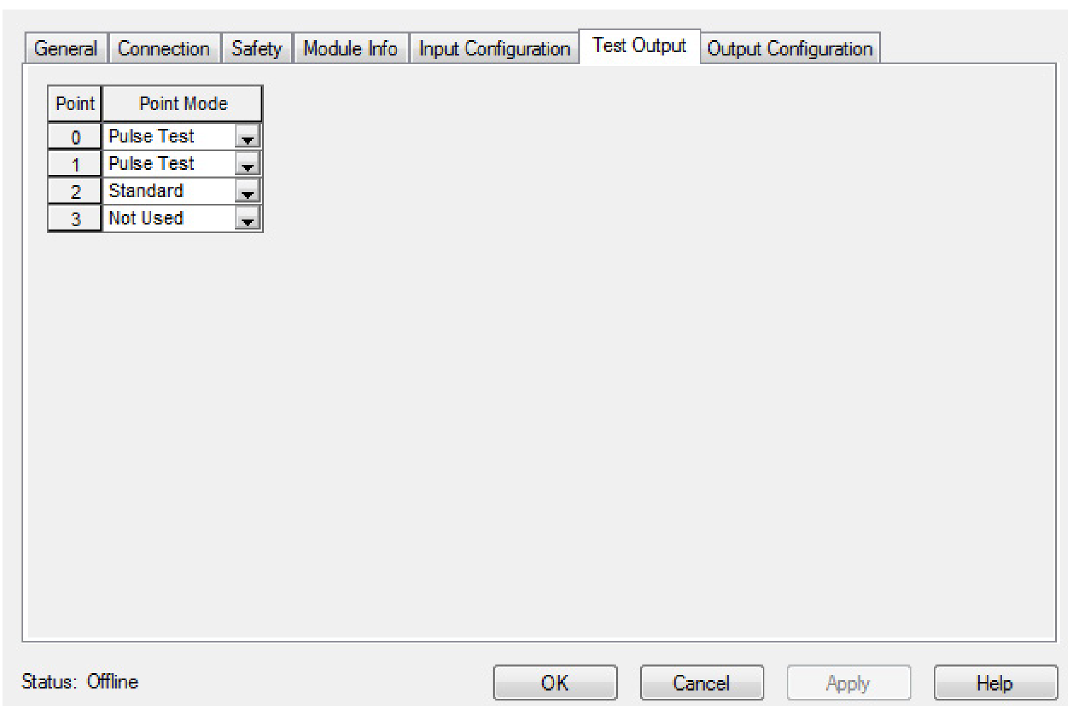
Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

Module Input Configuration



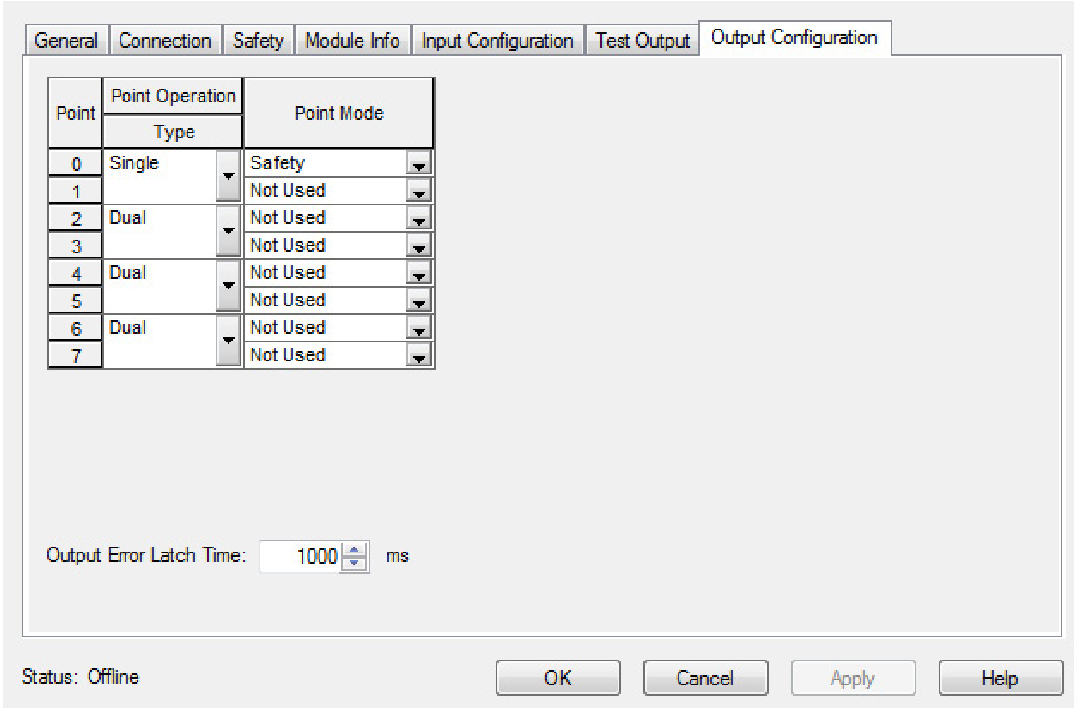
Point	Point Operation: Type	Point Operation: Discrepancy Time (ms)	Point Mode	Test Source	Input Delay Time (ms): Off->On	Input Delay Time (ms): On->Off
0	Single	0	Safety Pulse Test	0	0	0
1			Safety Pulse Test	1	0	0
2	Single	0	Safety Pulse Test	0	0	0
3			Not Used	None	0	0
4	Single	0	Not Used	None	0	0
5			Not Used	None	0	0
6	Single	0	Not Used	None	0	0
7			Safety	None	0	0

Module Test Output Configuration



Point	Point Mode
0	Pulse Test
1	Pulse Test
2	Standard
3	Not Used

Module Output Configuration



See also

Dual Channel Input Stop with Test and Lock (DCSTL) on page 72

Dual-Channel Input Stop with Test and Mute (DCSTM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual Channel Input Stop with Test and Mute (DCSTM) instruction monitors dual-input safety devices whose main function is to stop safely, for example, an E-stop, light curtain, or safety gate. This instruction can only energize Output 1 when both safety inputs, Channel A and Channel B, are in the active state as determined by the Input type operand, and the correct reset actions are carried out.

In addition, this instruction can mute a safety device, such as a light curtain. When muting is enabled, a safety device sensing field can be broken, where Channel A and Channel B can go to the safe state without de-energizing Output 1. The Muting Lamp Status input is used to monitor the status of the Muting Lamp output. If this input is ever OFF (0), a fault is generated.

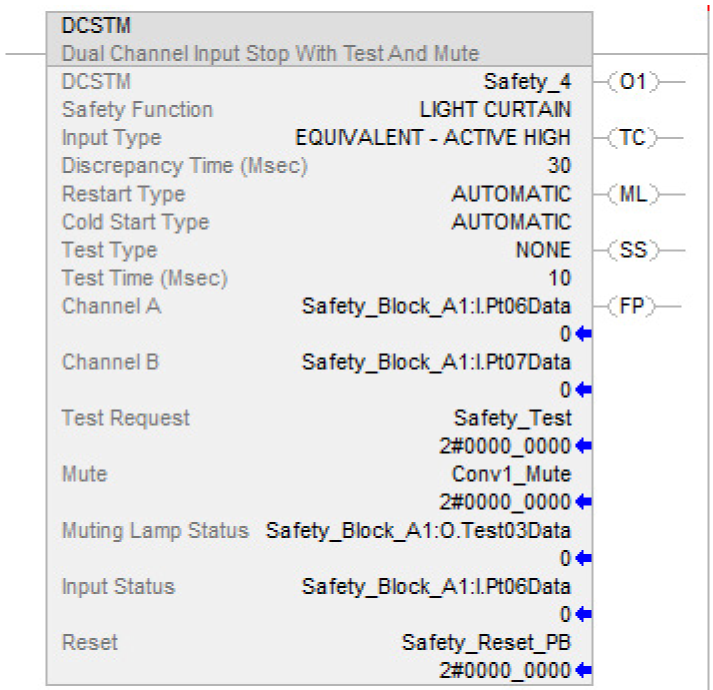
ATTENTION: When muting a safety device, the device is no longer protecting the hazard, so some other protection must be in place.

The timing diagrams from the Dual Channel Input Stop (DCS) and Dual Channel Input Stop Test (DCST) instruction are applicable to this instruction as well.

DCSTM operation diagrams, shown below, highlight the features of the mute-related operands, such as Mute, Muting lamp Status, and Muting Lamp.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

The DCSTM instruction requires its first operand be an instance of the DCI_STOP_TEST_MUTE data type.

IMPORTANT	Unexpected operation may occur if: • Output tag operands are overwritten. • Members of a structure operand are overwritten. • Structure operands are shared by multiple instructions.

IMPORTANT Make sure safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or Ple (Cat. 4) safety functions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands that are used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
DCSTM	DCI_STOP_TEST_MUTE	tag	DCSTM structure
Safety Function	DINT	list item	This operand provides a text name for how this instruction is being used. Choices include area scanner (3), safety mat (4), light curtain (2), and user-defined (100). This operand does not affect instruction behavior. It is for information/documentation purposes only.
Input Type	DINT	list item	This operand selects input channel behavior. **Equivalent - Active High (0):** Inputs are in the active state when Channel A and Channel B inputs are 1. **Complementary (2):** Inputs are in the active state when Channel A is 1 and Channel B is 0.
Discrepancy Time (ms)	DINT	immediate	The amount of time that the inputs can be in an inconsistent state before an instruction fault is generated. The inconsistent state depends on the Input Type. Equivalent: Inconsistent state is when: Channel A = 0 and Channel B =1, or Channel A =1 and Channel B =0 Complementary: Inconsistent state is when: Channel A = 0 and Channel B =0, or Channel A =1 and Channel B =1 The range is 5...3000 ms.

Operand	Data Type	Format	Description
Restart Type	BOOL	list item	This input configures Output 1 for either manual or automatic restart. **Manual (0): -** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1 **Automatic (1): -** Output 1 is energized 50 ms after all of the enabling conditions are met. **Important:** Automatic restart may only be used in application situations where no unsafe conditions can occur as a result of its use, or the reset function is being performed elsewhere in the safety circuit (for example, output function).
Cold Start Type	BOOL	list item	This operand specifies the Output 1 behavior when applying controller power or mode change to Run. **Manual (0): -** Output 1 is not energized when the Input Status becomes valid or when the Input Status fault is cleared. (The device must be tested before Output 1 can be energized.) **Automatic (1): -** Output 1 is energized immediately when the Input Status becomes valid or when the Input Status fault is cleared and both inputs are in their active state.

Operand	Data Type	Format	Description
Test Type	DINT	list item	The operand defines which type of test occurs when Test Request transitions from ON (1) to OFF (0). **None (0): -** Turns the testing feature OFF (0). **Manual (1): -** Output 1 is de-energized immediately when Test Request input transitions from ON (1) to OFF (0). The Test Command output is energized until a functional test is carried out, such as an open and close safety gate, break and clear light curtain, and reset actions are carried out depending on the setting of the Restart Type operand. **Active (2): -** Output 1 remains energized when the Test Request input transitions from ON (1) to OFF (0) and the Test Command output is energized, which should force an automatic test of the safety device. For example, a light curtain that has test capability. If the Channel A and Channel B outputs correctly transition to the safe state and back to the active state before Test Time expires, the Test Command output is de-energized and the safety device continues normal operation. If the safety inputs do not correctly transition before Test Time expires, Output 1 is de-energized immediately and a fault is generated.
Test Time	DINT	immediate	The maximum time for an active test to complete. If the test does not complete within this time, a fault is generated. Refer to the Test Type operand for more information. **Important:** This time cannot exceed 150 ms for type-2 light curtains as specified by EN-61496-1. The valid range is 5...1000 ms.

The following table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	DataType	Format	Description
Channel A[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Channel B[1]	BOOL	tag	This input is one of the two safety inputs to the instruction.
Test Request	BOOL	tag	This signal forces a functional test to occur. See the Test Type operand for more information. ON (1) -> OFF (0): Triggers a functional test.

Operand	DataType	Format	Description
Mute	BOOL	tag	This input is used to mute the safety device. OFF (0): Mute is not activated. ON (1): Mute is activated. The Muting Lamp output is energized and Output 1 is not de-energized when the safety device is tripped (Channel A or Channel B enters the safe state).
Muting Lamp Status	BOOL	tag immediate	This is the status of the muting lamp. If this status is not valid, Output 1 is de-energized immediately and a fault is generated. OFF (0): The Muting Lamp Status is invalid. A fault is generated. ON (1): The Muting Lamp Status is valid.
Input Status	BOOL	tag immediate	If instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	tag	If Restart Type = Manual, this input is used to energize Output 1 once Channel A and Channel B are both in the active state. If Restart Type = Automatic, this input is not used to energize Output 1. This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset.

1 If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

2 ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. to comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename Reset_Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

This table explains instruction outputs. The outputs may be external tags (safety output modules) or internal tags for use in other logic routines.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output is energized when the input conditions have been satisfied. The output becomes de-energized when: • Either Channel A or Channel B transitions to the safe state. • The Input Status input is OFF (0). • A manual test is requested (Test Request turns OFF (0) when Test Type = Manual). • An Active Test fault occurs (the Active Test does not complete within the Active Test Time). • The Mute input transitions from ON (1) to OFF (0) when Channel A or Channel B is in the safe state. • The Muting Lamp Status input is OFF (0).
Test Command (TC)	BOOL	If Test Type = Manual, this output is energized when a manual functional test must be carried out. If Test Type = Active, this output is energized to notify a safety device, such as light curtain, that an automatic test should be carried out.
Muting Lamp (ML)	BOOL	This output is intended to drive a muting lamp[1]. The status of the muting lamp should be fed into the Muting Lamp Status input. ON (1): Muting is currently active. The Muting Lamp is turned ON (1). OFF (0): Muting is not currently active.
Safe state (SS)	BOOL	This output turns ON (1) when the inputs are in a safe state regardless of whether the instruction is muted or not. ON (1): The inputs are currently in the safe state OFF (0): The inputs are not currently in the safe state.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section for a list of fault codes. This operand is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section for a list of diagnostic codes. This operand is not safety-related.

[1] Guard I/O module test outputs that are configured for muting can be used for this purpose.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

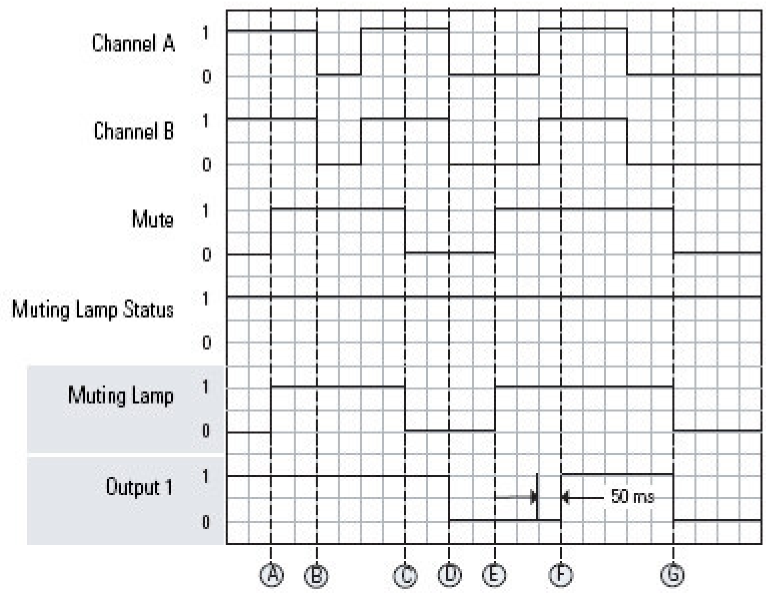
Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .TC, .ML, .SS and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in is false.

Operation

Normal

The timing diagram illustrates the normal muting behavior. At (A), the Muting Lamp output is energized when the Mute input turns ON (1). At (B), Output 1 is not de-energized because the instruction is currently muted. At (C), muting is turned OFF (0) but Output 1 remains energized because the safety inputs are now in the active state. At (D), Output 1 is de-energized because safety inputs transition to the safe state and muting is no longer turned ON (1). At (E), muting is activated again, but does not energize Output 1 because the mute signal is never allowed to energize Output 1. At (F), Output 1 is energized 50 ms after the safety inputs enter the active state. At (G), Output 1 is de-energized when muting is disabled and the safety inputs are in the safe state.

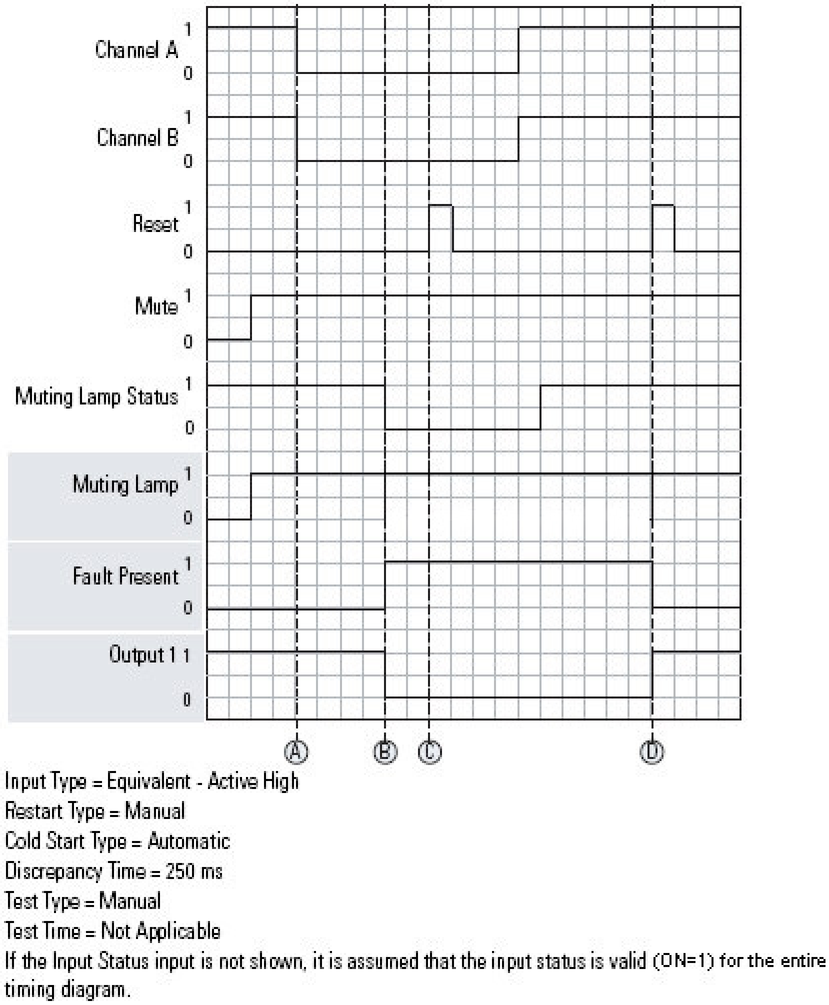


Input Type = Equivalent - Active High
Restart Type = Automatic
Cold Start Type = Automatic
Discrepancy Time = 250 ms
Test Type = Manual
Test Time = Not Applicable
If the Input Status input is not shown, it is assumed that the input status is valid (ON=1) for the entire timing diagram.
There is always a 50 ms delay before energizing Output 1 when it is configured to be energized automatically (Restart Type = Automatic).

Muting Lamp Status Fault Operation

The timing diagram illustrates the Muting Lamp Status fault. At (A), the safety inputs enter the safe state, but Output 1 remains energized because the instruction is muted.

At (B), the Muting Lamp Status input transitions to an invalid state, which immediately de-energizes Output 1 and generates a fault. At (C), the fault cannot be reset because the Muting Lamp Status is still invalid. At (D), the fault is cleared because a reset is triggered and the Muting Lamp Status is now valid. This also energizes Output 1 because the safety inputs are in the active state.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No fault.	None.
1	The Muting Lamp Status transitioned to an invalid state while the instruction was running.	• Check the status of the Mute input. • Reset the fault.

Fault Code	Description	Corrective Action
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.
16#4000 16384	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the active state. Channel B was in the safe state.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state). • Reset the fault.
16#4001 16385	Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, Channel A was in the safe state. Channel B was in the active state.	
16#4002 16386	Channel A went to the safe state and back to the active state while Channel B remained active.	
16#4003 16387	Channel B went to the safe state and back to the active state while Channel A remained active.	
16#4030 16432	The Active test did not complete within the Test Time.	• Check the device. • Make sure the test feature is working properly. • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None.
5	The Reset input is held ON (1)	Set the Reset input to OFF (0)
16#20 32	The Input Status was OFF(0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.
16#4000 16384	The device was not functionally tested at startup.	Perform a functional test of the inputs (put Channel A and Channel B in a safe state).
16#4001 16385	The device was not functionally tested after a fault occurred.	• Check the wiring. • Perform a functional test of the device (put Channel A and Channel B in a safe state).
16#4030 16432	Waiting for the manual functional test to occur.	Perform a functional test of the device (put Channel A and Channel B in a safe state).
16#4031 16433	The Active test is in progress.	Information only.

See also

Dual Channel Input Stop with Test and Mute (DCSTM) wiring and programming example on page 100

Index Through Arrays on page 540

Dual Channel Input Stop (DCS) on page 45

Dual Channel Input Stop with Test (DCST) on page 60

Status and Safety input and output for dual channel safety instructions on page 21

Dual-channel Input Stop with Test and Mute (DCSTM) wiring and programming example

This section demonstrates how to program and wire the Guard I/O module and program the instruction in the safety control portion of an application.

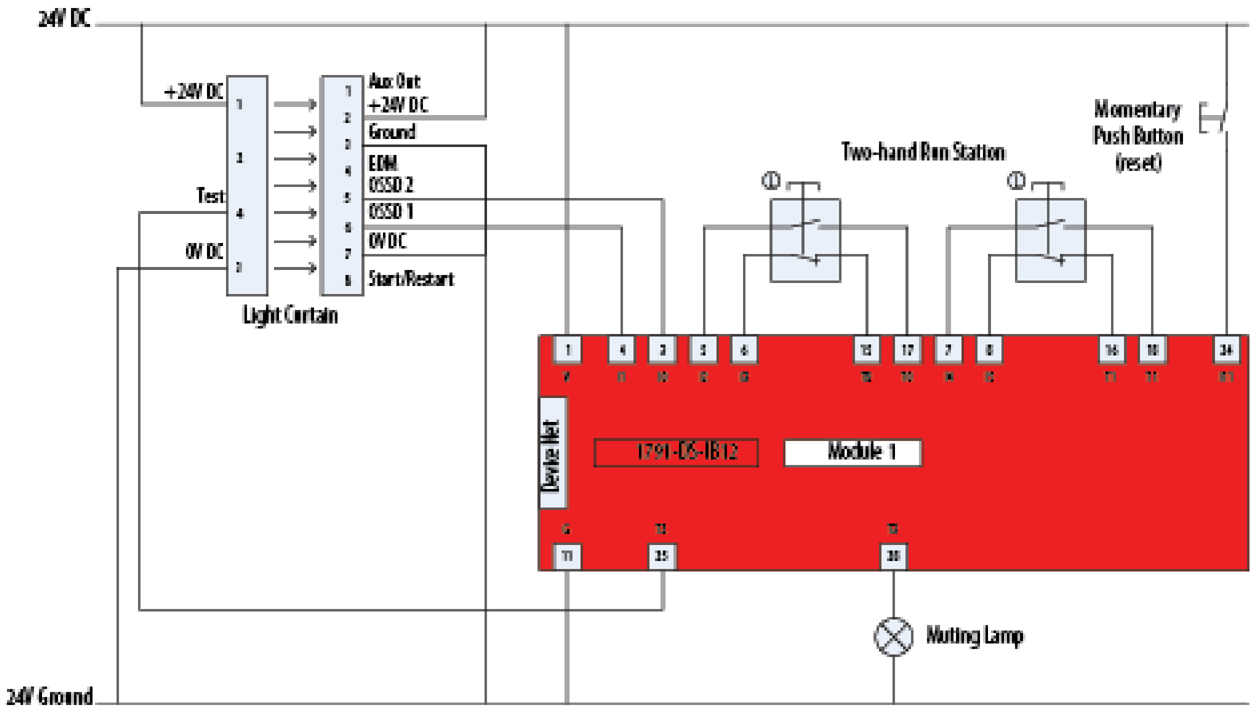
This application example complies with ISO 13849-1, Category 4 operation.

Tip: The standard control portion of the application is not shown in the following diagram.

In this example, the safety function of the Two-hand Run Station lets the light curtain safety function be muted when both buttons are pressed. This assumes that all user-responsible clauses in EN 574 are met.

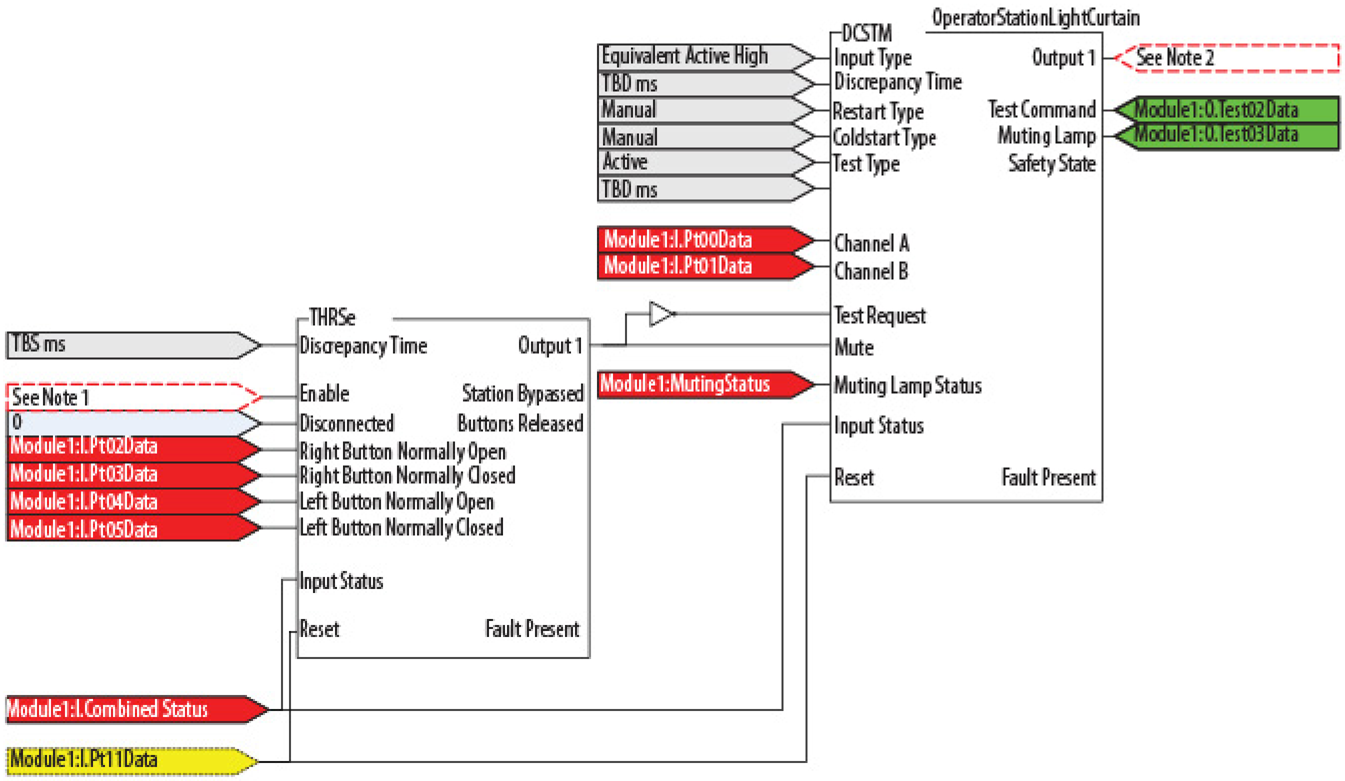
This example also uses the inverted output of the Two-hand Run Station to drive the Test Request input of the Dual Channel Input Stop with Test and Mute instruction (DCSTM). This causes the light curtain and its associated input points and wiring to be tested every time both buttons on the Two-hand Run Station are pressed.

Wiring Diagram



Programming Diagram

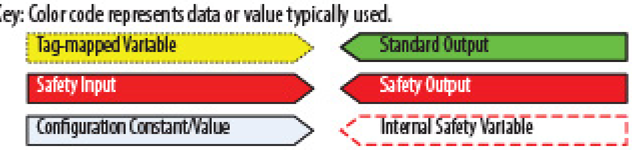
This programming diagram shows the DCSTM instruction being used with the THRSe instruction.



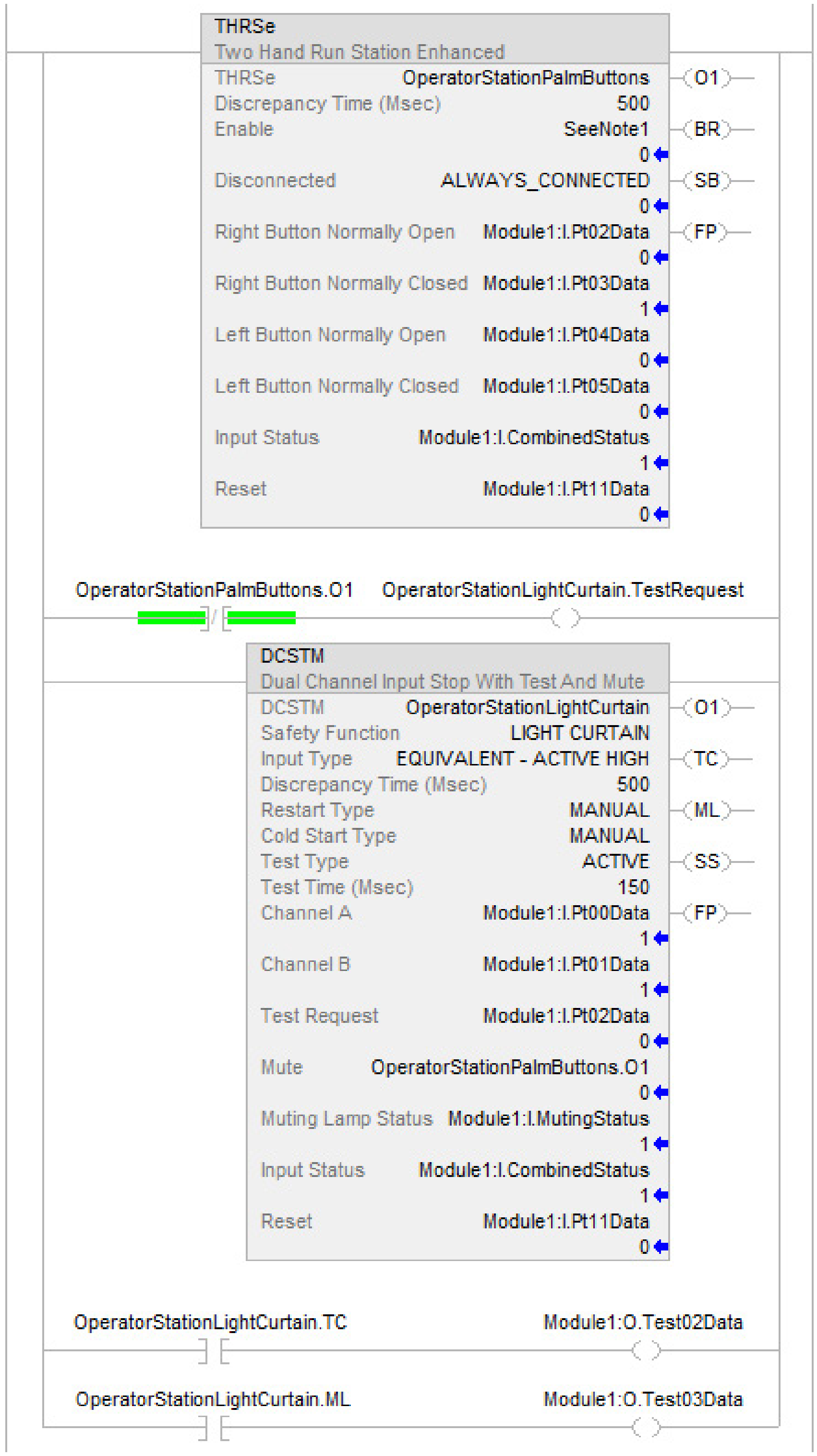
Note 1: This tag is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.

Note 2: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.

Key: Color code represents data or value typically used.

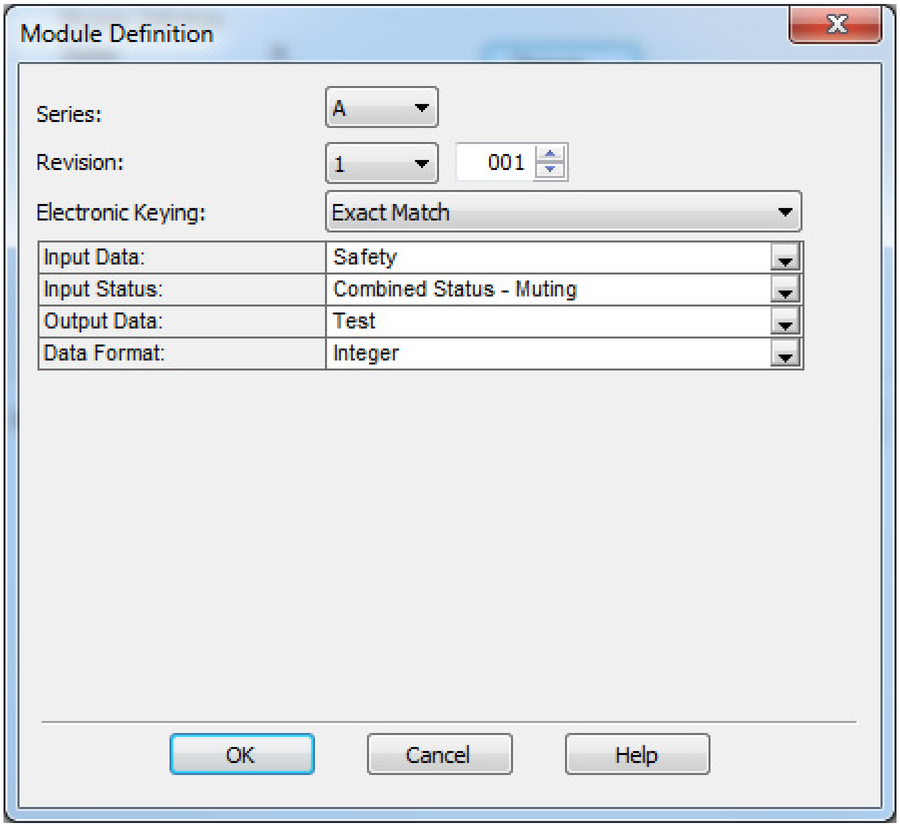


Ladder Diagram



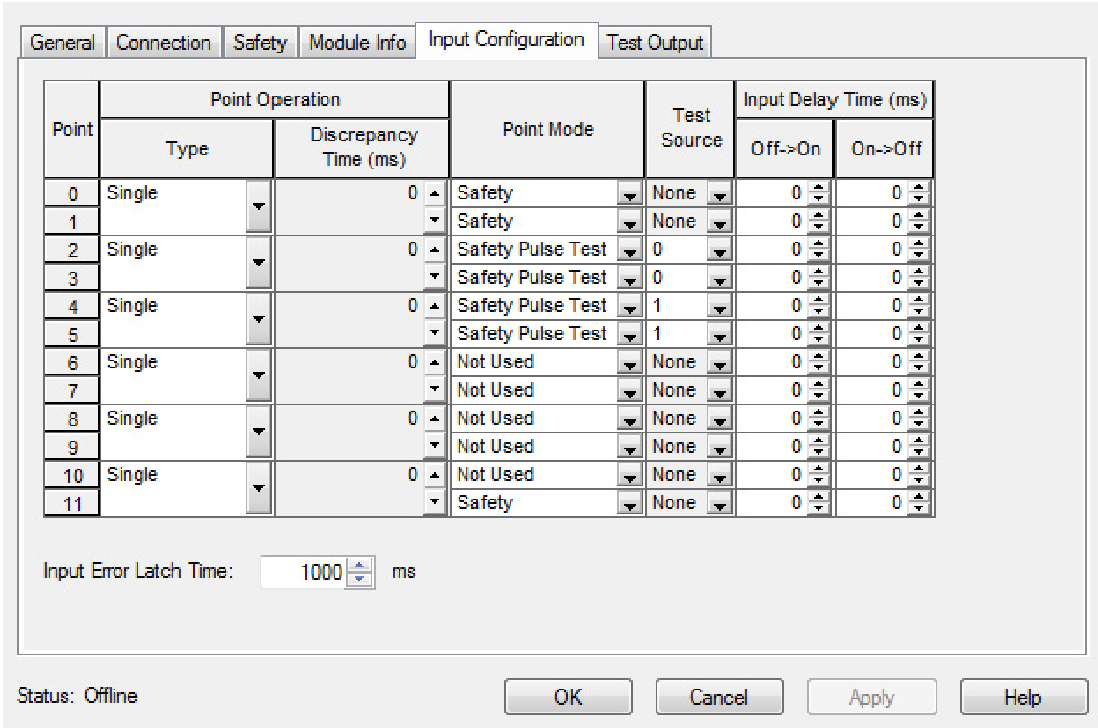
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.

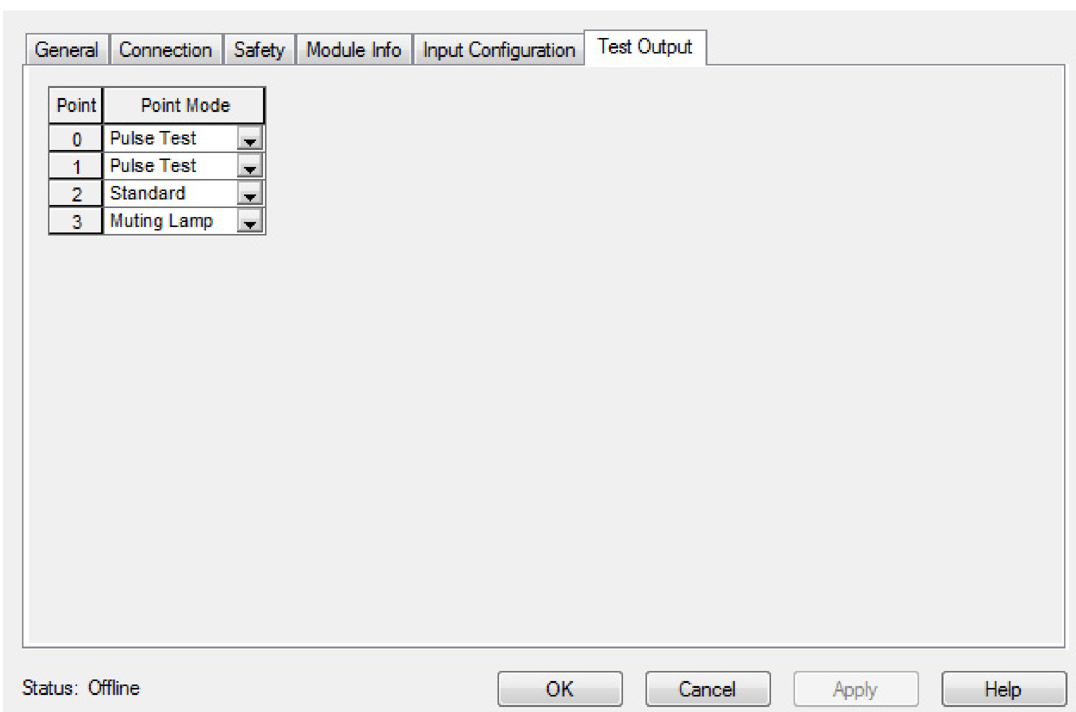


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

Module Input Configuration



Module Test Output Configuration



See also

Dual Channel Input Stop with Test and Mute (DCSTM) on page 89

Dual Channel Analog Input (DCA - integer version) and (DCAF - floating point version)

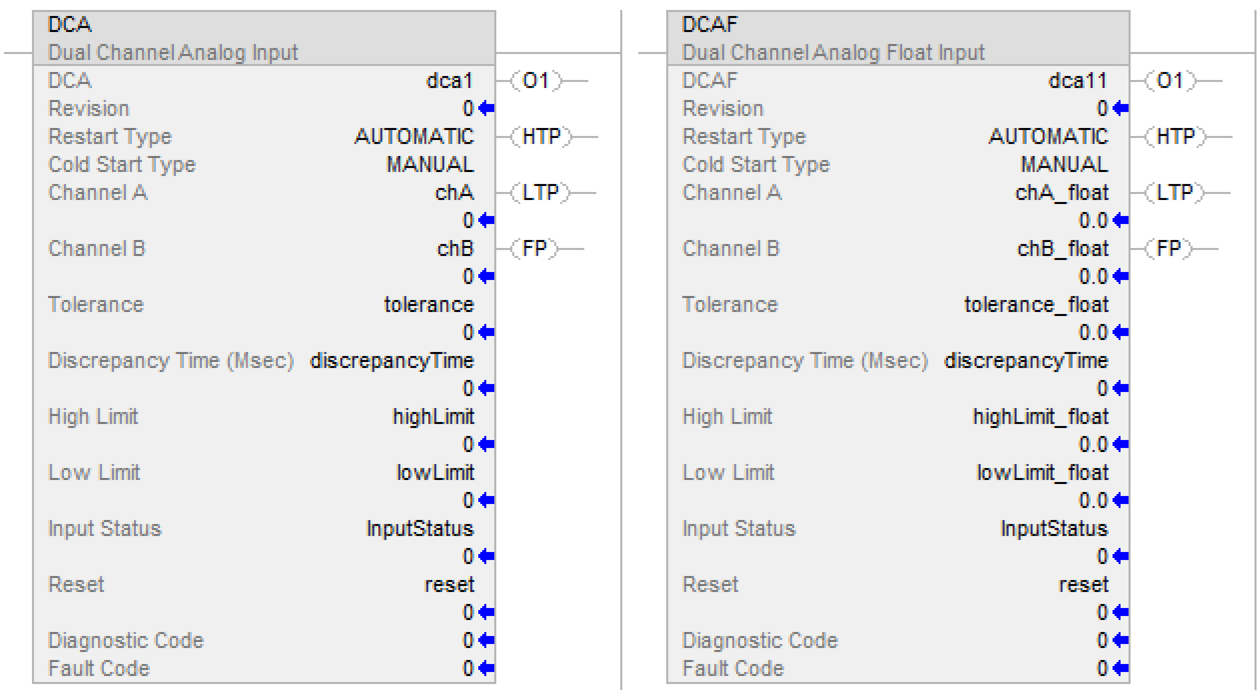
This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Dual Channel Analog Input instruction monitors two analog input channels originating from an analog input module. Output 1 turns on when both analog inputs, Channel A and Channel B, are within the Tolerance and the High and Low Limit settings, and correct reset actions have been performed.

IMPORTANT	Do not use the DCA instruction with the Guard I/O analog module's dual channel feature. Set Guard I/O module inputs to single-channel when using the DCA or DCAF instruction.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameters that are used to configure the instruction. These parameters cannot be changed at runtime.

Parameter	Data Type	Format	Description
(Integer) DCA	DCA_INPUT	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.
(Real) DCAF	DCAF_INPUT	tag	
Restart Type	BOOL	name	This parameter configures Output 1 for either Manual or Automatic Restart. **Manual (0) -** When both Channel A and Channel B are within the Tolerance setting and within the High and Low Limit settings, a transition of the Reset input from OFF (0) to ON (1) is required to energize Output 1. **Automatic (1) -** Output 1 is energized 50 ms after both Channel A and Channel B are within the Tolerance setting and within the High and Low Limit settings. **ATTENTION:** Automatic Restart may be used only in application situations where you can prove that no unsafe conditions can occur as a result of its use, or the reset function is being performed elsewhere in the safety circuit (for example, output function).
Cold Start Type	BOOL	name	This parameter specifies the Output 1 behavior when applying controller power or mode change to Run. **Manual (0) -** Output 1 is not energized when the Input Status becomes valid or when the Input Status fault is cleared. **Automatic (1) -** When both Channel A and Channel B are within the Tolerance setting and within the High and Low Limit settings, Output 1 is energized immediately when the Input Status becomes valid or when the Input Status fault is cleared.

The following table explains instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Channel A	DINT (DCA) REAL (DCAF)	tag	This input is one of the two safety analog inputs to the instruction.
Channel B	DINT (DCA) REAL (DCAF)	tag	This input is one of the two safety analog inputs to the instruction.

Operand	Data Type	Format	Description
Discrepancy Time (ms)	DINT	immediate tag	The amount of time that the Channel A and Channel B inputs are allowed to be out of tolerance before an instruction fault is generated. The valid range is 5...3000 ms. A setting of 0 disables the timer. The value of 0 can only be applied via the use of a tag. **Important:** Values from 1... 4 are reset to the minimum value (5). Values greater than 3000 are reset to the maximum value (3000).
High Limit	DINT (DCA) REAL (DCAF)	tag immediate	The HTP Output turns ON when the Channel A or Channel B input exceeds this value.
Low Limit	DINT (DCA) REAL (DCAF)	tag immediate	The LTP Output turns ON when the Channel A or Channel B input drops below this value.
Input Status	BOOL	tag immediate	If instruction inputs are from a safety I/O module, this is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[1]	BOOL	tag	This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset.
Tolerance	DINT (DCA) REAL (DCAF)	tag immediate	The number of counts that Channel A and Channel B can differ by without affecting Output 1.

[1] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to reset your signal tag name. Then use the OSF Instruction Bit tag as the reset source for the instruction.

The following table explains instruction outputs. The outputs may be used to drive external tags (safety output modules) or internal tags for use in other logic routines.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output is energized when the input conditions have been satisfied. The output becomes de-energized when: • The difference between the Channel A and Channel B input values exceeds the Tolerance setting for longer than the Discrepancy Time. • Channel A and or Channel B exceed the High or Low Limit settings. • The Input Status input is OFF (0).
High Trip Point (HTP)	BOOL	ON (1): The Channel A or Channel B input exceeds the High Limit input value. OFF (0): The Channel A or Channel B input is less than or equal to the High Limit input value.

Operand	Data Type	Description
Low Trip Point (LTP)	BOOL	ON (1): The Channel A or Channel B input drops below the Low Limit input value. OFF (0): The Channel A or Channel B input is greater than or equal to the Low Limit input value.
O1 On Time	DINT	This output represents the length of time in hours that Output 1 has been ON.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. For a list of fault codes, see Fault Codes. This parameter is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. For a list of diagnostic codes, see Diagnostic Codes. This parameter is not safety-related.
Revision	Constant	This output contains the firmware revision level of the instruction.

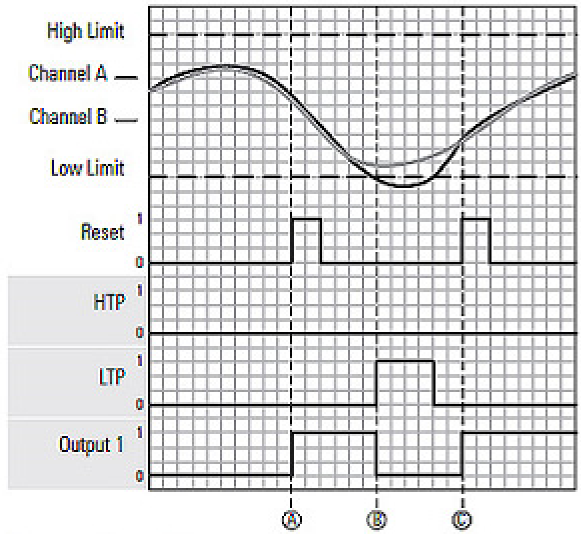
IMPORTANT Do not write to any instruction output tag under any circumstance.

Operation

Normal Operation

The timing diagram illustrates normal operation with Restart Type configured for Manual and Cold Start Type configured for Manual. At (A), Output 1 is energized because the Channel A and Channel B inputs are within the Tolerance setting and within the High and Low Limits settings when the reset is triggered. At (B), Output 1 is de-energized because the Channel A input has gone below the Low Limit. Output 1 is energized at (C) when a reset is triggered because Channel A is now within the Tolerance and Limit settings.

Normal Operation (Manual Restart, Manual Cold Start)



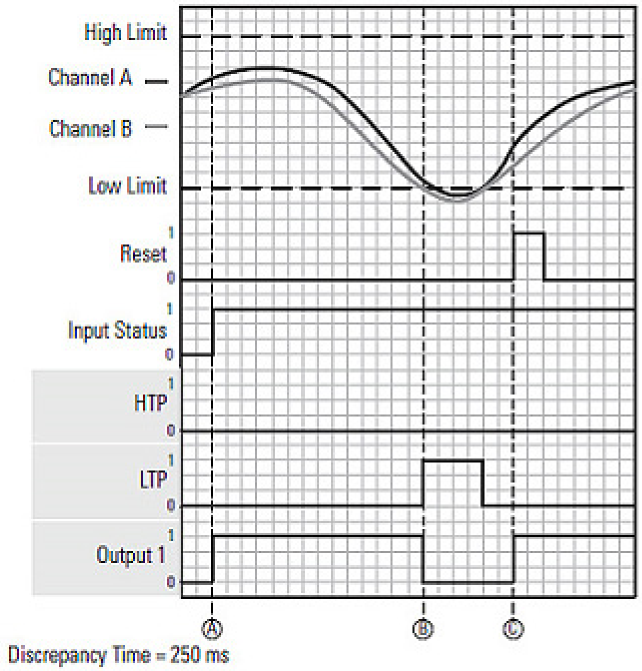
Discrepancy Time = 250 ms

If the Input Status input is not shown, it is assumed that the input status is valid (ON = 1) for the entire timing diagram.

Normal Operation (Manual Restart, Automatic Cold Start)

The timing diagram illustrates normal operation with Restart Type configured for Manual and Cold Start Type configured for Automatic. When the Cold Start Type is Automatic, Output 1 is energized as soon as the Input Status input becomes valid [OFF (0) to ON (1) transition] for the first time, such as when power is applied to a PLC controller.

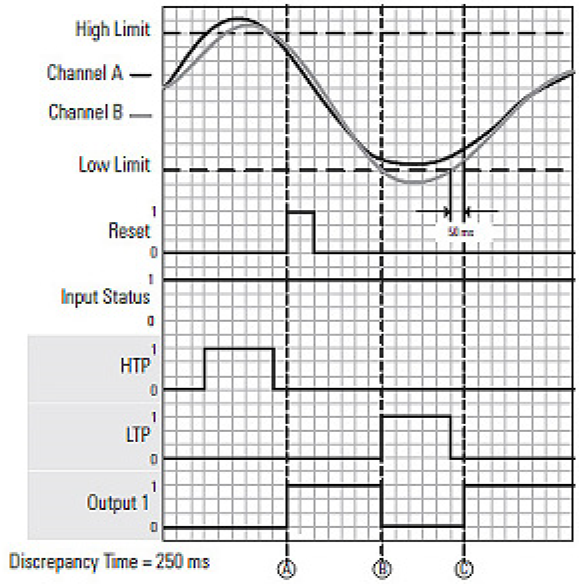
At (A), Output 1 is energized immediately after the Input status becomes valid while the Channel A and Channel B inputs are within Tolerance and within the High and Low Limits. At (B), Output 1 is de-energized when the Channel B input falls below the Low Limit. Output 1 cannot be energized again until (C), when a reset is triggered while the Channel A and Channel B inputs are within the Tolerance and Limit settings.



Normal Operation (Automatic Restart, Manual Cold Start)

The timing diagram illustrates normal operation with Automatic Restart and Manual Cold Start. At (A), Output 1 is energized when a reset is triggered while the Channel A and Channel B inputs are within Tolerance and within the High and Low Limits. Output 1 is de-energized at (B) when the Channel B input drops below the Low Limit. Output 1 is automatically energized again at

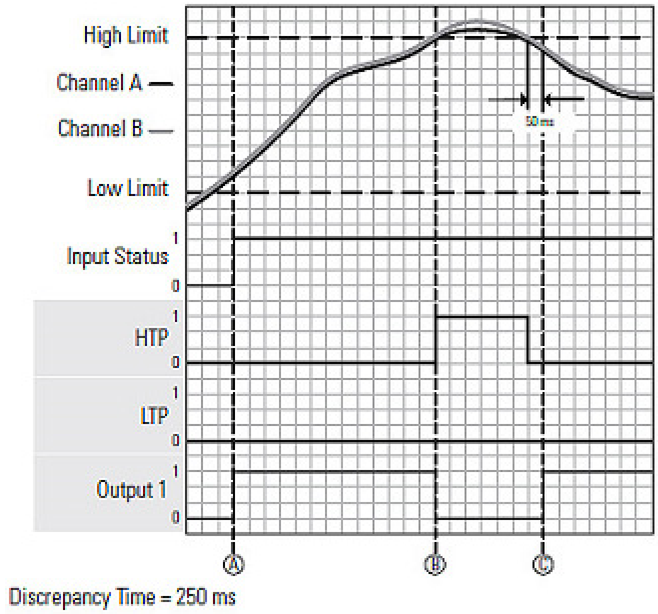
(C), 50 ms after the Channel B input is back within the Tolerance and Limit settings.



Normal Operation (Automatic Restart, Automatic Cold Start)

The timing diagram illustrates normal operation with Automatic Restart and Automatic Cold Start. When the Cold Start Type is Automatic, Output 1 is energized as soon as the Input Status input becomes valid [OFF (0) to ON (1) transition] for the first time, such as when power is applied to a PLC controller. Channel A and Channel B must be within Tolerance and within the High and Low Limits for Output 1 to be energized.

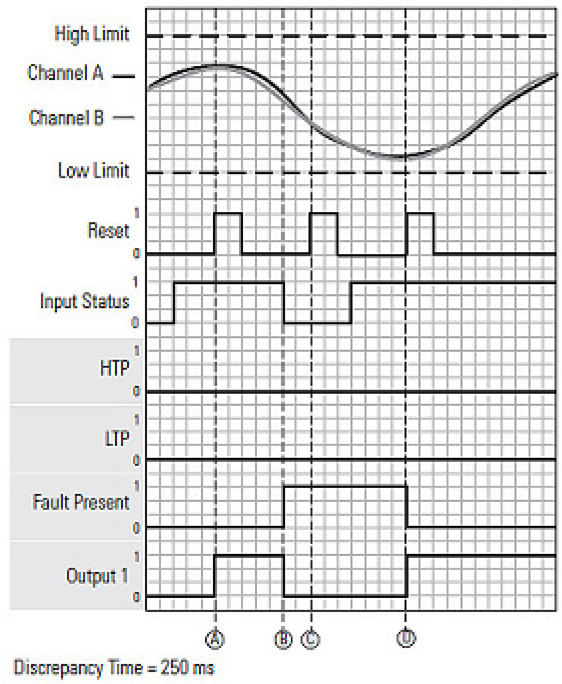
At (A), Output 1 is energized when the Input Status input becomes valid while the Channel A and Channel B inputs are within Tolerance and within the High and Low Limits. At (B), Output 1 is de-energized when the Channel A and Channel B inputs go above the High Limit. Output 1 is automatically energized at (C), 50 ms after the Channel A and Channel B inputs fall back within the Limits while remaining within Tolerance.



Input Status Fault

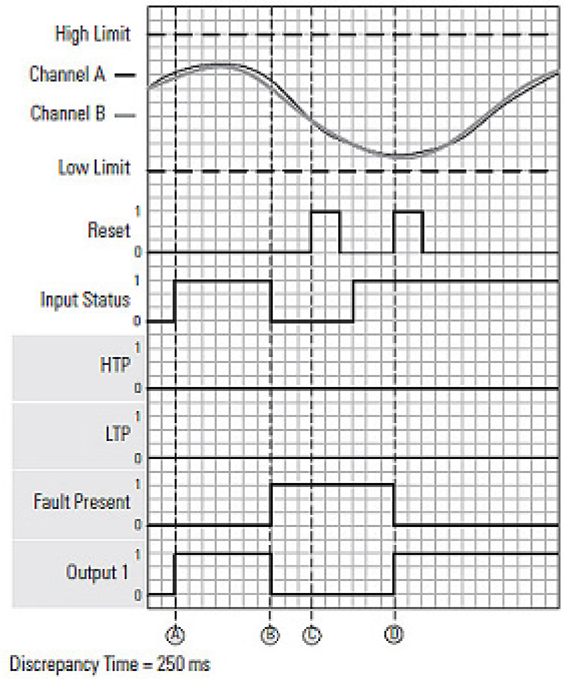
Input Status Fault (Manual Restart, Manual Cold Start)

The timing diagram shows a fault occurring when the Input Status input becomes invalid. Output 1 is energized at (A), when a reset is triggered and the Channel A and Channel B inputs are within the Tolerance and the High and Low Limits. A fault occurs at (B) because the Input Status input becomes invalid, which de-energizes Output 1. The fault cannot be cleared at (C) because the Input Status is still invalid. At (D), Input Status is valid, the fault is cleared, and Output 1 is energized when the reset is triggered.



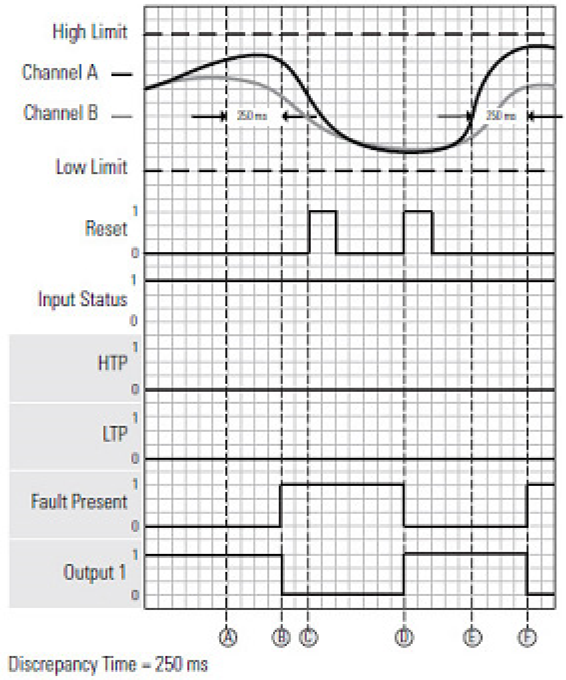
Input Status Fault (Manual Restart, Automatic Cold Start)

The timing diagram illustrates a fault occurring when the Input Status input becomes invalid. Output 1 is energized at (A), when the Input Status becomes valid because the Cold Start Type is Automatic and the Channel A and Channel B inputs are within Tolerance and within the High and Low Limits. A fault occurs at (B) when the Input Status becomes invalid, which de-energizes Output 1. The fault cannot be cleared at (C) because the Input Status is still invalid. At (D), Input Status is valid, the fault is cleared, and Output 1 is energized when the reset is triggered.



Discrepancy Fault (Manual Restart)

The timing diagram illustrates a fault occurring when the difference between Channel A and Channel B exceeds the Tolerance for longer than the Discrepancy Time. At (A), Channel A and Channel B go out of Tolerance and the discrepancy timer starts. At (B), a discrepancy fault occurs because Channel A and Channel B have been out of Tolerance for at least 250 ms, the configured Discrepancy Time. At (C), the fault is not cleared because the difference between the Channel A and Channel B inputs is still greater than the Tolerance. The fault is cleared and Output 1 is energized at (D) when a reset is triggered and the difference between the Channel A and Channel B inputs falls within the Tolerance. At (E), the difference between Channel A and Channel B again goes beyond the Tolerance and the discrepancy timer starts. Another discrepancy fault occurs at (F) when the Discrepancy Time is exceeded.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are set to 0.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the internal logic used to source input status. • Reset the fault.
16#4050 16464	The difference between Channel A and Channel B input values exceeded the Tolerance setting for longer than the Discrepancy Time.	• Check the wiring. • Bring Channel A and Channel B to within the tolerance level. • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	None.
16#05 5	The Reset input is held ON (1).	Set the Reset input to OFF (0).
16#20 32	The Input Status input was OFF (0) when the instruction started.	Check the I/O module connection or the internal logic used to source input status.
16#4050 16464	At startup, the difference between Channel A and Channel B input values is greater than the Tolerance setting.	Verify that Channel A and Channel B inputs are valid and adjust the tolerance setting appropriately for the application.
16#4051 16465	The Low Limit setting is greater than the High Limit setting.	Adjust the settings so that the Low Limit setting is less than the High Limit setting.
16#4052 16466	The Channel A input value is less than the Low Limit setting.	Verify that the Channel A and Channel B inputs are valid and adjust the High and Low Limit settings appropriately for the application.
16#4053 16467	The Channel B input value is less than the Low Limit setting.	Verify that the Channel A and Channel B inputs are valid and adjust the High and Low Limit settings appropriately for the application.
16#4054 16468	The Channel A input value is greater than the High Limit setting.	Verify that the Channel A and Channel B inputs are valid and adjust the High and Low Limit settings appropriately for the application.
16#4055 16469	The Channel B input value is greater than the High Limit setting.	Verify that the Channel A and Channel B inputs are valid and adjust the High and Low Limit settings appropriately for the application.
16#4056 16470	The Tolerance input value is a negative number.	Change the Tolerance input value to a positive number.
16#4057 16471	The difference between Channel A and Channel B input values is greater than the Tolerance setting.	Verify that Channel A and Channel B inputs are valid and adjust the Tolerance setting appropriately for the application.
16#4058 16472	The Discrepancy Time setting is not within the allowable range and is being forced to the minimum or maximum value.	Adjust the Discrepancy Time setting to within the allowable range of 5...3000 ms.

Affects Math Status Flags

No

Major / Minor Faults

None. See Common Attributes for operand-related faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .HTP, .LTP and .FP are cleared to false. The Diagnostic Code and Fault Code outputs are set to 0
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung-condition-in is false.

See also

Common Attributes on page 529

Dual Channel Analog Input (DCA - integer version) and (DCAF - floating point version) wiring and programming example on page 118

Status and Safety input and output for dual channel safety instructions on page 21

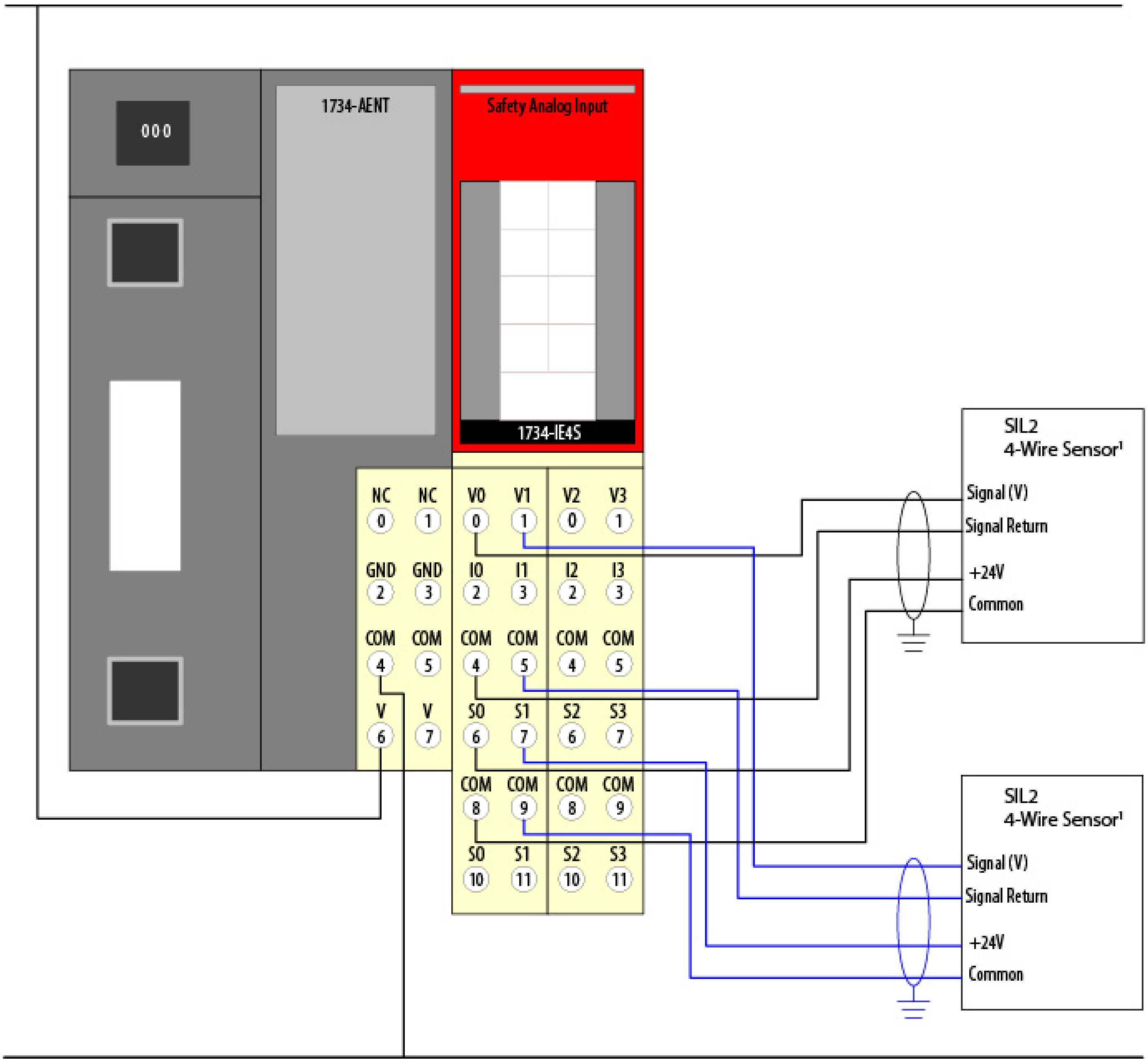
Dual Channel Analog Input (DCA - integer version) and (DCAF - floating point version) wiring and programming example

This example complies with ISO13849 PLe and IEC61511 SIL 3 operation. It is an example of a relatively simple safety application where temperature sensors are represented by the two 4-wire sensors.

The example shows how to interface the field devices to a 1734-IE4S POINTGuard Analog Input module. The example illustrates how to configure the I/O modules and use I/O tags in the associated logic for this simple application, including how to use the Dual Channel Analog input instruction to control the safety aspects of this application. The standard/control part of this application is not shown.

This example does not include I/O conditioning and fault latching logic, which can be desired for diagnostic reasons.

Wiring Example



(1) Signal Return and Common are at the same potential.

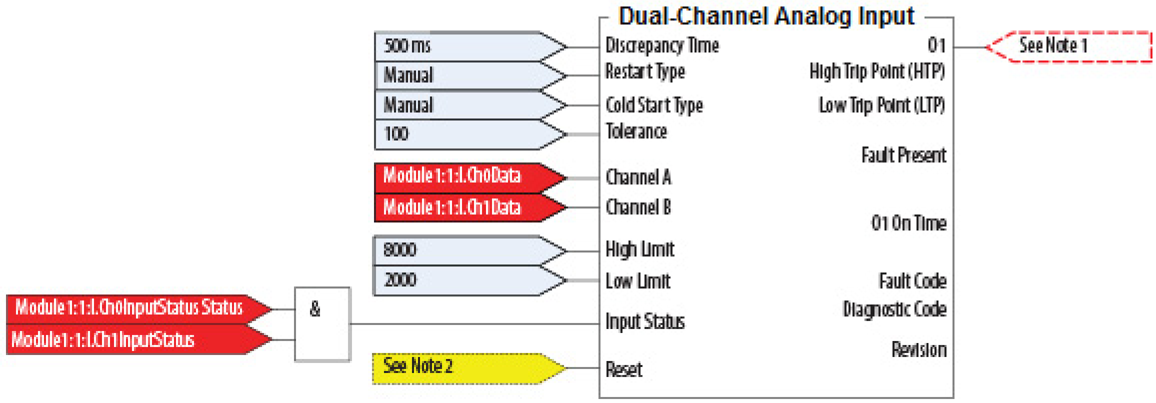
(2) If the sensor has a digital output for use with the Tachometer mode, it must be a push-pull type or have appropriate pull-up or pull-down resistors for NPN or PNP type. The 1734-IE4S module does not provide low impedance of these pull-up or pull-down resistors.

(3) This wiring configuration is also used for SIL 2 redundant Tachometer mode

(4) For analog voltage output sensors, the signal levels for operation for the application must be outside the signal level when the signal is not present, for example, when the wire is broken.

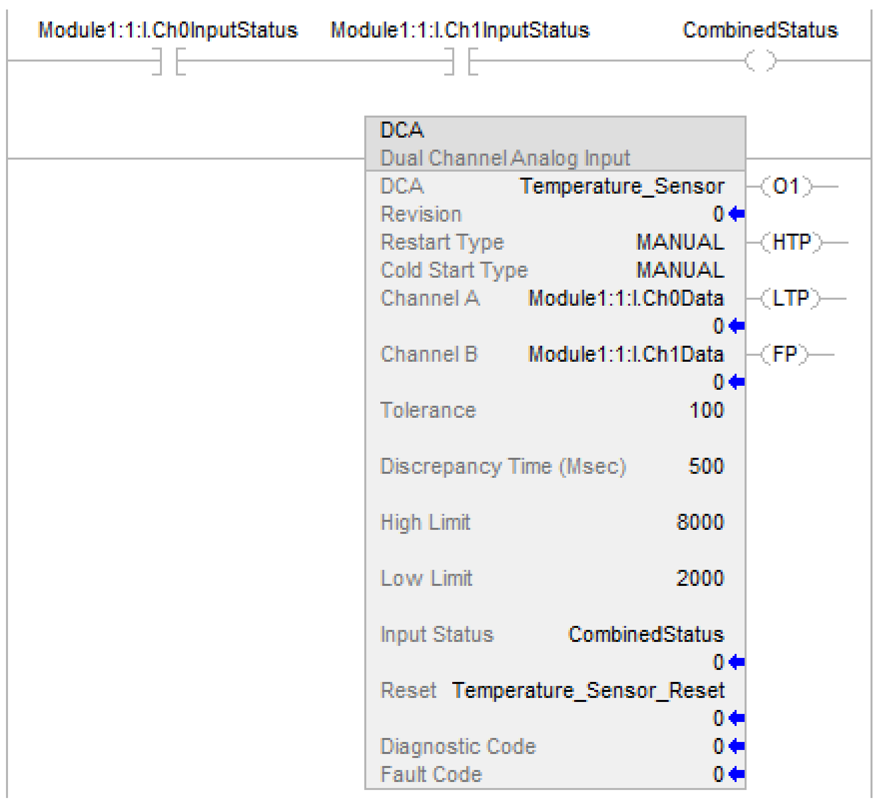
Programming Example

This programming diagram shows the instructions with inputs.



Note 1: This tag is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.
Note 2: The source can be mapped or safety data.

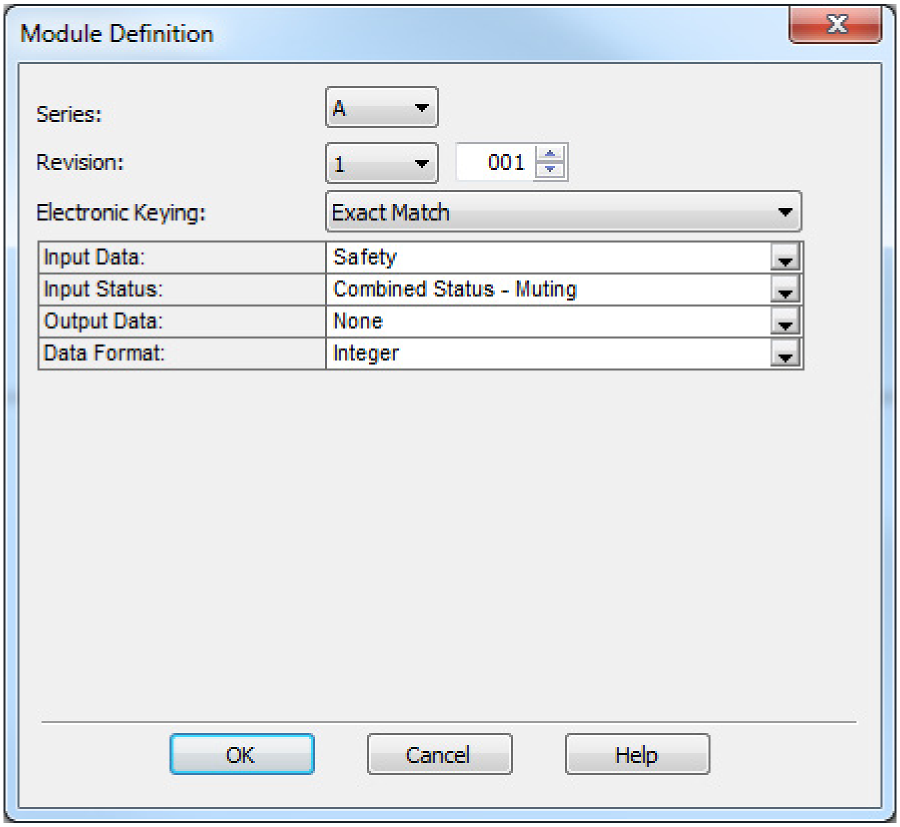
Ladder Diagram



The programming software is used to configure the input parameters of the Guard I/O module, as illustrated.

Configure the module as shown in the following diagram.

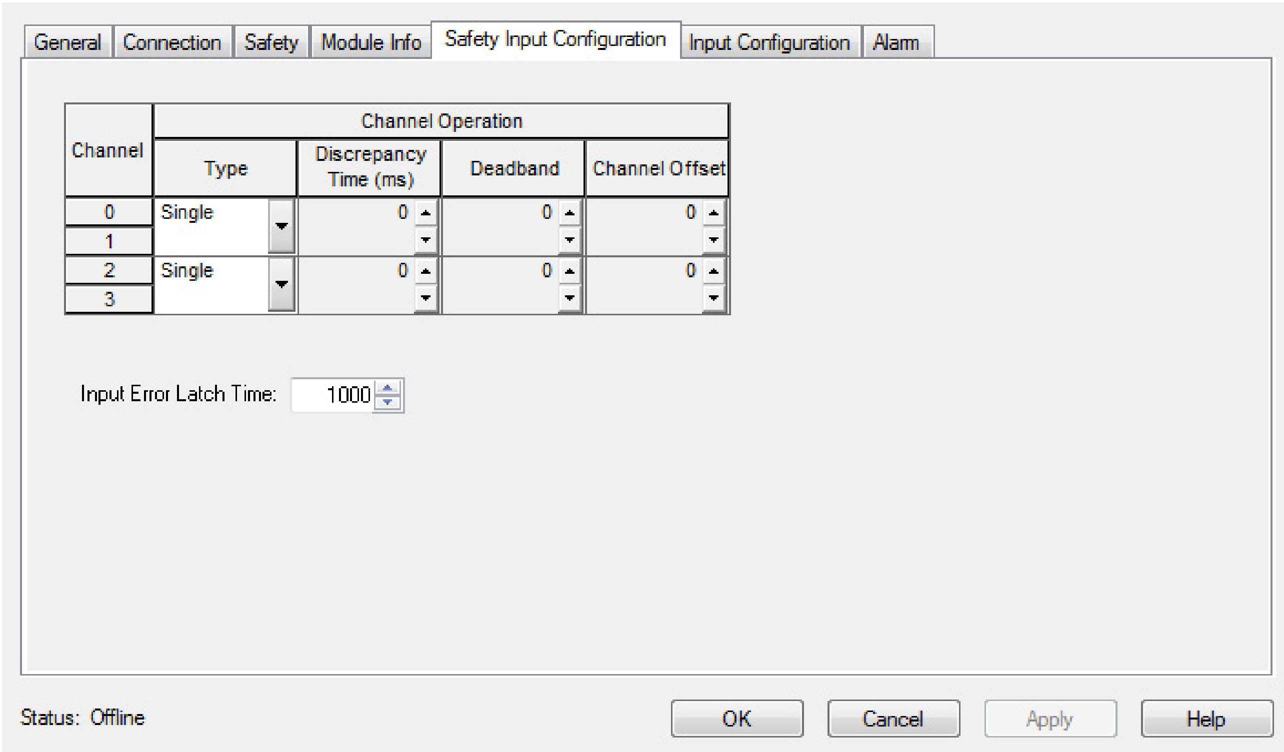
Module Definition



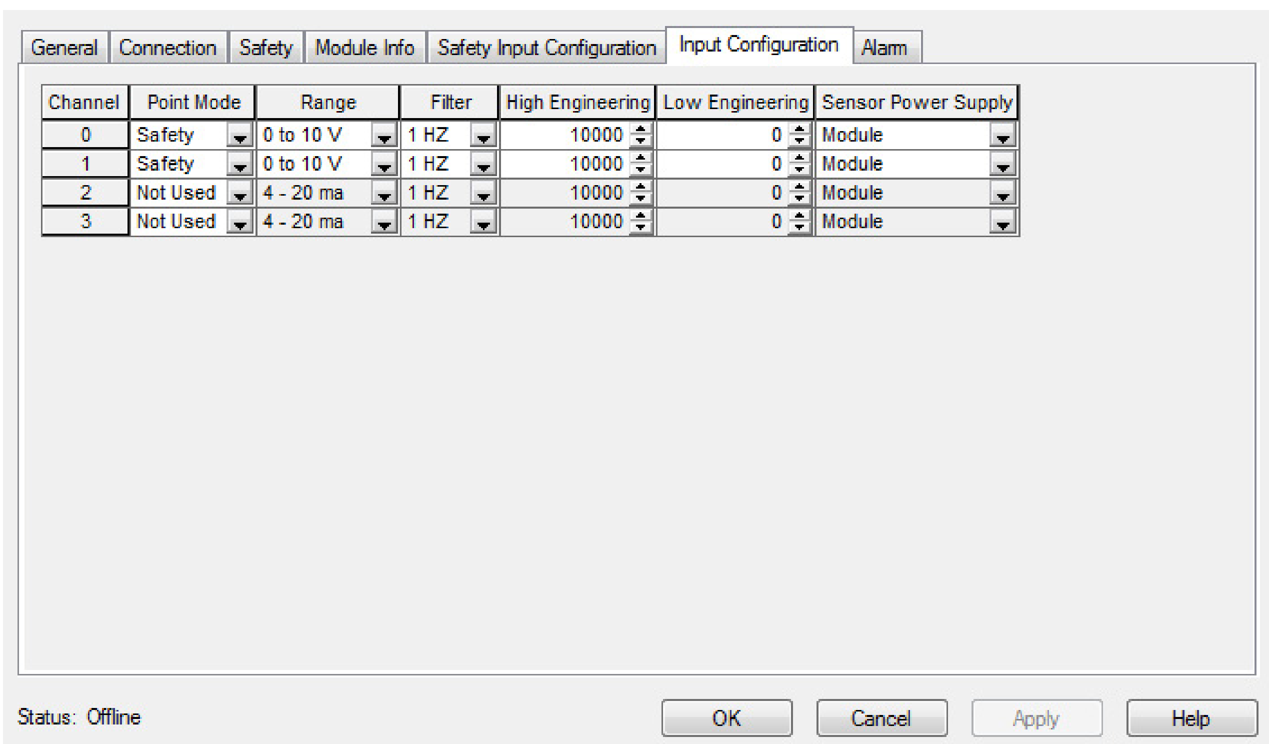
Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. You can also select **Compatible Match**.

Configure the inputs of the module as shown in the following diagrams.

Module Safety Input Configuration



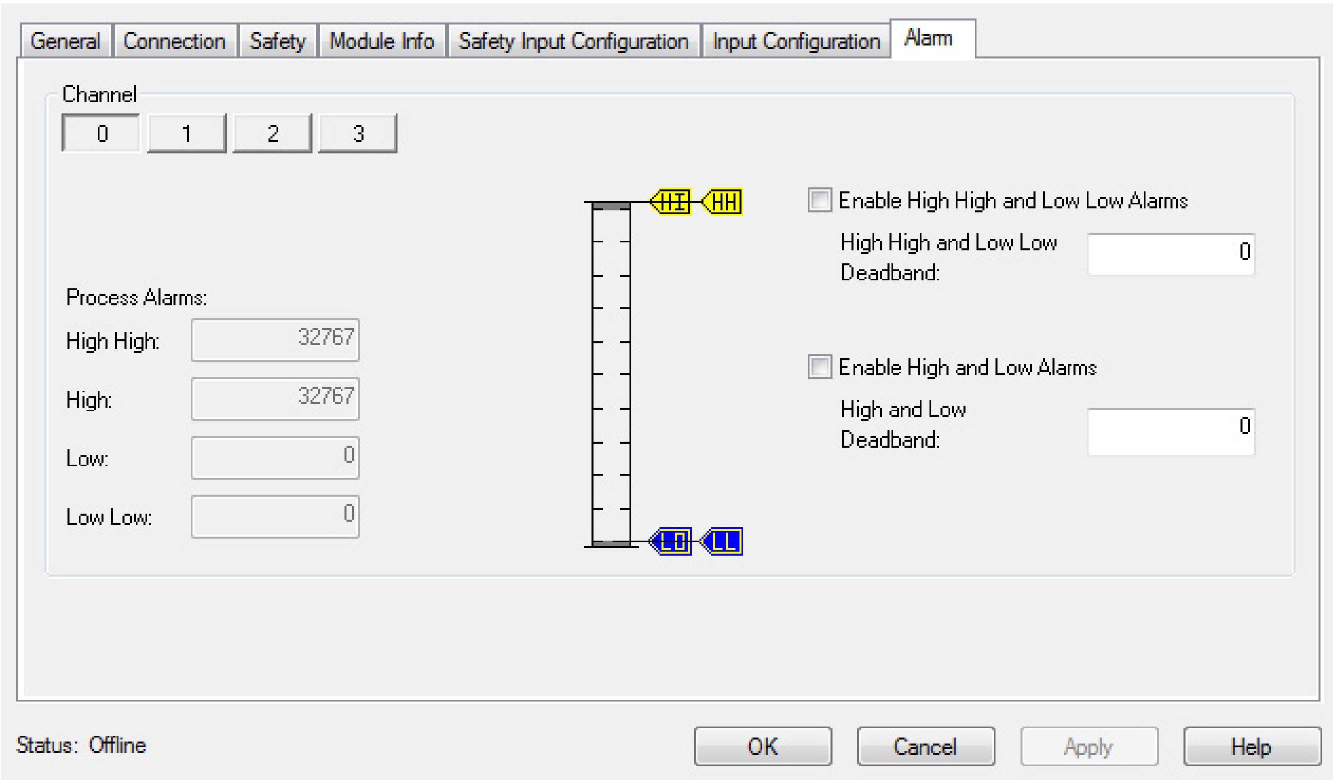
Module Input Configuration



Configure Module 1 Alarm Configuration for Channel 0 and 1. Configure channel 0, and then configure Channel 1 identical to Channel 0.

IMPORTANT Do not select the Alarm check boxes, because it enables the Analog Modules dual channel feature, which must not be used with the DCA instruction.

Alarm Configuration



See also

[Dual Channel Analog Input (DCA - integer version) and (DCAF - floating point version)] on [page 106]

Safety Mat (SMAT)

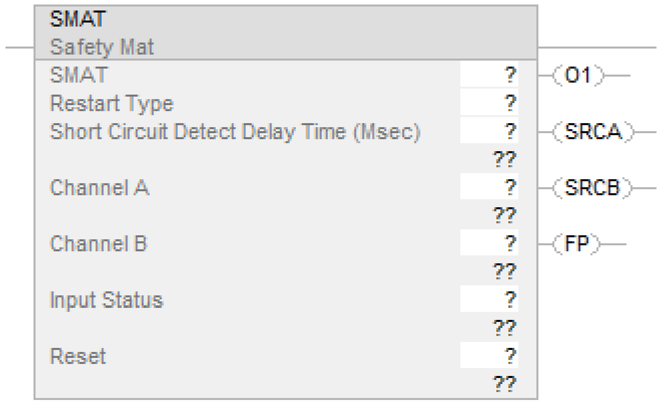
This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The purpose of the Safety Mat instruction is to indicate, through O1 (Output 1), if the safety mat is occupied.

Safety mats typically consist of two conductive plates held apart by non-conductive separators. Each conductive plate, Channel A and Channel B of the safety mat, are alternately sourced by the safety-mat instruction's SRCA (Source A) and SRCB (Source B) outputs. Output A and Output B of the safety mat are routed to the safety mat instruction's Channel A and Channel B inputs.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

IMPORTANT Make sure that your safety input points are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameters that are used to configure the instruction.

Operand	Data Type	Format	Description
SMAT	SAFETY_MAT	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.
Restart Type	DINT	name	This input configures Output 1 for either manual or automatic Restart. **Manual (0) -** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1 **Automatic (1) -** Output 1 is energized 50 ms after all of the enabling conditions are met. **ATTENTION:** Automatic Restart may only be used in application situations where you can prove that no unsafe conditions can occur as a result of its use, or the reset function is being performed elsewhere in the safety circuit (for example, output function).
Short Circuit Detect Delay Time	DINT	immediate	This parameter is the time (5…250 ms) that the instruction uses to determine the difference between a short circuit and the safety mat being occupied. When using this instruction with 1791DS I/O modules, the short-circuit detection-delay time has to be greater than the associated module's input-error latch time. The module's input-error latch time holds the test output fault generated by the two channels being shorted together for the configured amount of time. Output 1 goes to the safe state as soon as possible (task period and input filter dependent), only the declaration of a fault is delayed by this time. It has no effect on the safety reaction time.

The following table explains instruction inputs. The inputs are typically used to select different modes of application operation by enabling other instructions.

Operand	Data Type	Format	Description
Channel A[1]	BOOL	tag	This input is sourced by the Channel A output of the safety mat.
Channel B[1]	BOOL	tag	This input is sourced by the Channel B output of the safety mat.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this value is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.

Operand	Data Type	Format	Description
Reset[2]	BOOL	tag	If the Restart Type = Manual, this input is used to energize Output 1. This input also clears the instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present (FP) and Fault Code outputs are reset.

[1] If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. to comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename Reset_Signal tag in this example to your reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

The following table provides the outputs to the instruction. In many applications, the output tags may represent the state of actual field devices. They may also be internal tags used to represent machine state information for use with other instructions.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output is energized when all input conditions are satisfied. The output becomes de-energized when the following occurs: • An instruction detects an open or a short circuit condition • The normal operation of the instruction causes Output 1 to be de-energized
Source A (SRCA)	BOOL	This output is used to source the Channel A input of the safety mat.
Source B (SRCB)	BOOL	This output is used to source the Channel B input of the safety mat.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section below for a list of fault codes. This parameter is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section below for a list of diagnostic codes. This parameter is not safety-related.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.

IMPORTANT Do not write to any instruction output tag under any circumstance.

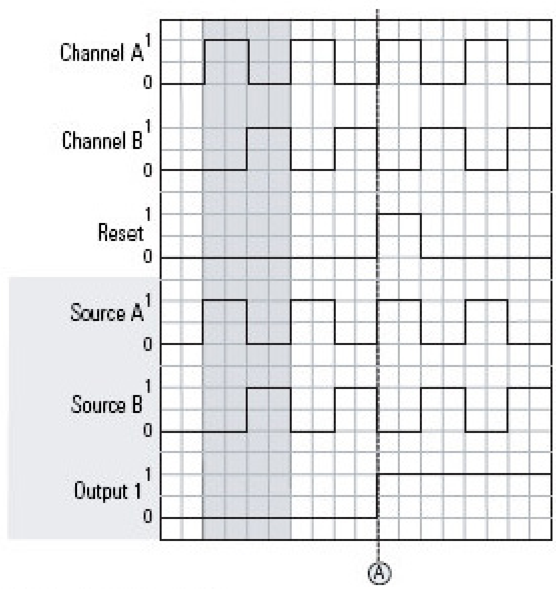
Circuit Verification Test

The Safety Mat instruction monitors the Channel A and Channel B Safety Mat Inputs. Before Output 1 can be energized, a verification of the safety mat circuit must be completed, verifying that the Source A and Source B output to Channel A and Channel B input connections are good. This process is referred to as the circuit verification test (CVT) and is identified by the shaded areas in the timing diagrams. Output 1 can be energized when the CVT test is successful and the proper Restart-Type conditions are met.

Normal Operation

Manual Restart Operation

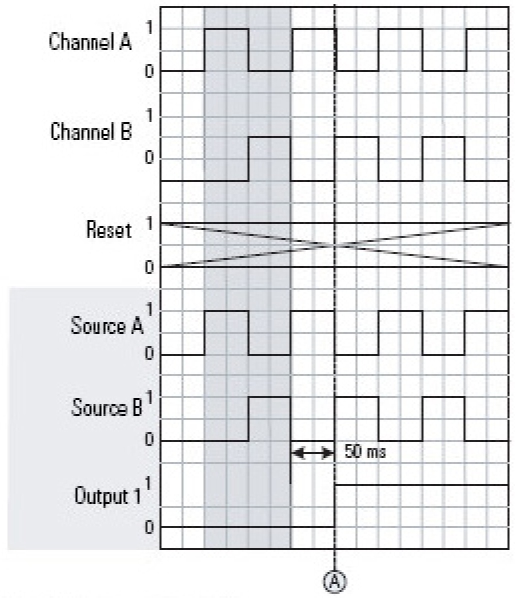
The timing diagram illustrates the instruction being configured for manual restart. At (A), Output 1 is energized when the reset input transitions from OFF (0) to ON (1) after the CVT.



The shaded area is the CVT.

Automatic Restart Operation

The timing diagram illustrates the instruction being configured for automatic restart. At (A), Output 1 is energized 50 ms after the CVT test.

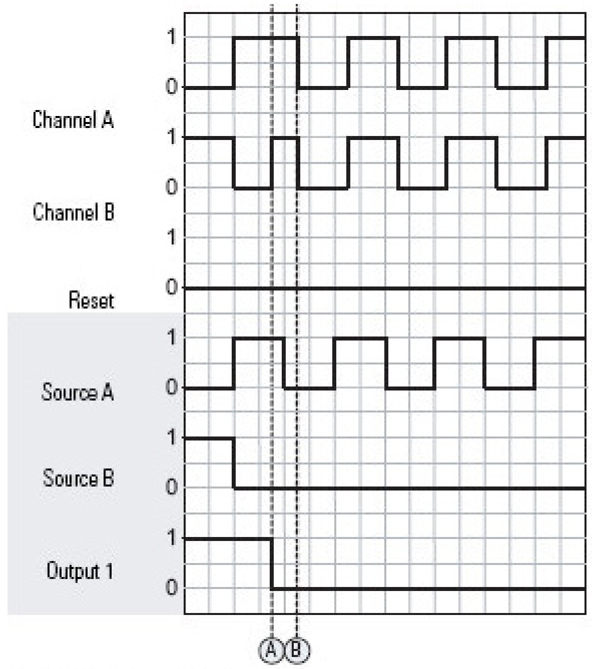


The shaded area is the CVT.

Safety Mat Occupied Operation

The timing diagram illustrates Output 1 being de-energized when the safety mat becomes occupied. At (A), the safety mat is considered occupied and Output 1 is de-energized when the Channel A and Channel B inputs are both

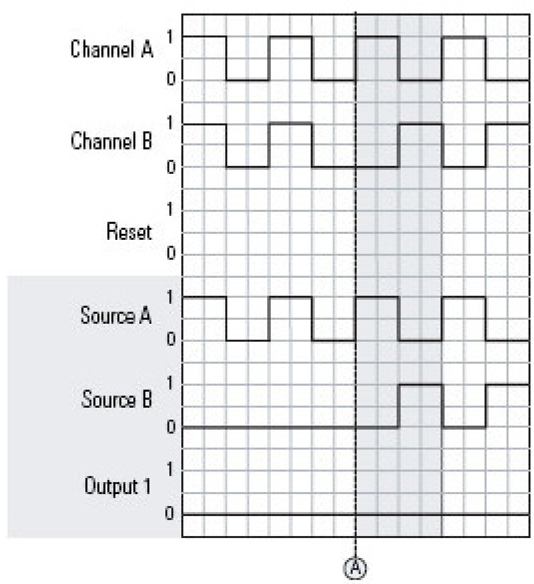
ON (1). At (B), the Channel A and Channel B inputs follow the Source A output for as long as the safety mat is occupied.



The shaded area is the CVT.

Safety Mat Unoccupied Operation

The timing diagram illustrates the safety mat being unoccupied and the Safety Mat instruction is initializing. At (A), the Channel A and Channel B inputs begin tracking the Source A and Source B outputs. Output 1 can then be energized based on the configured Restart Type and after the CVT.

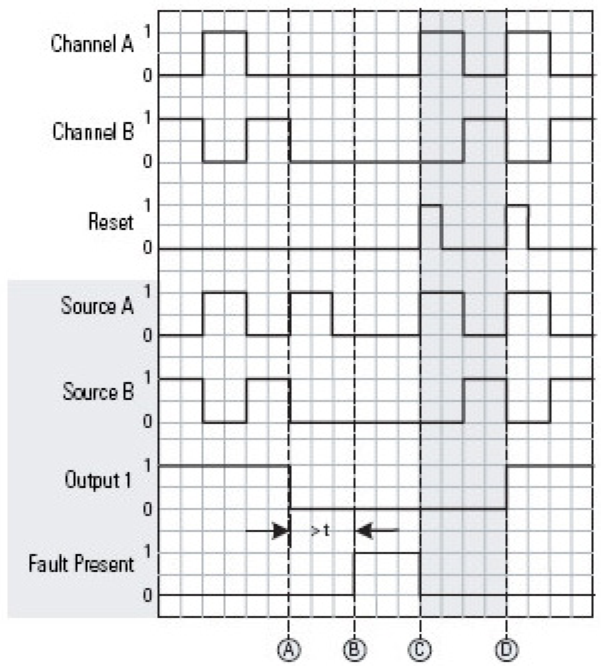


The shaded area is the CVT.

Fault Detection Operation

The instruction detects the source output to channel input open circuits and short circuits. A short circuit between Channel A and Channel B appears to the instruction as though the mat is occupied, where Output 1 is de-energized.

The timing diagram illustrates the safety mat being occupied and the connection between Source A and Channel A is open. The restart type is configured for Manual. At (A), the circuit is opened and the Channel A input stops following the Source A output. Output 1 is de-energized and the short-circuit detect delay timer is started. At (B), the timer expires and a fault is generated. At (C), the opened circuit is corrected and the fault is reset when an OFF (0) to ON (1) transition is detected on the Reset input. At (D), the Safety Mat instruction completes the CVT test, and an OFF (0) to ON (1) transition is detected on the Reset input, and Output 1 is energized.



t = Short Circuit Detect Delay Time

The shaded area is the CVT.

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	None.

Fault Code	Description	Corrective Action
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connections. • Reset the fault.
16#8000 32768	Channel A is shorted to power.	• Correct the short or open circuit. • Reset the fault.
16#8001 32769	Channel B is shorted to power.	
16#8002 32770	Channels A and B are shorted to power.	
16#8003 32771	Channel A is shorted to power and Channel B is either shorted to ground or open.	
16#8004 32772	Channel A is either shorted to ground or is open.	
16#8005 32773	Channel A is either shorted to ground or is open and Channel B is shorted to power.	
16#8006 32774	Channel B is either shorted to ground or open.	

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
00	No fault.	None
16#05 5	The Reset input is held ON (1)	Set the Reset input to OFF (0).
16#20 32	The Input Status input was OFF (0) when the instruction started.	Check the I/O module connections.

Affects Math Status Flags

No

Major / Minor Faults

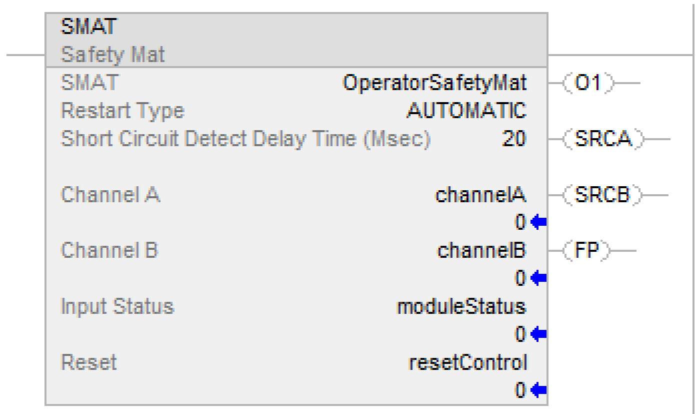
None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .SRCA, .SRCB and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.

Condition/State	Action Taken
Postscan	Same as Rung-condition-in is false.

Example



See also

Common Attributes on page 529

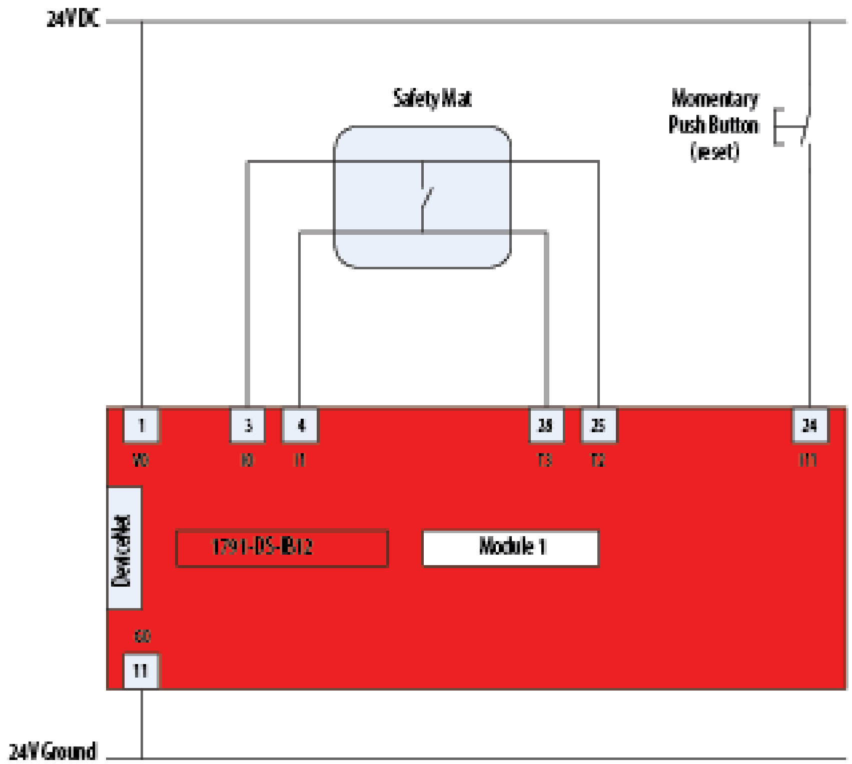
Index Through Arrays on page 540

Safety Mat (SMAT) wiring and programming example on page 132

Safety Mat (SMAT) wiring and programming example

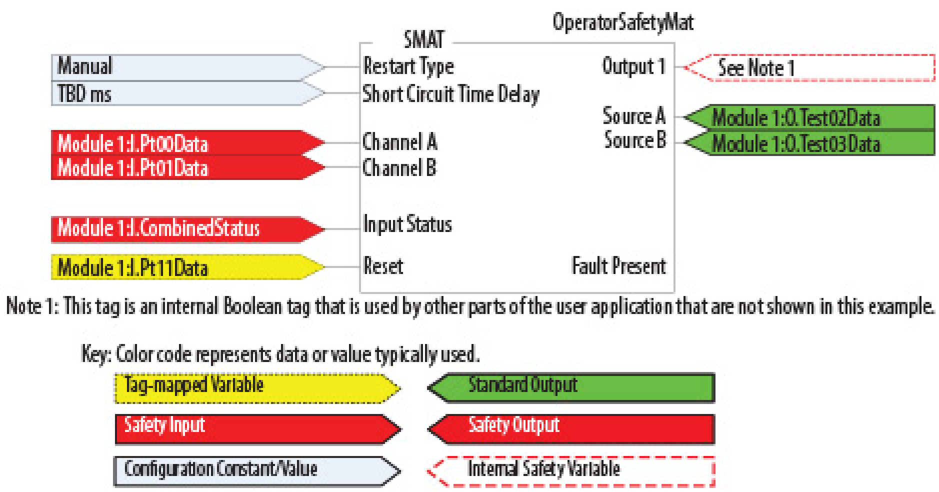
The standard control portion of the application is not shown.

Wiring Diagram

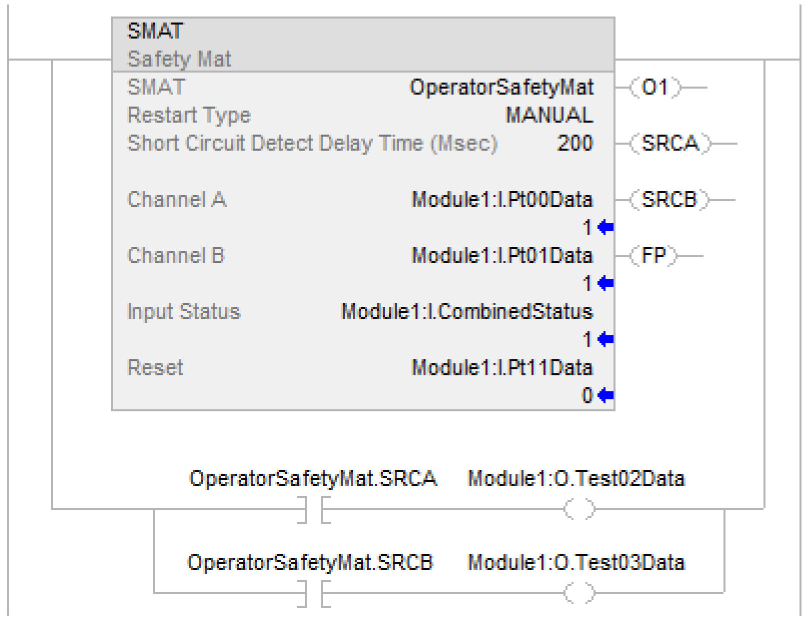


Programming Example

The following programming diagram shows the instruction with inputs and outputs.

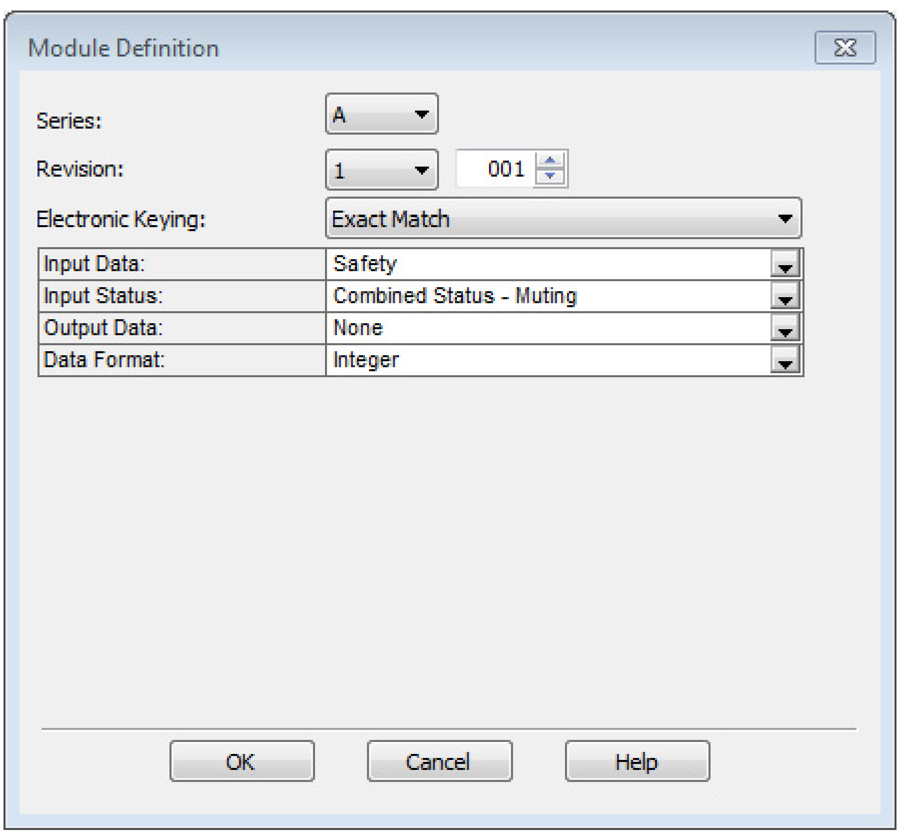


Ladder Diagram



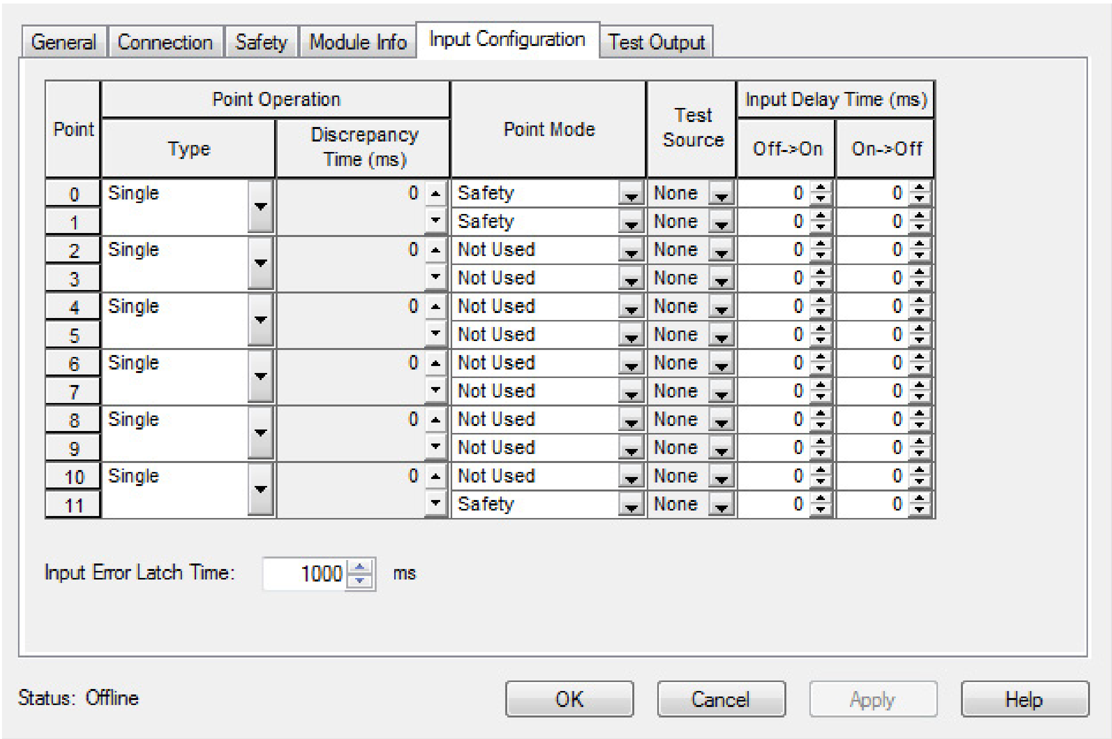
The programming software is used to configure the input and output parameters of the Guard I/O module, as illustrated.

Module Definition

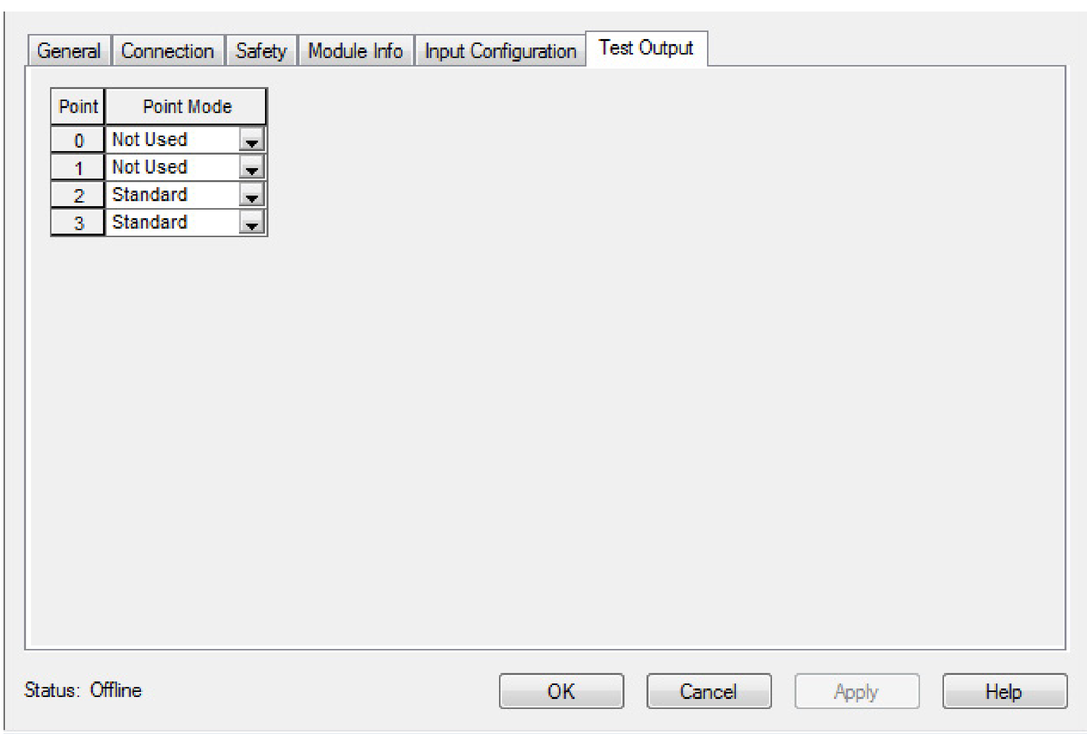


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. You can also select **Compatible Match**.

Module Input Configuration



Module Output Configuration



See also

Safety Mat (SMAT) on page 123

Two Hand Run Station Enhanced (THRSe)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

Use this instruction to monitor the inputs of a Two-hand Run Station. Each run station button has two inputs; one normally-closed (N.C.) contact and one normally-open (N.O.) contact. To energize Output 1, the instruction must be enabled and connected with no faults present. Then both buttons must be pressed within 500 ms of one another.

IMPORTANT The right and left buttons of the Two-hand Run Station must be pressed within 500 ms of one another to energize Output 1. To make sure this situation can be properly detected, the safety task period cannot exceed 40 ms and the input device's requested packet interval (RPI) cannot exceed 20 ms.

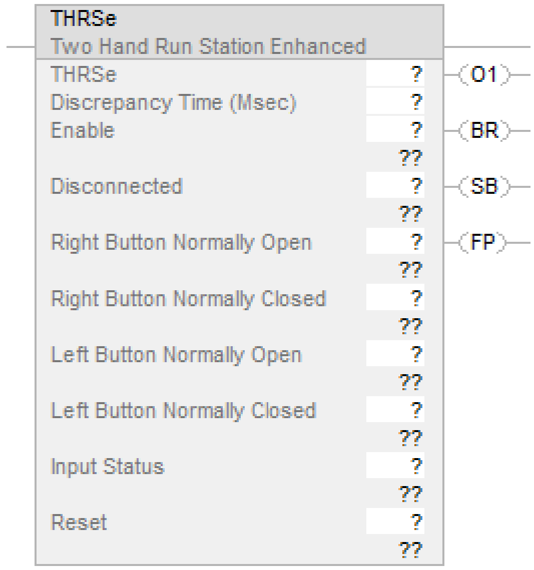
Refer to the GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093, GuardLogix Controllers User Manual, publication 1756-UM020, GuardLogix Controller Systems Reference Manual, publication, RM099 for more information on the safety task period and the RPI.

The Buttons Released (BR) output turns ON (1) whenever the Two-hand Run Station is connected and enabled, no faults are present, and both the right and left buttons are in the released (safe) state. In this case, all four contacts are in the safe state.

The Two-hand Run Station may be disconnected when not in use. To properly disconnect the Two-hand Run Station, the Disconnected input must be ON (1) and all button inputs must be OFF (0). When the Two-hand Run Station is disconnected, the (SB) Station Bypassed output turns ON (1).

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT	Do not use the same tag for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

IMPORTANT	Make sure that your safety input points are configured as Single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameter used to configure the instruction. This parameter cannot be changed at runtime.

Operand	Data Type	Description
THRSe	THRS_ENHANCED	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.
Discrepancy Time	DINT	The amount of time that the instruction lets the normally-open and normally-closed button contacts be inconsistent before generating a fault. The inconsistent state occurs when the normally-open contact and the normally-closed contact have the same logical value; that is, both are ON (1) or both are OFF (0). The valid range is 100 to 3000 ms.

The following table provides the input parameters for the instruction.

Operand	Data Type	Description
Enable	BOOL	ON (1): The device is enabled. Output 1 is energized when both buttons are pressed within 500 ms of one another. OFF (0): The device is disabled. Output 1 stays de-energized.
Disconnected	BOOL	This input indicates whether the run station is disconnected. When this input is ON (1) and all of the button inputs (Right Button Normally Open, Right Button Normally Closed, Left Button Normally Open, Left Button Normally Closed) are OFF (0), the Station Bypassed output turns ON (1). ON (1): The run station is disconnected. Output 1 cannot be energized. OFF (0): The run station is not disconnected. Output 1 may be energized.
Right Button Normally Open[1]	BOOL	This is the normally-open contact for the right button.
Right Button Normally Closed[1]	BOOL	This is the normally-closed contact for the right button.
Left Button Normally Open[1]	BOOL	This is the normally-open contact for the left button.
Left Button Normally Closed[1]	BOOL	This is the normally-closed contact for the left button.
Input Status	BOOL	If the instruction inputs are from a safety I/O module, this value is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset.

[1] If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

[2] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. to comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename Reset_Signal tag in this example to your reset signal tag name. Then use the OSF instruction Output Bit tag as the reset source of the instruction.

The following table provides the output parameters for the instruction.

Operand	Data Type	Description
Output 1 (01)	BOOL	This output is energized when the run station is enabled and connected, and both buttons are pressed within 500 ms of one another. Output 1 is de-energized when one or more of the following occurs: • The right or the left button is released, or any one of the four contacts transitions to the safe state. • The Input Status input turns OFF (0), which indicates the inputs have become invalid. • The Enable input turns OFF (0). • The Disconnected input turns ON (1).
Buttons Released (BR)	BOOL	This output is ON (1) when both buttons are released, the run station is connected and enabled, and no faults are present.
Station Bypassed (SB)	BOOL	This output is ON (1) when the run station has been properly disconnected and no faults are present. See the *Disconnecting the Two-hand Run Station* section.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the *Fault Codes* section below for the list of fault codes. This parameter is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the *Diagnostic Codes* section below for a list of diagnostic codes. This parameter is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Disconnecting the Two-hand Run Station

To energize the Station Bypassed output (disconnect the Two-hand Run Station), the Disconnected input must be ON (1), and all the button inputs must be OFF (0).

If a fault occurs while disconnecting the Two-hand Run Station, trigger a reset after the inputs are in the correct state.

Connecting the Two-hand Run Station

To de-energize the Station Bypassed output (connect the Two-hand Run Station), the Disconnected input must be OFF (0), and the button inputs must be in the release safe state.

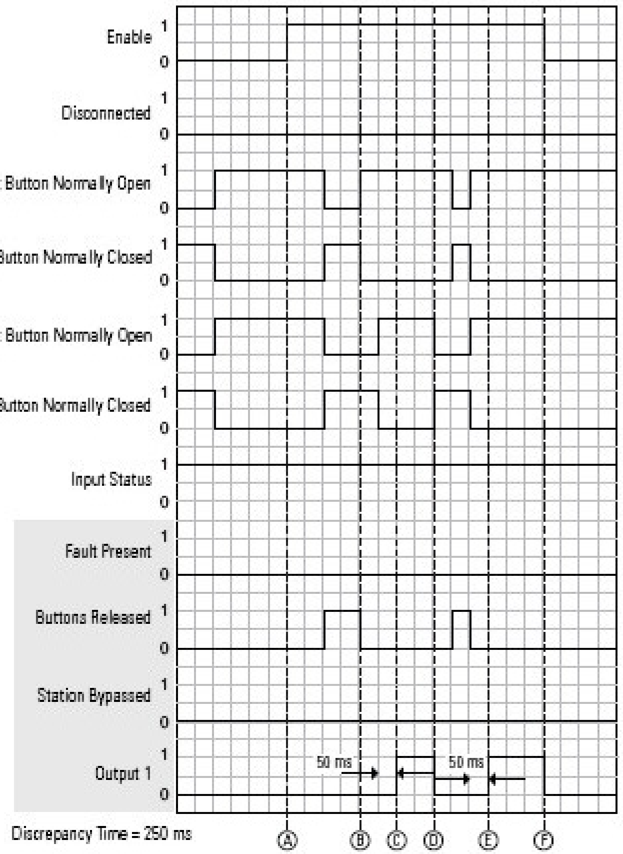
If a fault occurs while connecting the Two-hand Run Station, trigger a reset after the inputs are in the correct state.

Operation

Normal Operation

As shown in the timing diagram, the Buttons Released output turns ON (1) whenever both buttons are released, the run station is connected and enabled, and no faults are present.

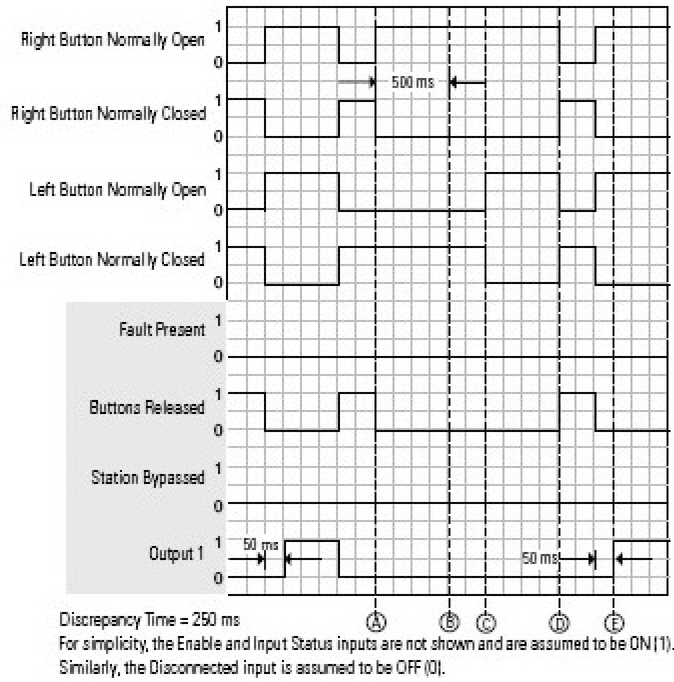
Before (A), the left and right buttons are both pressed, but Output 1 has not yet been energized because the Enable input is OFF (0). When the Enable input transitions from OFF (0) to ON (1) at (A), Output 1 is not energized because the buttons must be pressed while the Enable input is ON (1). At (B), the right button is pressed but the left button is still released, which turns OFF (0) the Buttons Released output. At (C), both buttons have been pressed within 500 ms of one another, which energizes Output 1 after a 50 ms delay. Output 1 is de-energized when the left button is released at (D). Output 1 is energized 50 ms after both buttons are pressed at (E). Lastly, at (F),Output 1 is de-energized because the Enable input turns OFF (0).



Button Held Down Diagnostic Operation

Output 1 cannot be energized when the right and left buttons are not pressed within 500 ms of one another.

At (A), the right button is pressed while the left button remains released. At (B), the buttons have been in an inconsistent state for 500 ms, which generates a diagnostic signal that requires both buttons be released before Output 1 can be energized again. At (C), the left button is pressed, but Output 1 is not energized because both buttons have not been released after the right button was held down longer than 500 ms. Both buttons are released, which clears the diagnostic signal at (D). Output 1 is energized after a 50 ms delay when both buttons are pressed within 500 ms of one another at (E).

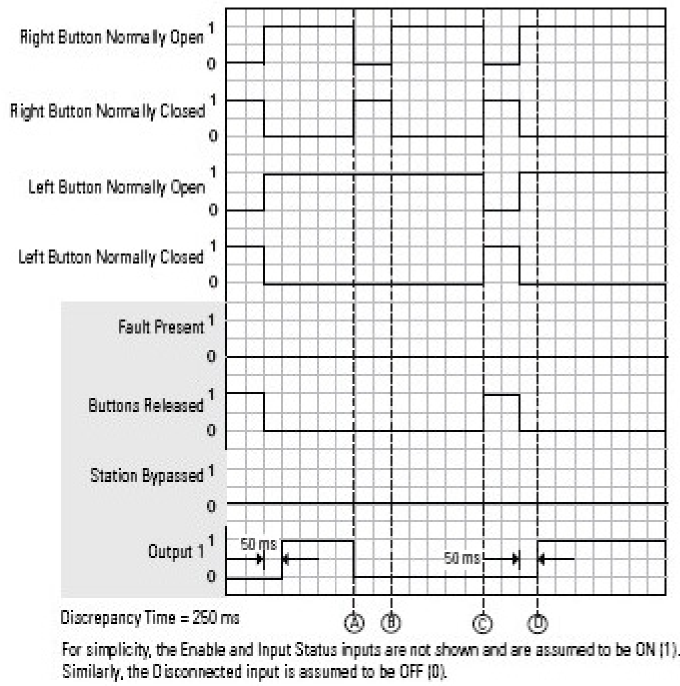


Button Glitch Diagnostic Operation

When one button is released while the other button remains pressed, both buttons must be released to the safe state before Output 1 can be energized again.

At (A), Output 1 is de-energized because the right button is released.

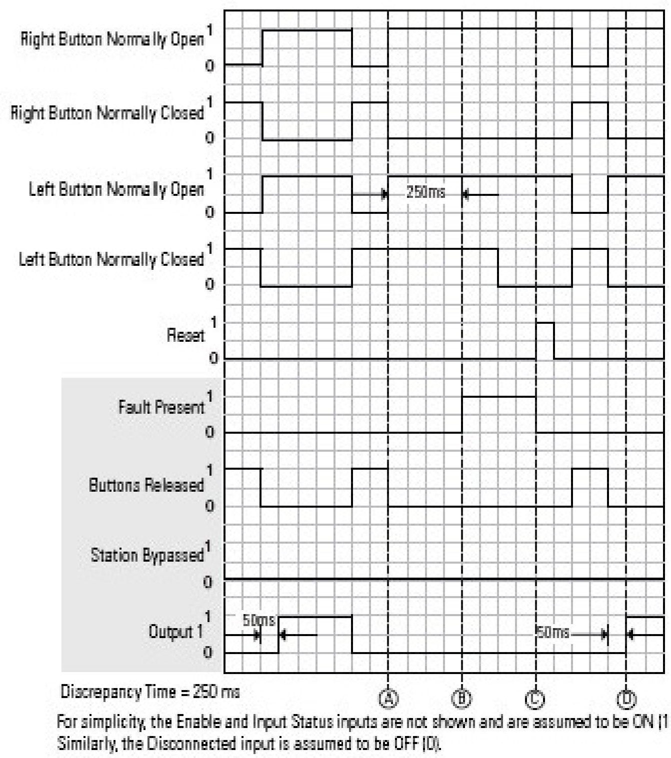
At (B), the right button is pressed, but the left button remained released since (A), generating a diagnostic signal that requires both buttons to be released before Output 1 can be energized again. Both buttons are released at (C), which clears the diagnostic signal. At (D), Output 1 is energized after a 50 ms delay when both buttons are pressed within 500 ms of one another.



Button Discrepancy Fault (Channel-to-channel) Operation

A discrepancy fault occurs when the two channels of one button are in an inconsistent state for more than the configured Discrepancy Time (250 ms in this example).

At (A), the right button is pressed, but only the normally-open contact of the left button turns ON (1) while the normally-closed contact remains OFF (0). After the Left Button Normally Open and the Left Button Normally Closed inputs have been inconsistent for 250 ms, the fault occurs at (B). At (C), the fault is cleared by a Reset. Lastly, at (D), Output 1 is energized 50 ms after both buttons are pressed.

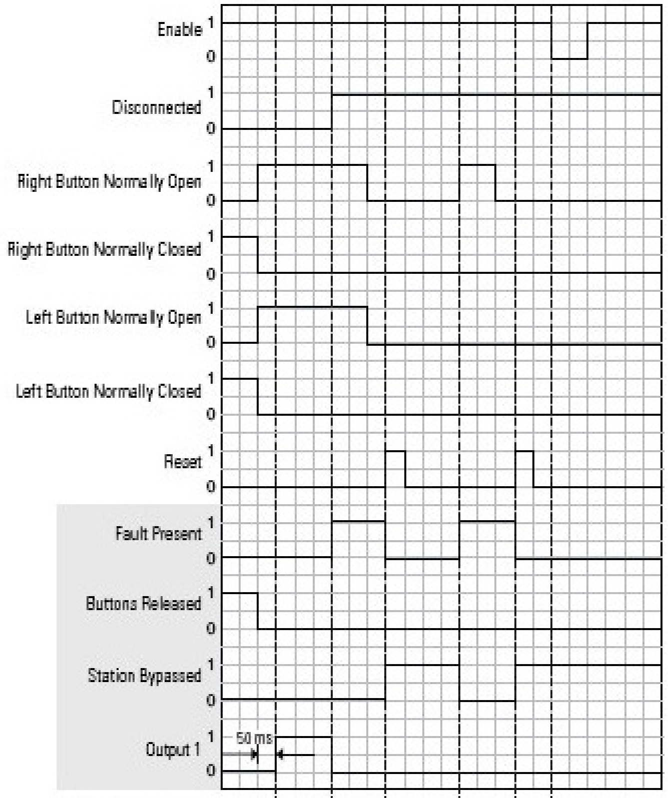


Run Station Disconnected (Station Bypassed) Operation

When the run station is properly disconnected, Output 1 cannot be energized. The Station Bypassed output is energized whenever the run station is properly disconnected.

At (A), Output 1 is energized 50 ms after both buttons are pressed. At (B), Output 1 is de-energized and a fault occurs when the Disconnected input turns ON (1). To clear the fault, both buttons must be released and a reset triggered at (C). The Station Bypassed output turns ON (1). At (D), the Station Bypassed output turns OFF (0) and a fault occurs when the Right Button Normally Open input turns ON (1) while the Disconnected input is ON (1). At (E), the fault is cleared and the Station Bypassed output is turned ON (1) when a reset is triggered with the Disconnected input ON (1) and all button inputs OFF (0). Lastly, at (F), the Enable input transitions from ON (1) to OFF (0) to

ON (1), but has no effect on the Station Bypassed output, which remains ON (1).



Discrepancy Time = 250 ms

For simplicity, the Input Status input is not shown and is assumed to be ON (1), which indicates the inputs are valid.

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	None
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#7001 28673	The right button contacts were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, the Right Button Normally Open was ON (1) and the Right Button Normally Closed was OFF (0).	• Check the wiring. • Bring the right button contacts to a consistent state. • Reset the fault.
16#7002 28674	The right button contacts were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, the Right Button Normally Closed was ON (1) and the Right Button Normally Open was OFF (0).	

Fault Code	Description	Corrective Action
16#7003 28675	The left button contacts were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, the Left Button Normally Open was ON (1) and the Left Button Normally Closed was OFF (0).	• Check the wiring. • Bring the left button contacts to a consistent state. • Reset the fault.
16#7004 28676	The left button contacts were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault, the Left Button Normally Closed was ON (1) and the Left Button Normally Open was OFF (0).	
16#7005 28677	The Right Button Normally Open input transitioned from ON (1) to OFF (0) to ON (1) while the Right Button Normally Closed input remained ON (1).	• Check the wiring. • Released the right button, bringing both contacts to the OFF (0) state. • Reset the fault.
16#7006 28678	The Right Button Normally Closed input transitioned from ON (1) to OFF (0) to ON (1) while the Right Button Normally Open input remained ON (1).	
16#7007 28679	The Left Button Normally Open input transitioned from ON (1) to OFF (0) to ON (1) while the Left Button Normally Closed input remained ON (1).	• Check the wiring. • Released the left button, bringing both contacts to the OFF (0) state. • Reset the fault.
16#7008 28680	The Left Button Normally Closed input transitioned from ON (1) to OFF (0) to ON (1) while the Left Button Normally Open input remained ON (1).	
16#7030 28720	The Disconnected input was ON (1), but all of the button inputs were not OFF (0).	• To disconnect the Two-hand Run Station, set all button inputs to OFF (0) and reset the fault. • To connect the run station, set the Disconnected input to OFF (0) and reset the fault.
16#7031 28721	The button inputs were disconnected for longer than the Discrepancy time, but the Disconnected input was OFF (0).	• To disconnect the Two-hand Run Station, set the Disconnected input to ON (1) and reset the fault. • To connect the Two-hand Run Station, set all button inputs to their normal state and reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
00	No fault.	None
16#20 32	The Input Status was OFF (0) when the instruction started.	Check the I/O module connection
16#7001 28673	The device is not in the safe state for start-up.	Release both buttons to OFF (0).
16#7002 28674	The right button is held down. The left and right buttons have been in an inconsistent state for longer than 500 ms.	Release both buttons to OFF (0).

Diagnostic Code	Description	Corrective Action
16#7003 28675	The left button is held down. The left and right buttons have been in an inconsistent state for longer than 500 ms.	Release both buttons to OFF (0).
16#7004 28676	The right button was released and then pressed while the left button remained pressed.	Release both buttons to OFF (0).
16#7005 28677	The left button was released and then pressed while the right button remained pressed.	Release both buttons to OFF (0).
16#7060 28768	The run station is not enabled.	Enable or disconnect the run station.
16#7061 28769	The run station is bypassed.	No action required.

Affects Math Status Flags

No

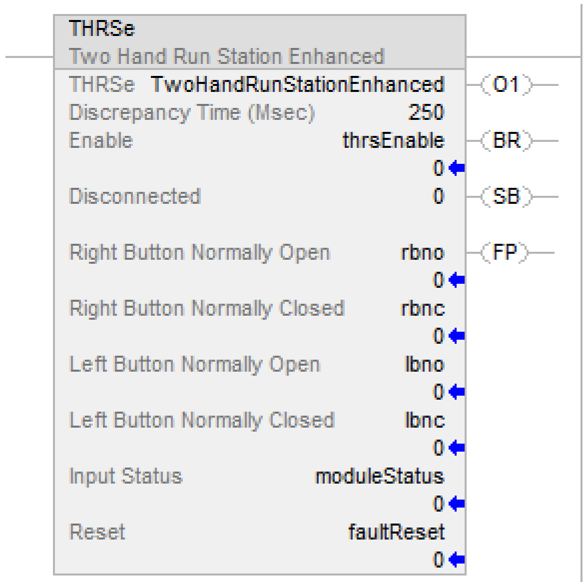
Major / Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Enable-in is false	The .O1, .BR, .SB and .FP are cleared to false.
Enable-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung-condition-in is false.

Examples



See also

Index Through Arrays on page 540

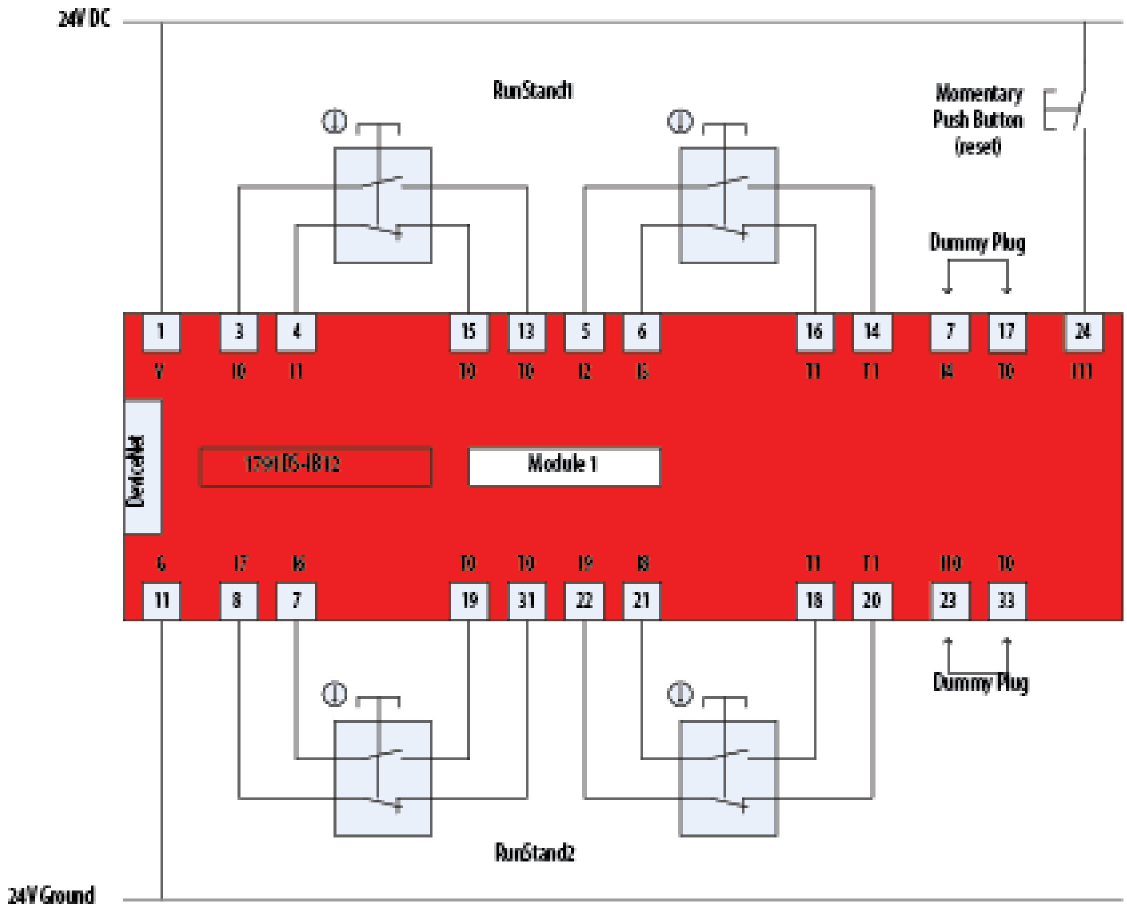
Two Hand Run Station Enhanced (THRSe) wiring and programming example on page 148

Status and Safety input and output for safety instructions on page 21

Two Hand Run Station Enhanced (THRSe) wiring and programming example

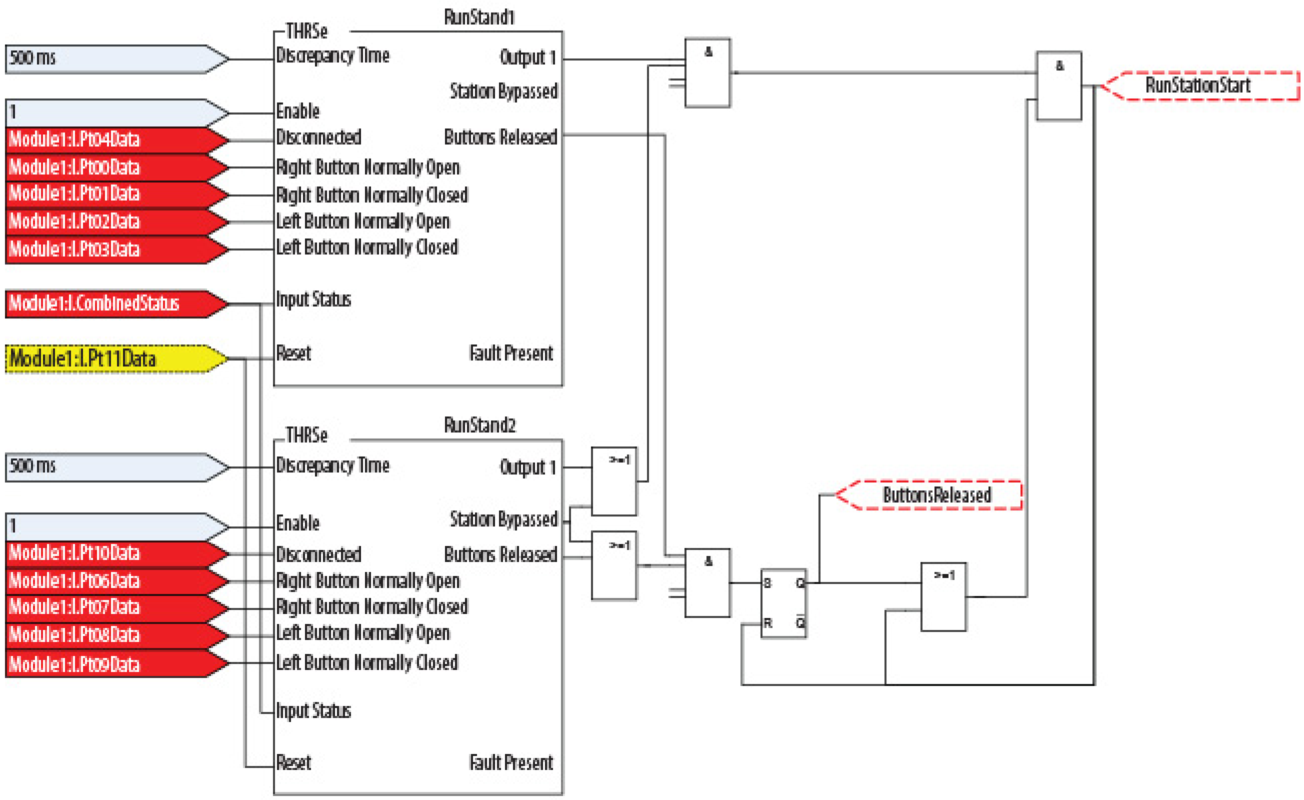
This example complies with ISO 13849-1 Category 4 operation. The standard control portion of the application is not shown. There are (2) two-hand run stations are shown connected to a 1791DS-IB12 module.

Wiring Diagram

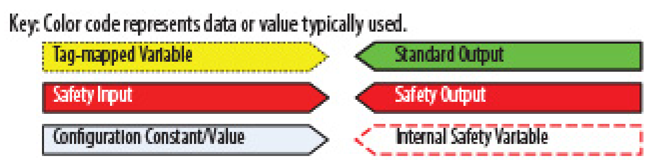


This programming diagram logically illustrates the use of two THRSe instructions. If one of the Two-hand Run Station's buttons is released, the output is de-energized and the other Two-hand Run Station's buttons must also be released before the output can be energized again.

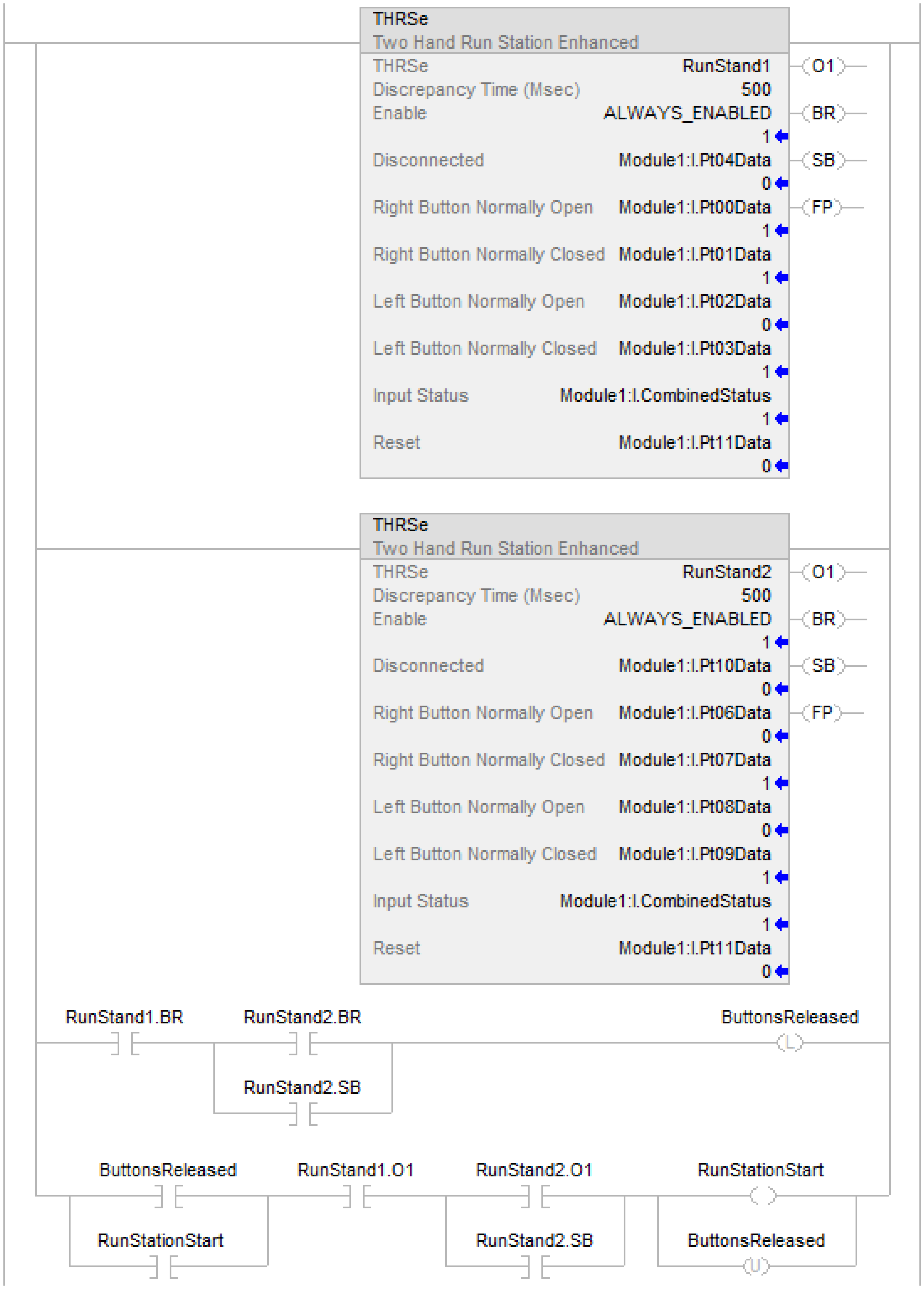
Programming Diagram



NOTE 1: This tag is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.

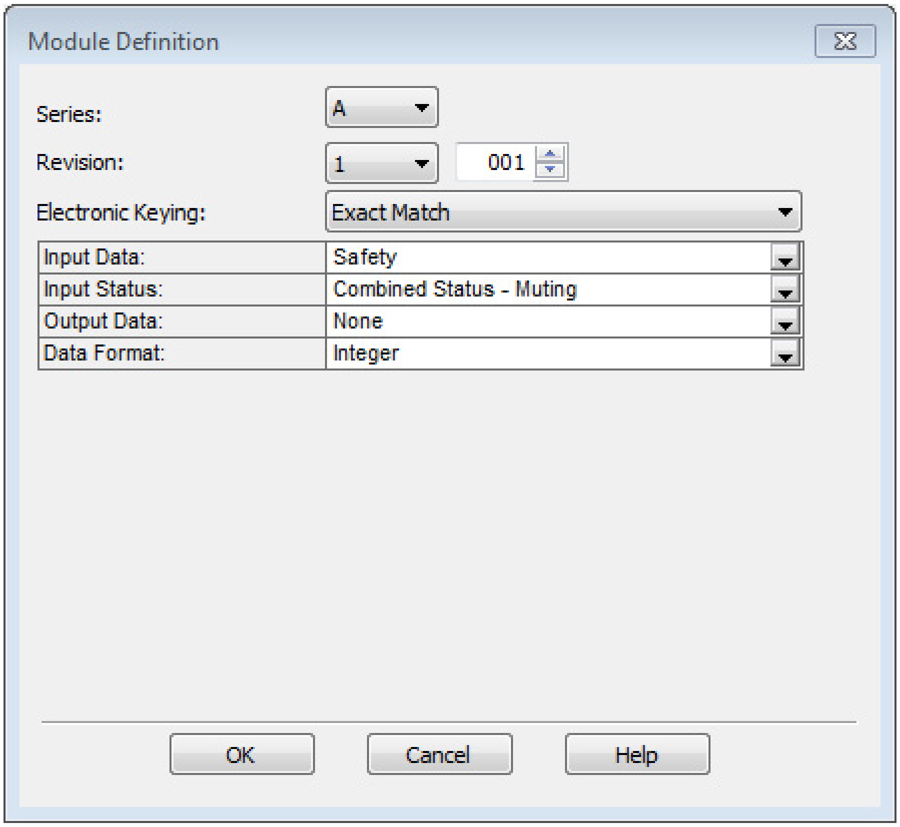


Ladder Diagram



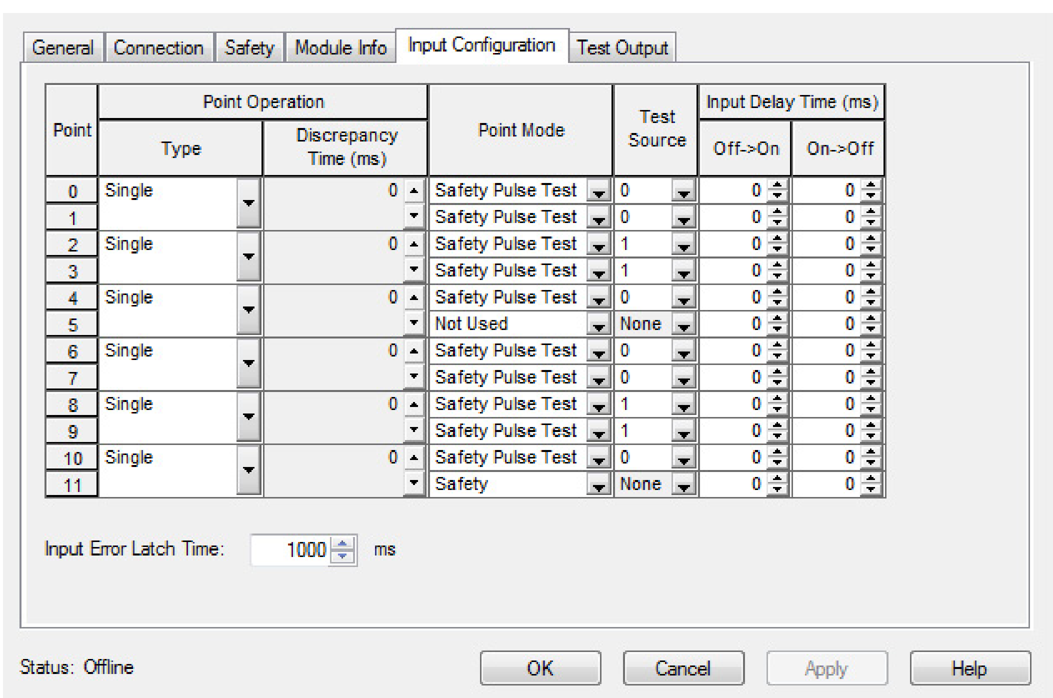
The programming software is used to configure the input and test output parameters of the Guard I/O module, as illustrated.

Module Definition

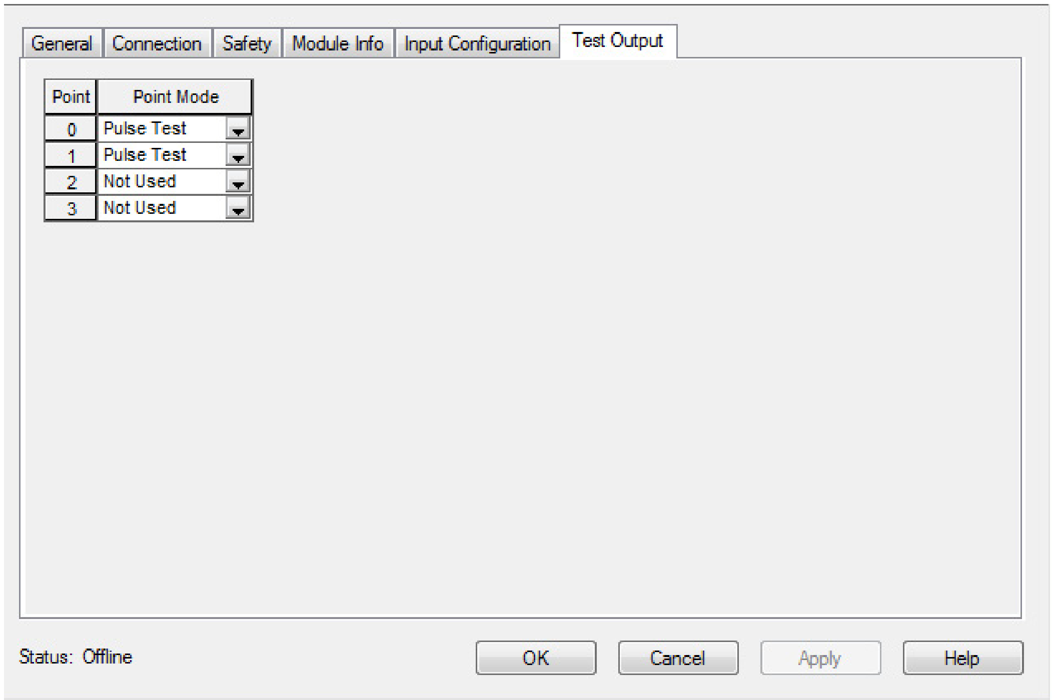


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. You can also select **Compatible Match**.

Module Input Configuration



Module Test Output Configuration



See also

Two-Hand Run Station - Enhanced (THRSe) on page 136

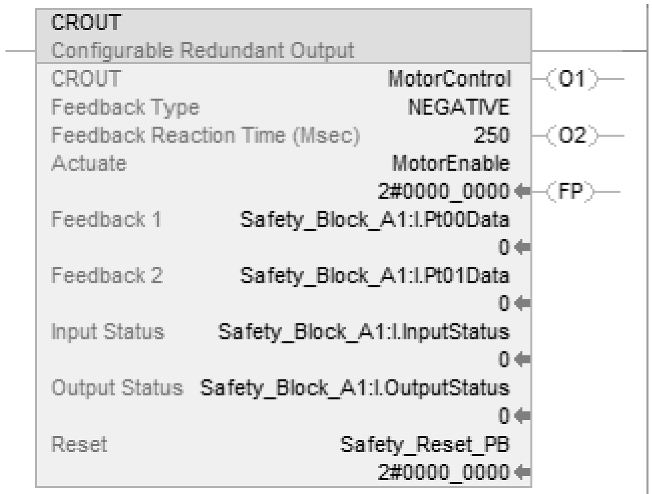
Configurable Redundant Output (CROUT)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Configurable Redundant Output instruction controls and monitors redundant outputs. The reaction time for output feedback is configurable. The instruction supports positive and negative feedback signals.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
CROUT	CONFIGURABLE_ROUT	tag	CROUT structure

Operand	Data Type	Format	Description
Feedback Type	BOOL	name	This operand defines the feedback ON and OFF states. **Positive:** ON (1): Feedbacks ON / Outputs ON OFF (0): Feedbacks OFF / Outputs OFF **Negative:** ON (1): Feedbacks OFF / Outputs ON OFF (0): Feedbacks ON / Outputs OFF
Feedback Reaction Time	DINT	immediate	This operand specifies the amount of time that the instruction waits for Feedback 1 and Feedback 2 to reflect the state of Output 1 and Output 2 as specified by the configured Feedback Type. The valid range is 5 to 1000 ms.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Actuate	BOOL	tag	This input energizes or de-energizes Output 1 and Output 2. ON (1): Output 1 and Output 2 are energized if no faults exist. OFF (0): Output 1 and Output 2 are de-energized.
Feedback 1	BOOL	tag	This input is constantly monitored to make sure that it reflects the state of Output 1. When Output 1 transitions, this input must detect the transition within the Feedback Reaction Time.
Feedback 2	BOOL	tag	This input is constantly monitored to make sure that it reflects the state of Output 2. When Output 2 transitions, this input must detect the transition within the Feedback Reaction Time.
Input Status	BOOL	tag immediate	If instruction inputs are from a safety I/O module, this is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Output Status	BOOL	tag immediate	This input indicates the output status of the I/O module or modules used by this instruction. ON (1): The I/O connection and the I/O module are operational. OFF (0): The module has a fault or the connection to the module has been lost.
Reset[1]	BOOL	tag	This input clears the instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The FP and Fault Code outputs are reset.

[1] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the 'Reset_Signal' tag in the example shown

below to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

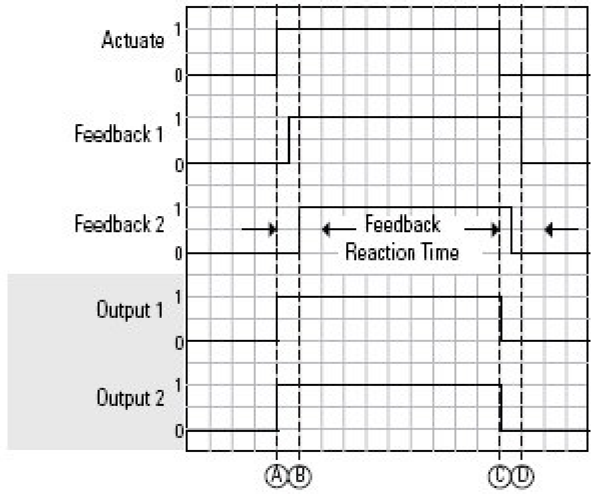
The following table explains the instruction outputs.

Operand	Data Type	Description
Output 1 (01)	BOOL	This output is used to control one channel of a two channel output device. Output 1 is de-energized when 1 or more of the following occurs: • A feedback fault occurs. • Input Status or Output Status inputs become invalid (OFF = 0). • The Actuate input turns OFF (0).
Output 2 (02)	BOOL	This output is used to control one channel of a two channel output device. Output 2 is de-energized when 1 or more of the following occurs: • A feedback fault occurs. • Input Status or Output Status inputs become invalid (OFF = 0). • The Actuate input turns OFF (0).
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section below for the list of fault codes. This parameter is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section below for a list of diagnostic codes. This parameter is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Normal Operation

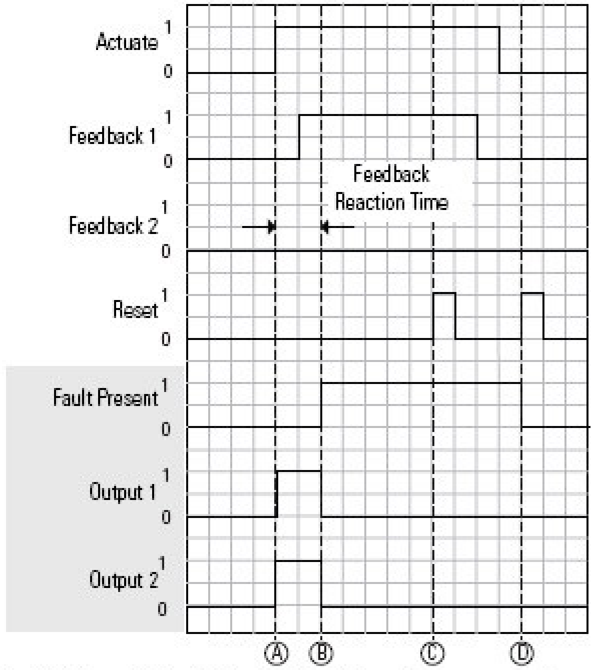
This timing diagram shows normal operation of this instruction to control dual channel outputs when the Feedback Type is Positive. Outputs 1 and 2 are energized at (A) when the Actuate input turns ON (1). Both feedback inputs react before the Feedback Reaction timer has expired, so Output 1 and Output 2 remain energized in steady state at (B). Outputs 1 and 2 are de-energized at (C) when the Actuate input turns OFF (0). At (D), both feedback inputs react before the Feedback Reaction timer has expired, so Output 1 and Output 2 remain de-energized in steady state.



Input Status and Output Status inputs (not shown) are assumed to be valid (ON = 1).

Feedback Fault

A feedback fault can occur when either Feedback 1 or Feedback 2 fails to correctly reflect the state of Output 1 and Output 2. The Feedback Type is configured as Positive in this diagram example. Output 1 and Output 2 are energized at (A), but at (B), Feedback 2 has not turned ON (1) before the Feedback Reaction timer expires, generating a feedback fault. The fault cannot be cleared at (C), because Feedback 1 and Feedback 2 do not yet reflect the state of Output 1 and Output 2. The fault is cleared at (D) when the Reset input turns ON (1) and both Feedback 1 and Feedback 2 are OFF (0), correctly reflecting the state of Output and Output 2.



Input Status and Output Status inputs (not shown) are assumed to be valid (ON = 1).

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

Fault Code	Description	Corrective Action
0	No fault	None
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#5000 20480	Feedback 1 and Feedback 2 turned OFF (0) unexpectedly.	• Check the feedback signals. • Reset the fault.
16#5001 20481	Feedback 1 turned OFF (0) unexpectedly.	• Check the feedback 1 signal. • Reset the fault.
16#5002 20482	Feedback 2 turned OFF (0) unexpectedly.	• Check the feedback 2 signal. • Reset the fault.
16#5003 20483	Feedback 1 and Feedback 2 turned ON (1) unexpectedly.	• Check the feedback signal. • Reset the fault.

Fault Code	Description	Corrective Action
16#5004 20484	Feedback 1 turned ON (1) unexpectedly.	• Check the feedback 1 signal. • Reset the fault.
16#5005 20485	Feedback 2 turned ON (1) unexpectedly.	• Check the feedback 2 signal. • Reset the fault.
16#5006 20486	Feedback 1 and Feedback 2 did not turn ON (1) within the Feedback Reaction Time.	• Check the feedback signal or adjust the Feedback Reaction Time. • Reset the fault.
16#5007 20487	Feedback 1 did not turn ON (1) within the Feedback Reaction Time.	• Check the feedback 1 signal or adjust the Feedback Reaction Time. • Reset the fault.
16#5008 20488	Feedback 2 did not turn ON (1) within the Feedback Reaction Time.	• Check the feedback 2 signal or adjust the Feedback Reaction Time. • Reset the fault.
16#5009 20489	Feedback 1 and Feedback 2 did not turn OFF (0) within the Feedback Reaction Time.	• Check the feedback signal or adjust the Feedback Reaction Time. • Reset the fault.
16#500A 20490	Feedback 1 did not turn OFF (0) within the Feedback Reaction Time.	• Check the feedback 1 signal or adjust the Feedback Reaction Time. • Reset the fault.
16#500B 20491	Feedback 2 did not turn OFF (0) within the Feedback Reaction Time.	• Check the feedback 2 signal or adjust the Feedback Reaction Time. • Reset the fault.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No fault	None
16#20 32	The Input Status was OFF (0) when the instruction started.	Check the I/O module connection.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	Check the I/O module connection.
16#5000 20480	The Actuate input is held ON (1).	Set the Actuate input to OFF (0).

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01 and .02 outputs are cleared to false. The Diagnostic Code and Fault Code outputs are set to 0
Rung-condition-in is true	The instruction executes.
Postscan	Same as Rung-condition-in is false.

See also

Configurable Redundant Output (CROUT) wiring and programming example on page 160

Index Through Arrays on page 540

Safety Instructions on page 15

Status and Safety input and output for safety instructions on page 21

Configurable Redundant Output (CROUT) wiring and programming example

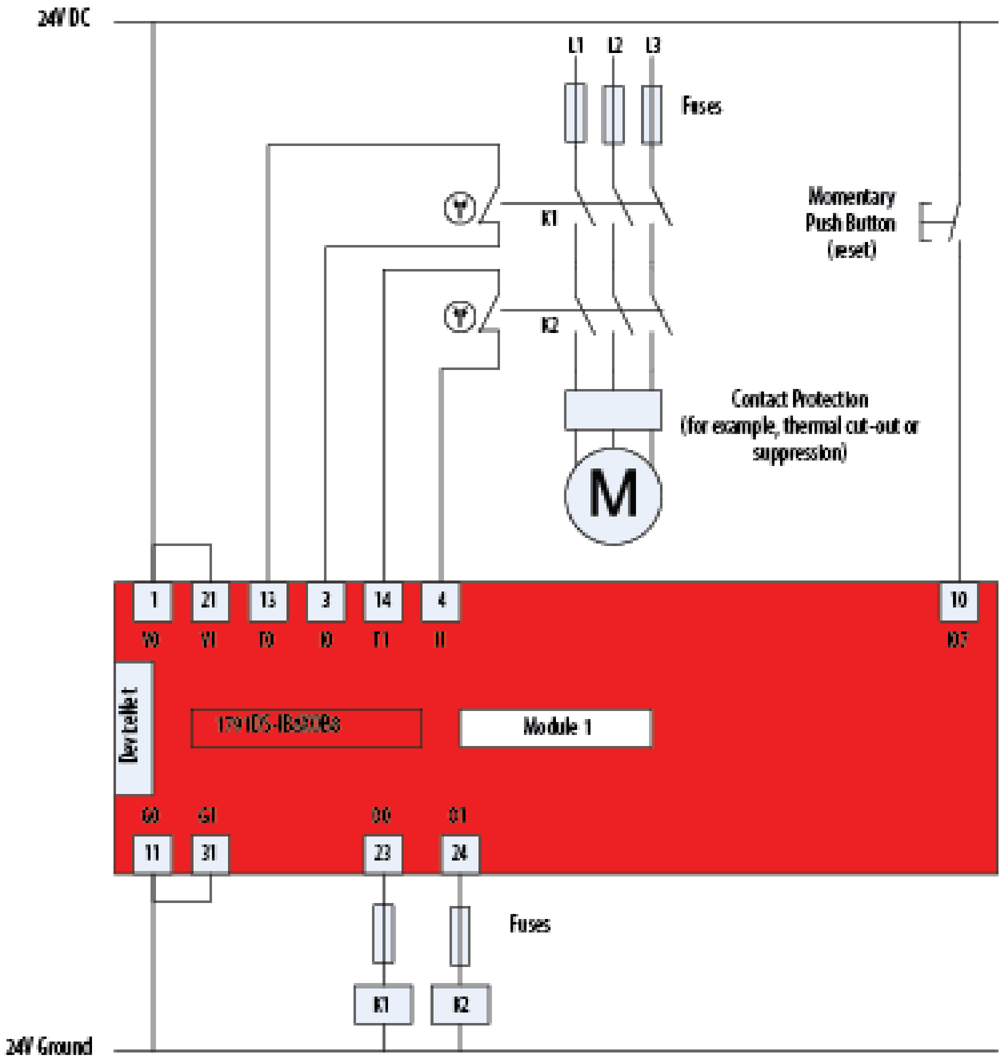
This section demonstrates how to wire the Guard I/O module and program the instruction in the safety control portion of an application.

This application example complies with ISO 13849-1, Category 4 operation.

Tip: The standard control portion of the application is not shown in the following diagram.

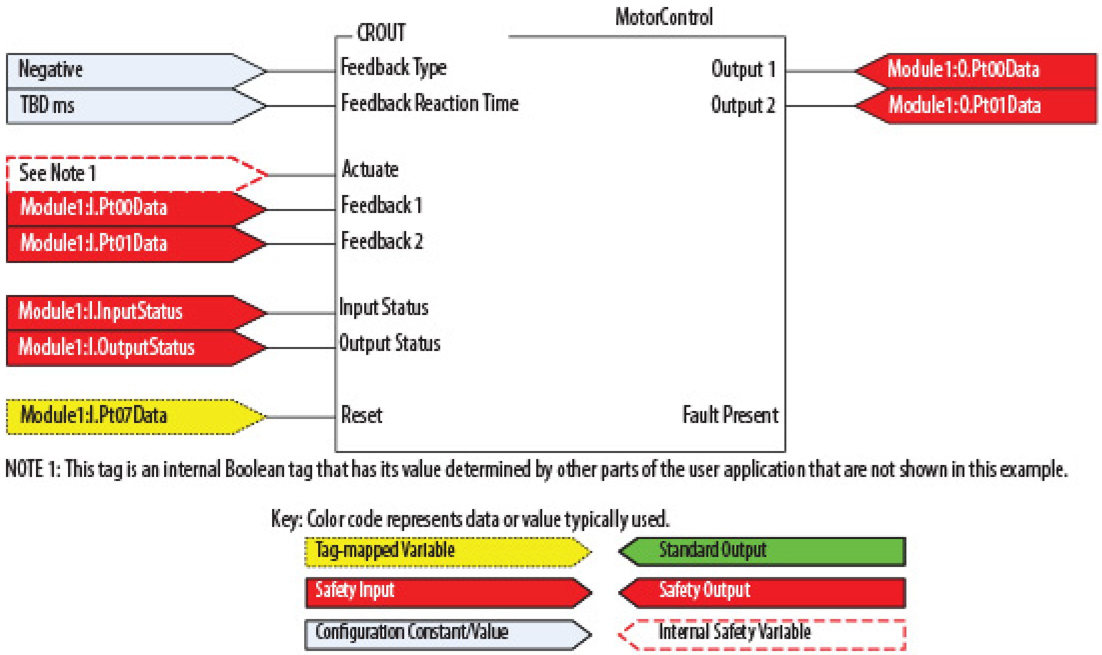
Wiring Diagram

This wiring diagram shows how to use the Configurable Redundant Output instruction with a 1791DS-IB8XOB8 module for motor control. The application includes a momentary push button for reset.

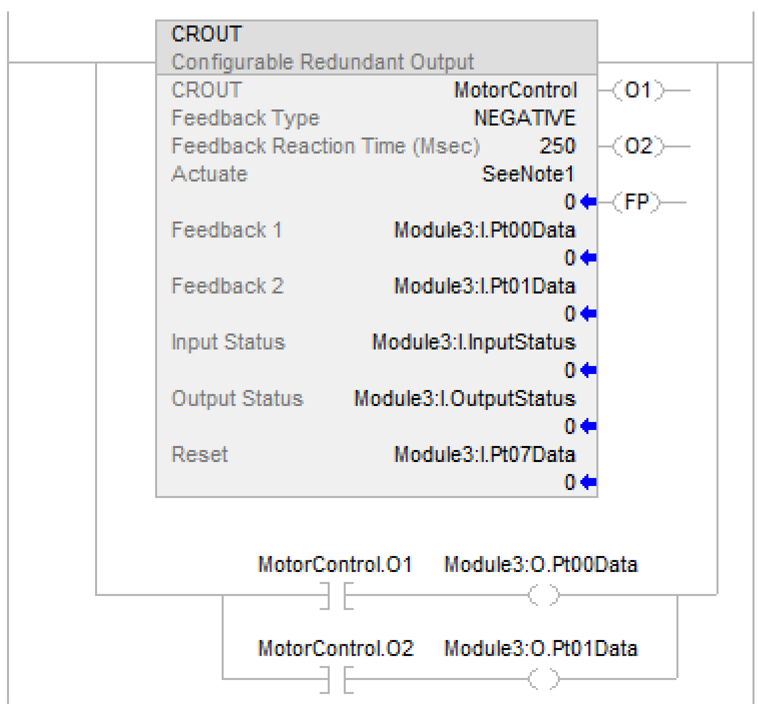


Programming Diagram

The programming diagram logically illustrates the instruction with inputs and outputs.



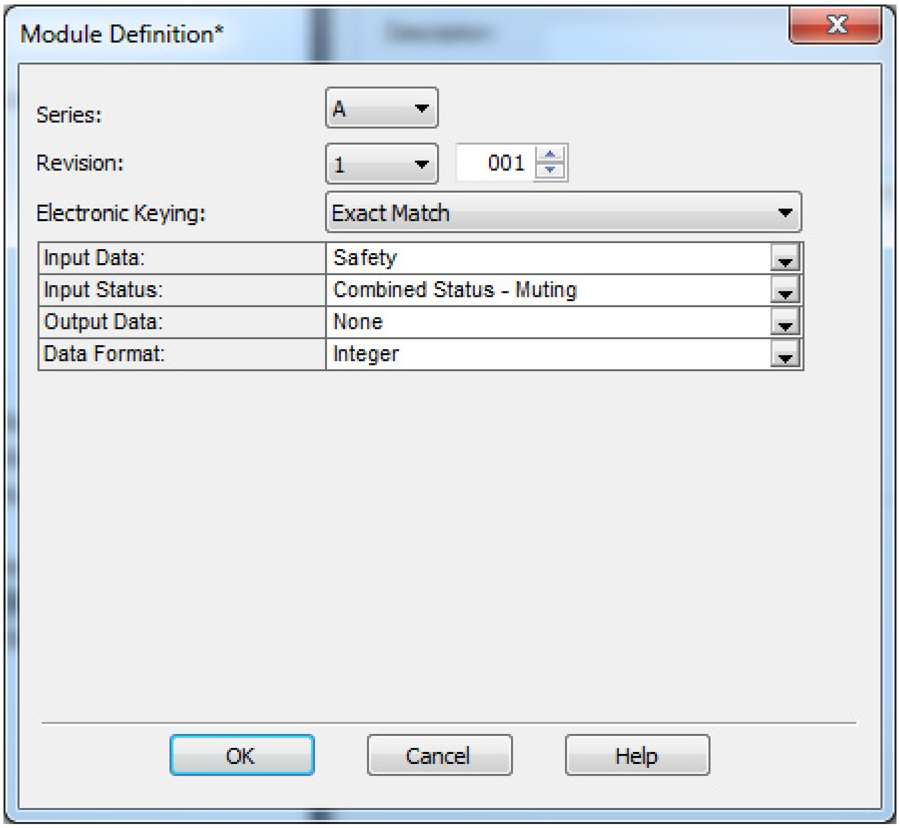
Ladder Diagram



Tip: The tag in the preceding image is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.

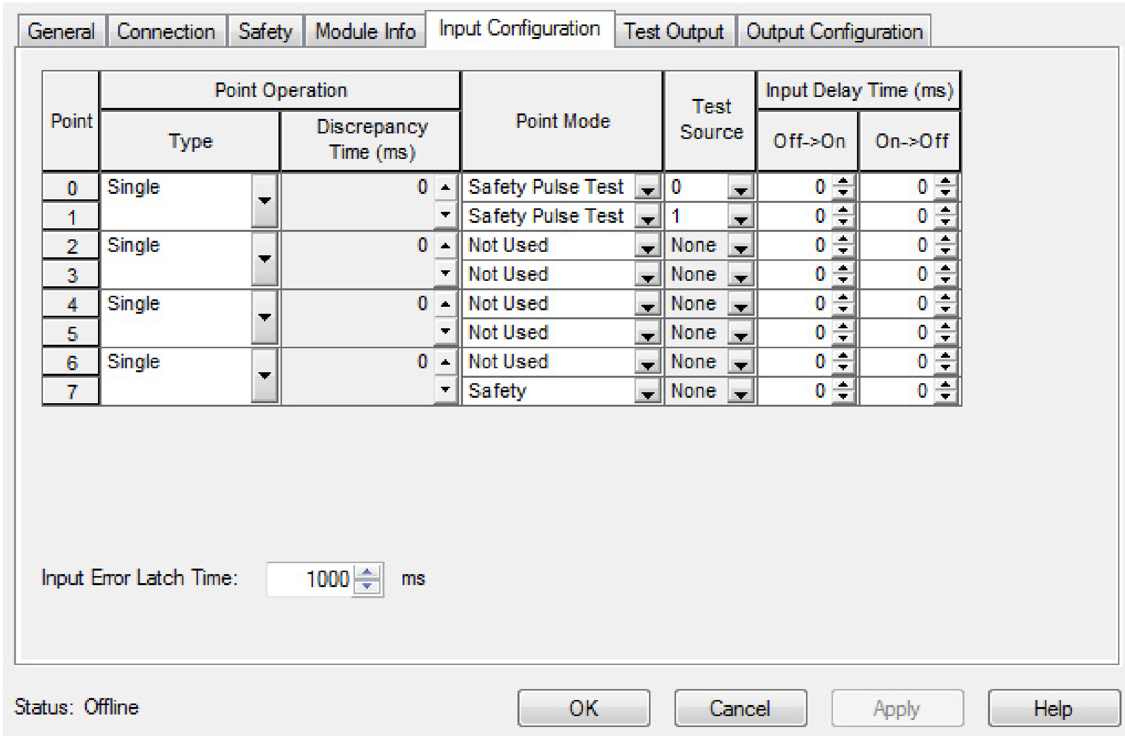
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.

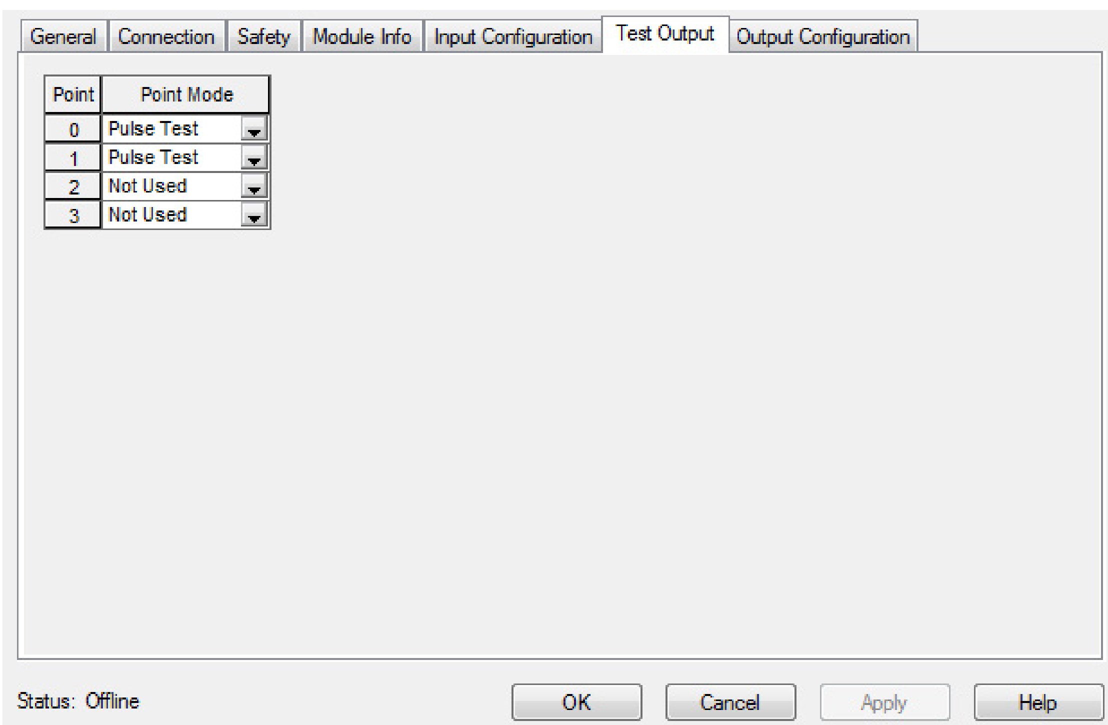


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

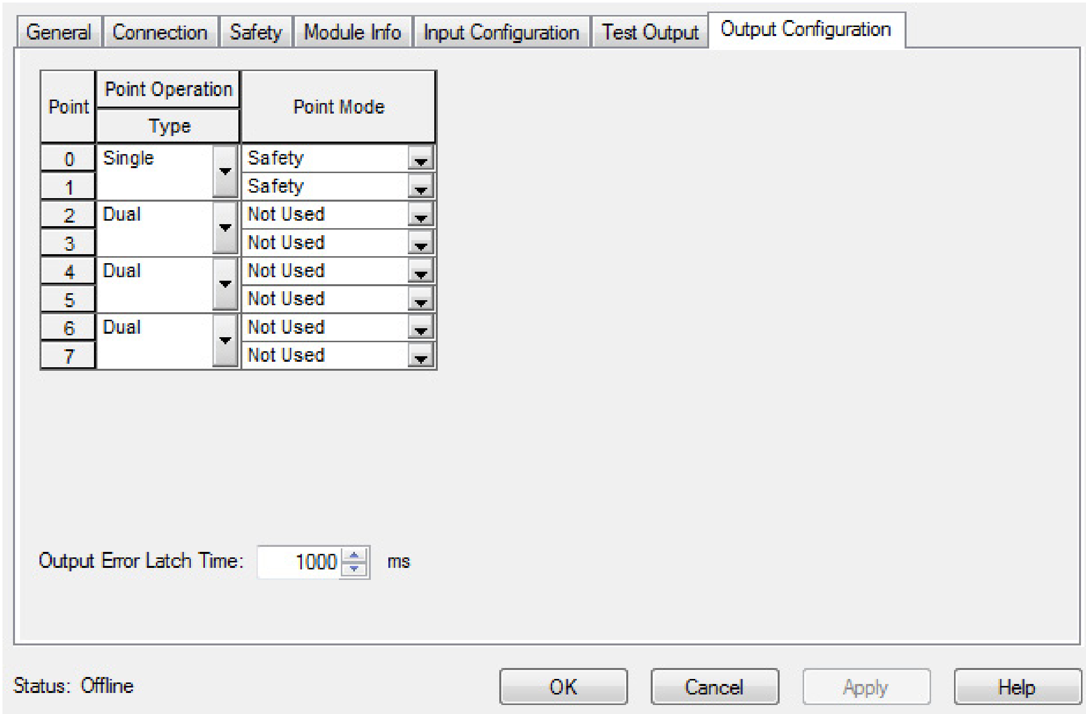
Module Input Configuration



Module Test Output Configuration



Module Output Configuration



See also

Configurable Redundant Output (CROUT) on page 153

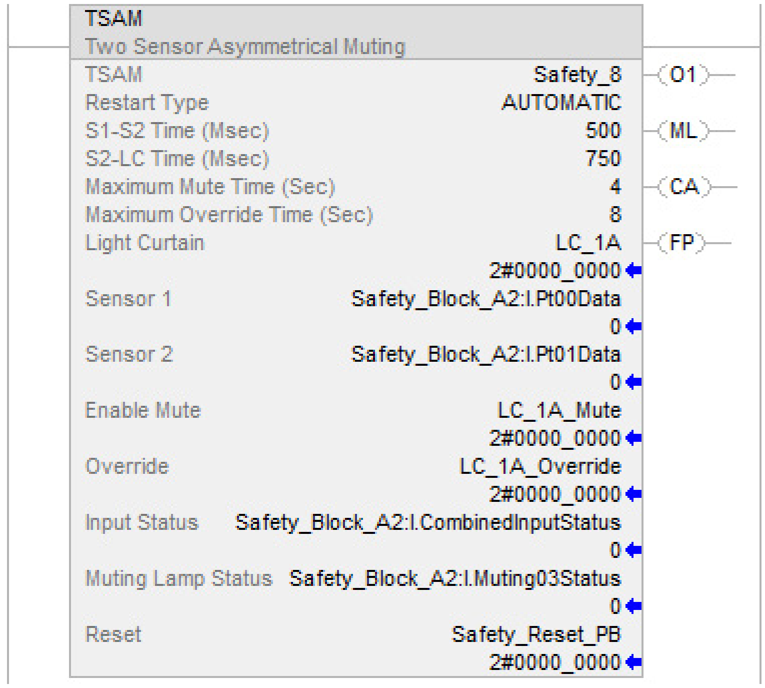
Two Sensor Asymmetrical Muting (TSAM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

This instruction provides a temporary, automatic disabling of the protective function of a light curtain, which allows material to be transported through the light curtain sensing field without stopping the machine. Muting sensors differentiate between materials and personnel, and must act together along with the light curtain, in a specific switching sequence when the appropriate material passes the sensing field.

Available Languages

Ladder Diagram



Function Block

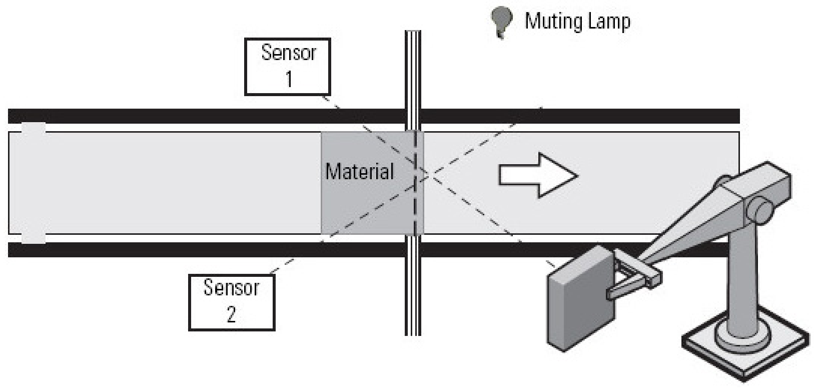
This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Two Sensor Asymmetrical Muting Application

Two Sensor Asymmetrical Muting uses two muting sensors arranged asymmetrically on either side of the light curtain. Their sensors intersect just behind the light curtain in the center of the protected opening.



ATTENTION: The muting sensors must be arranged so a person cannot activate the muting sensors in the same switching sequence as the material and enter the area when a hazardous condition exists. Sensor setup must take into account material size, shape, and speed. Additional guarding may also be necessary.

Specific guarding requirements should be identified through a hazard or risk assessment of your application.

Operands

IMPORTANT Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

This table provides the parameters for this instruction. The parameters cannot be changed at runtime.

Parameter	Data Type	Format	Description
TSAM	MUTING_TWO_SENSOR_ASYM	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.

Parameter	Data Type	Format	Description
Restart Type	BOOL	name	This input configures Output 1 for either manual or automatic restart. **MANUAL (0)** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1. **AUTOMATIC (1)** Output 1 is energized 50ms after all of the enabling conditions are met. **ATTENTION:** Automatic restart may be used only in application situations where you can prove that no unsafe conditions can occur as a result of its use.
S1-S2 Time	DINT	immediate	The maximum amount of time allowed between clearing or blocking of the muting sensor inputs (Sensor 1 and Sensor 2) before generating a fault. The valid range is 5 through 180,000 ms. Setting this input to 0 disables the S1-S2 timer.
S2-LC Time	DINT	immediate	The maximum amount of time allowed between clearing or blocking of the Sensor 2 muting sensor and the Light Curtain before generating a fault. The valid range is 5 through 180,000 ms. Setting this input to 0 disables the S2-LC timer.
Maximum Mute Time	DINT	immediate	The maximum amount of time during which the instruction lets the protective function of the light curtain be disabled before generating a fault. The valid range is 0 through 3600 s. Setting this input to 0 disables the Maximum Mute timer.
Maximum Override Time	DINT	immediate	The maximum amount of time that the instruction lets the override feature energize the Output 1 output. The valid range is 0 through 30 s. Setting this input to 0 disables the Maximum Override timer.

This table provides the input parameters for this instruction.

Parameter	Data Type	Format	Description
Light Curtain	BOOL	tag	An input channel with OFF (0) as its safe state, this input represents the current state of the physical light curtain. You are responsible for properly conditioning this input. Typically, conditioning is accomplished using Dual Channel Input Stop instruction controlling a light curtain. ON (1): The light curtain is clear. OFF (0): The light curtain is blocked.
Sensor 1	BOOL	tag	One of two muting sensors, Sensor 1 must be the first sensor to be blocked and the last to be cleared in the muting sequence. ON (1): Sensor 1 is clear. OFF (0): Sensor 1 is blocked.
Sensor 2	BOOL	tag	One of two muting sensors, Sensor 2 must be the second sensor to be blocked and the first to be cleared in the muting sequence. ON (1): Sensor 2 is clear. OFF (0): Sensor 2 is blocked.

Parameter	Data Type	Format	Description
Enable Mute	BOOL	immediate tag	This input allows the protective function of the light curtain to be disabled (muted) when the correct muting sequence occurs. ON (1): The protective function of the light curtain is disabled when the correct muting sequence occurs. OFF (0): The protective function of the light curtain is always enabled.
Override	BOOL	tag	This input allows a temporary bypass of the muting instruction's function. Output 1 is energized regardless of the status of the Input Status input or the existence of faults. OFF (0): Override function is disabled OFF (0) -> ON (1): Output 1 is energized regardless of the status of the Input Status input or the existence of faults. Output 1 remains energized while the Override input remains ON (1) or until the Maximum Override timer expires. **ATTENTION:** Activation of the override function requires the use of a hold-to-run device where the operator can see the point of hazard, that is, the light curtain sensing field.
Input Status	BOOL	immediate tag	If the instruction inputs are from a safety I/O module, this is the status from the I/O module or modules (Connection Status or Combined Status). If the instruction inputs are derived from internal logic, it is the responsibility of the application programmer to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Muting Lamp Status	BOOL	immediate tag	This input represents the status of the muting lamp. ON (1): The muting lamp is operating properly. The light curtain's protective function is disabled (muted) after the correct muting sequence is followed. OFF (0): The muting lamp is defective or missing. The light curtain's protective function is always enabled.
Reset[1]	BOOL	tag	This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset. Output 1 is energized when the Restart Type is manual. Output 1 is not energized at the same time faults are cleared.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the 'Reset_Signal' tag in this example to your reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table provides the output parameters for this instruction.

Parameter	Data Type	Description
Output 1 (O1)	BOOL	ON (1): The light curtain sensing field is not obstructed, the light curtain is being muted, or the light curtain is being overridden. OFF (0): The light curtain sensing field is obstructed.
Muting Lamp (ML)	BOOL	This output indicates the status of the light curtain's protective function. ON (1): The light curtain's protective function is disabled. OFF (0): The light curtain's protective function is enabled.
Clear Area (CA)	BOOL	This output indicates when the light curtain sensing field must be cleared (all muting sensors and the light curtain are ON) before processing can continue. ON (1): The light curtain sensing field must be cleared. OFF (0): The light curtain sensing field is clear.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes in this instruction for the list of fault codes.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section in this instruction for a list of diagnostic codes. This parameter is not safety-related.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.

IMPORTANT Do not write to any instruction output tag under any circumstance.

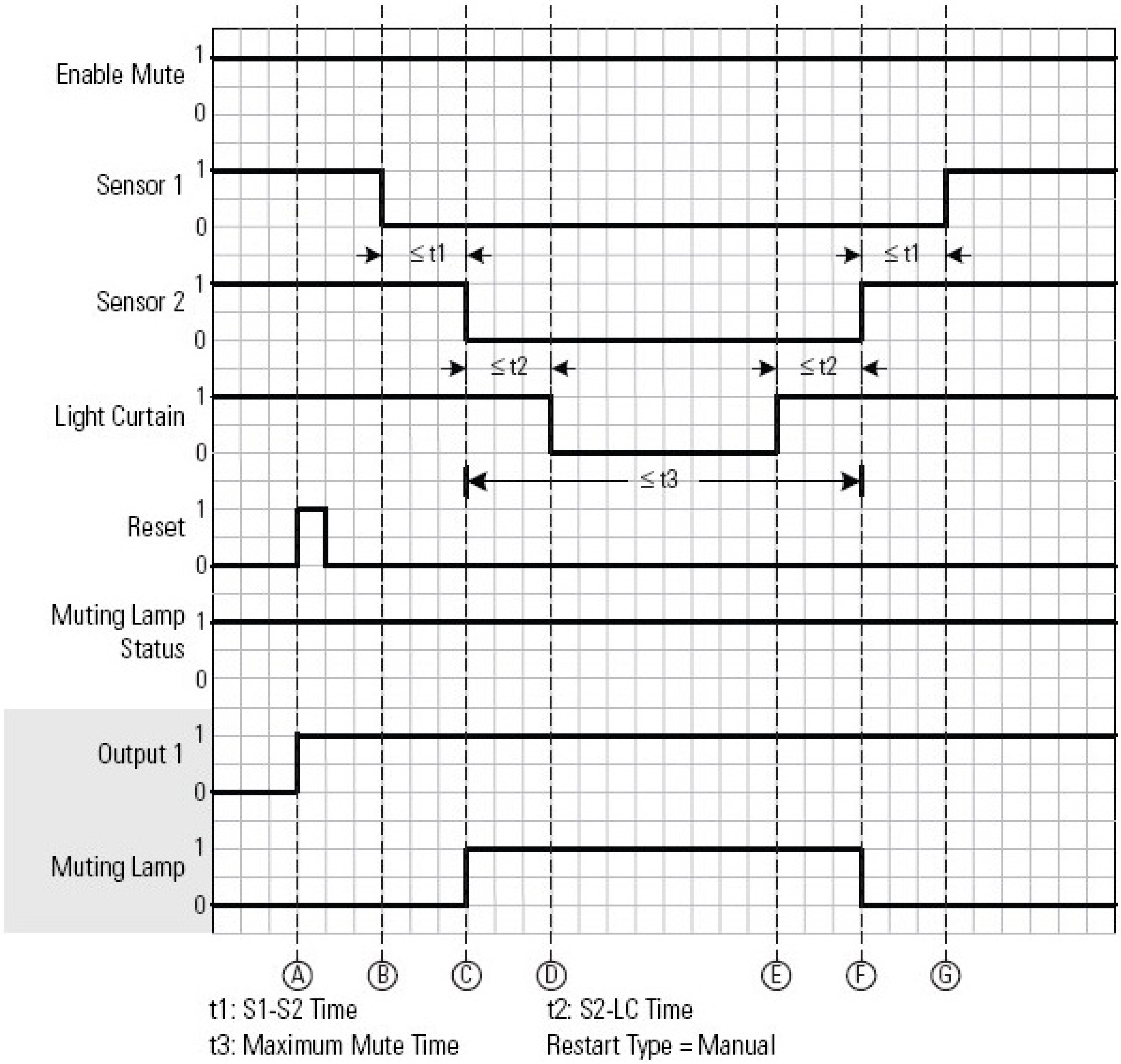
Operation

Normal Operation

One sequence of muting sensor and light-curtain input transitions lets the protective function of the light curtain be disabled (muted). That sequence must start with both of the muting sensors and the light curtain in their ON (1) state, which indicates that the light-curtain sensing field is clear of all personnel and material.

At (A), the Sensors and the Light Curtain are cleared and the Output 1 output is energized when the Reset input turns ON (1). At (B), the material blocks Sensor 1, starting the S1-S2 timer. At (C), the material blocks Sensor 2 within the S1-S2 Time period, so the S1-S2 timer stops. The S2-LC and Maximum Mute timers start. The Muting Lamp output turns ON (1), indicating that muting is enabled. At (D), the material blocks the Light Curtain within the S2-LC Time period, so the S2-LC timer stops. From (D) to (E), Output 1 remains energized while the material passes through the Light Curtain. At (E), the material clears the Light Curtain, starting the LC-S2 timer. At (F), the material clears Sensor 2 within the S2-LC and Maximum Mute time periods, so both timers stop. The S2-S1 timer starts and the Muting Lamp output turns OFF

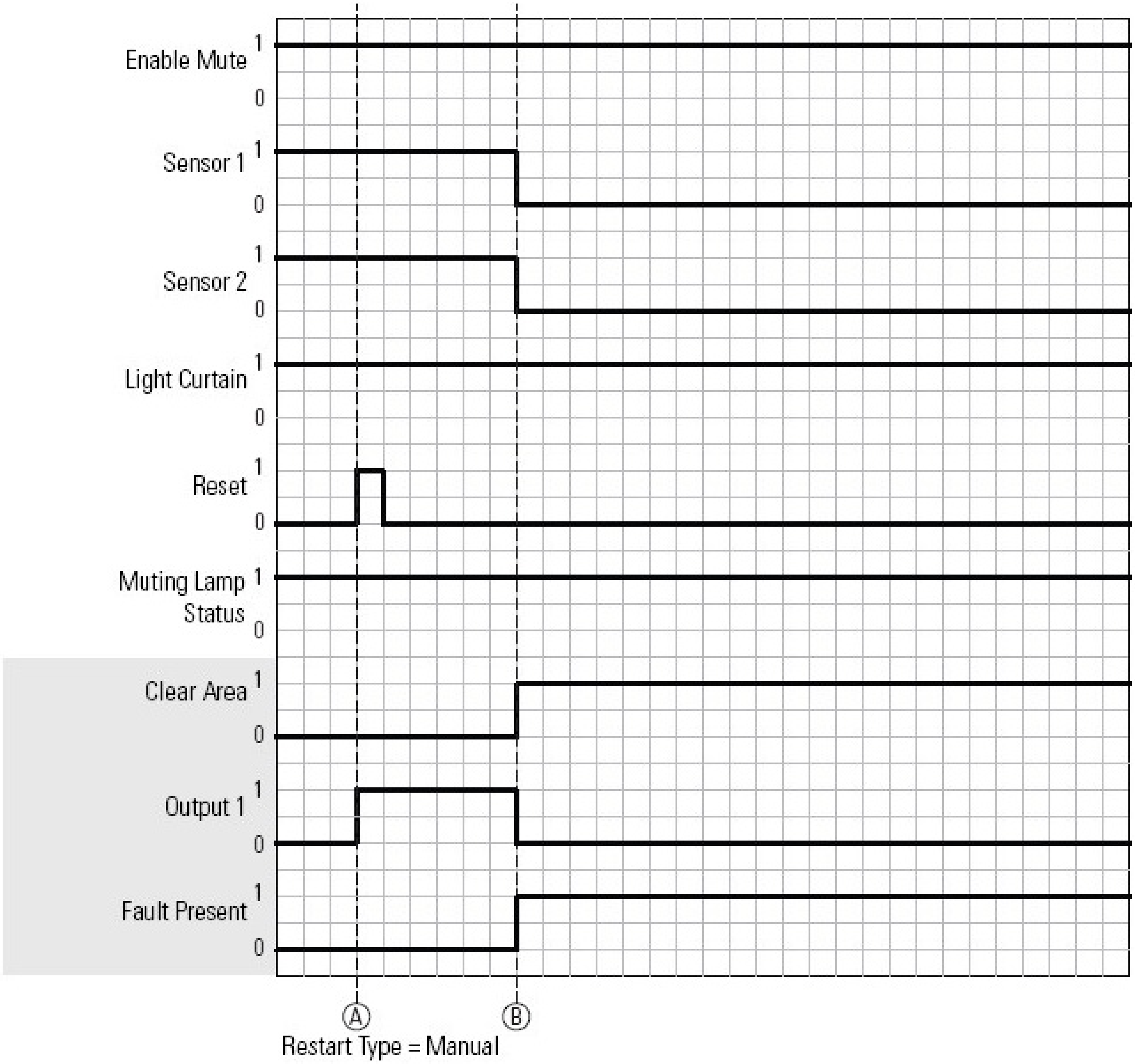
(0), indicating that muting is disabled. At (G), the material clears Sensor 1, stopping the S2-S1 timer.



Invalid Sequence

Any input sequence other than the normal operation sequence results in Output 1 being de-energized.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), Sensor 1 and Sensor 2 are simultaneously blocked, causing Output 1 to be de-energized and the Fault Present and Clear Area outputs to turn ON (1). The override feature can be used to clear the material from the light curtain sensing field and de-energize the Clear Area output.

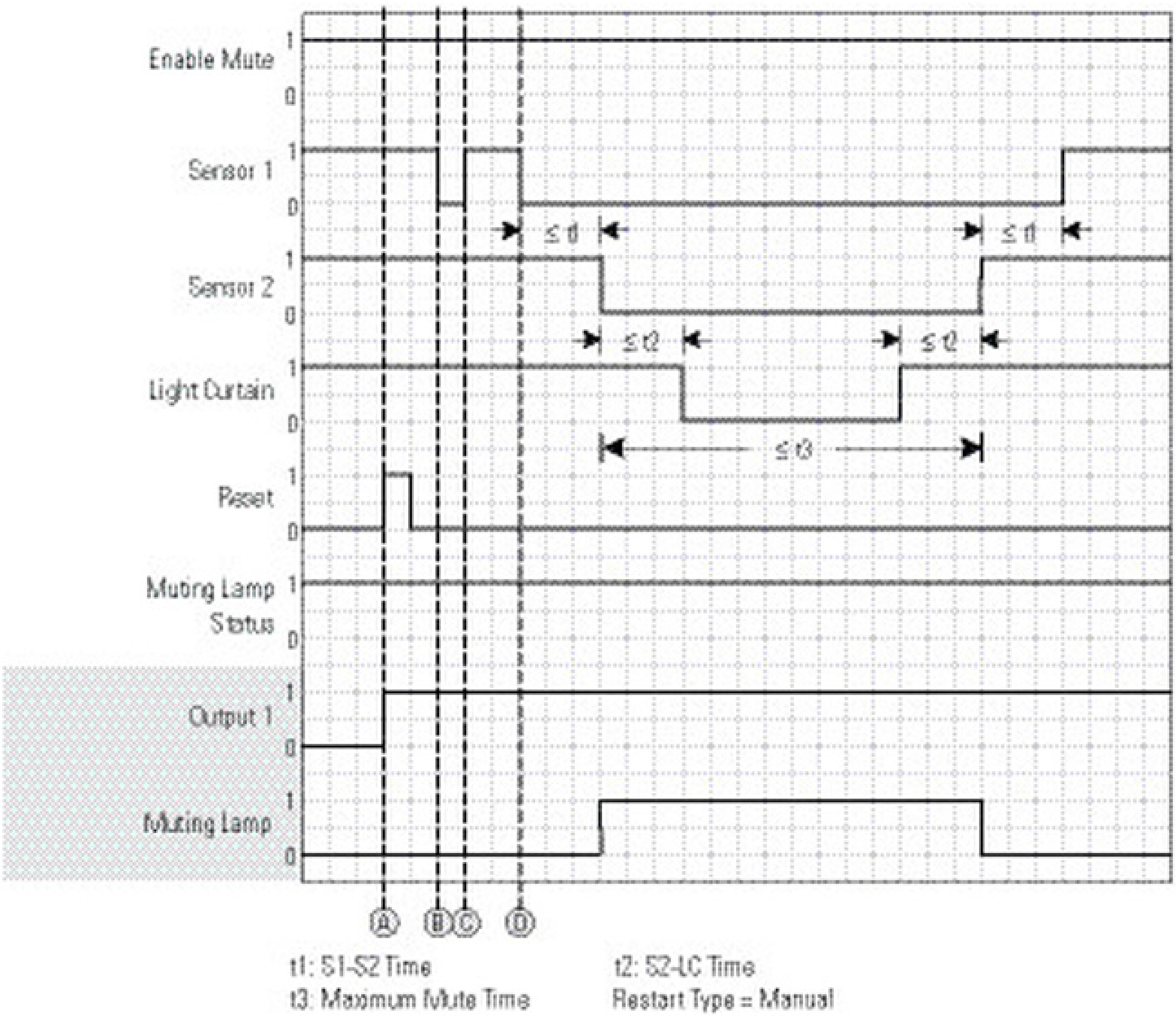


Tolerated Sequence

The Two-sensor Asymmetrical Muting (TSAM) instruction tolerates application dynamics that might cause an input to oscillate due to over-travel or load vibration.

At (A) Output 1 is energized just as in a normal sequence of operation. At (B), Sensor 1 turns OFF (0), starting the S1-S2 timer. Sensor 1 turns ON at (C), stopping the S1-S2 timer. At (D), the material completely blocks Sensor 1, turning it OFF (0), and the normal muting sequence continues. A sensor can glitch, as illustrated from (B) to (C), as a result of overtravel or load vibration.

As s long as the final input sequence is valid, muting function will be allowed to occur.

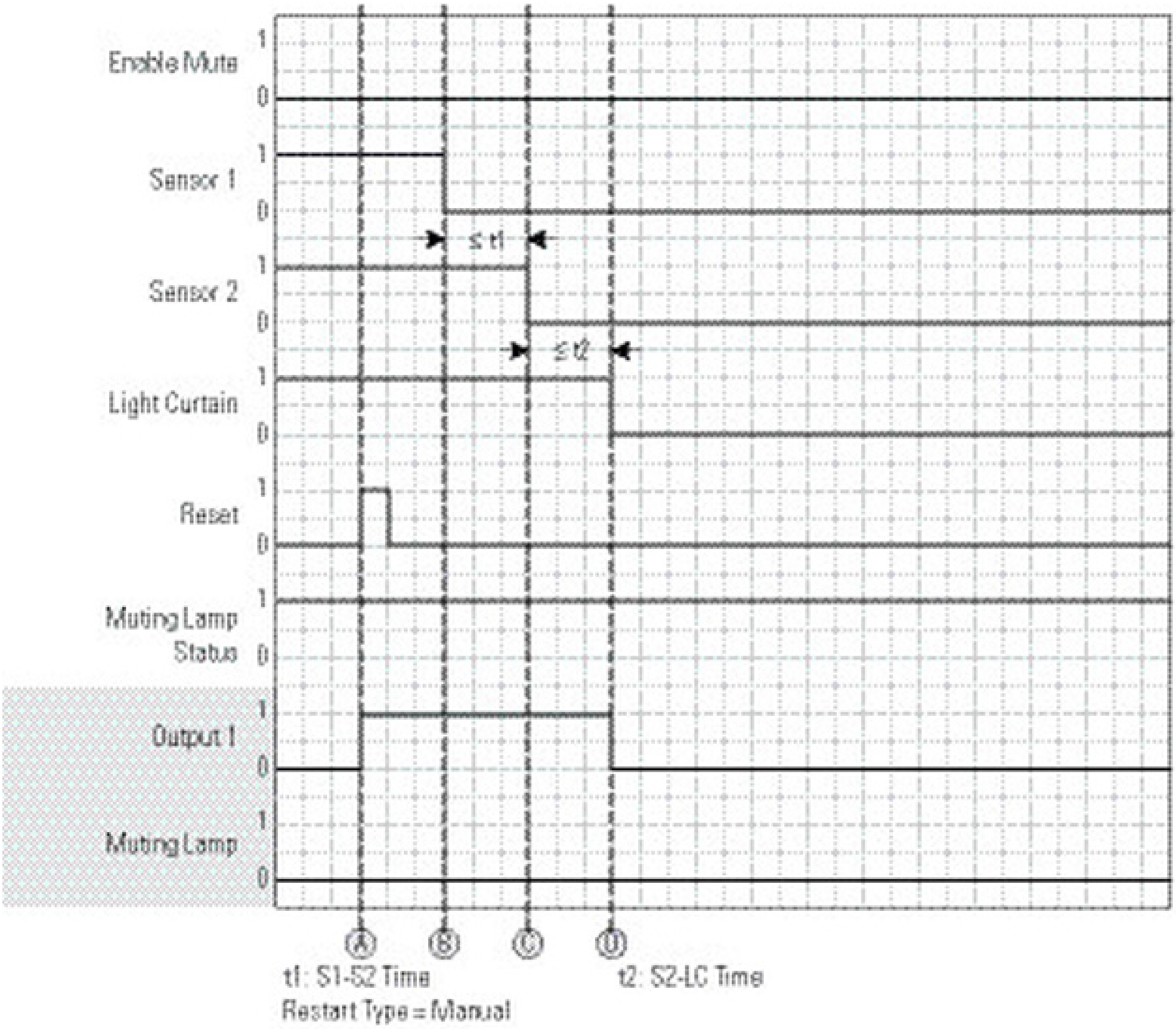


Dangerous Portion of Cycle

The Enable Mute input enables or disables the protective function of the light curtain. When the Enable Mute input is OFF (0), the protective function of the light curtain is enabled and material may not pass through the light curtain sensing field.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), the material blocks Sensor 1, turning it OFF (0) and starting the S1-S2 timer. At (C), the material blocks Sensor 2 within the S1-S2 time period so the S1-S2 timer stops and the S2-LC timer starts. Because the Enable Mute input is OFF (0), muting is disabled and the Muting Lamp output remains OFF (0). The material blocks the Light Curtain at (D), and Output 1 is de-energized.

If the application does not have parts of its cycle where it is unacceptable for material to pass through the light curtain, you can disable this feature by setting the Enable Mute input to a constant value of ON (1).

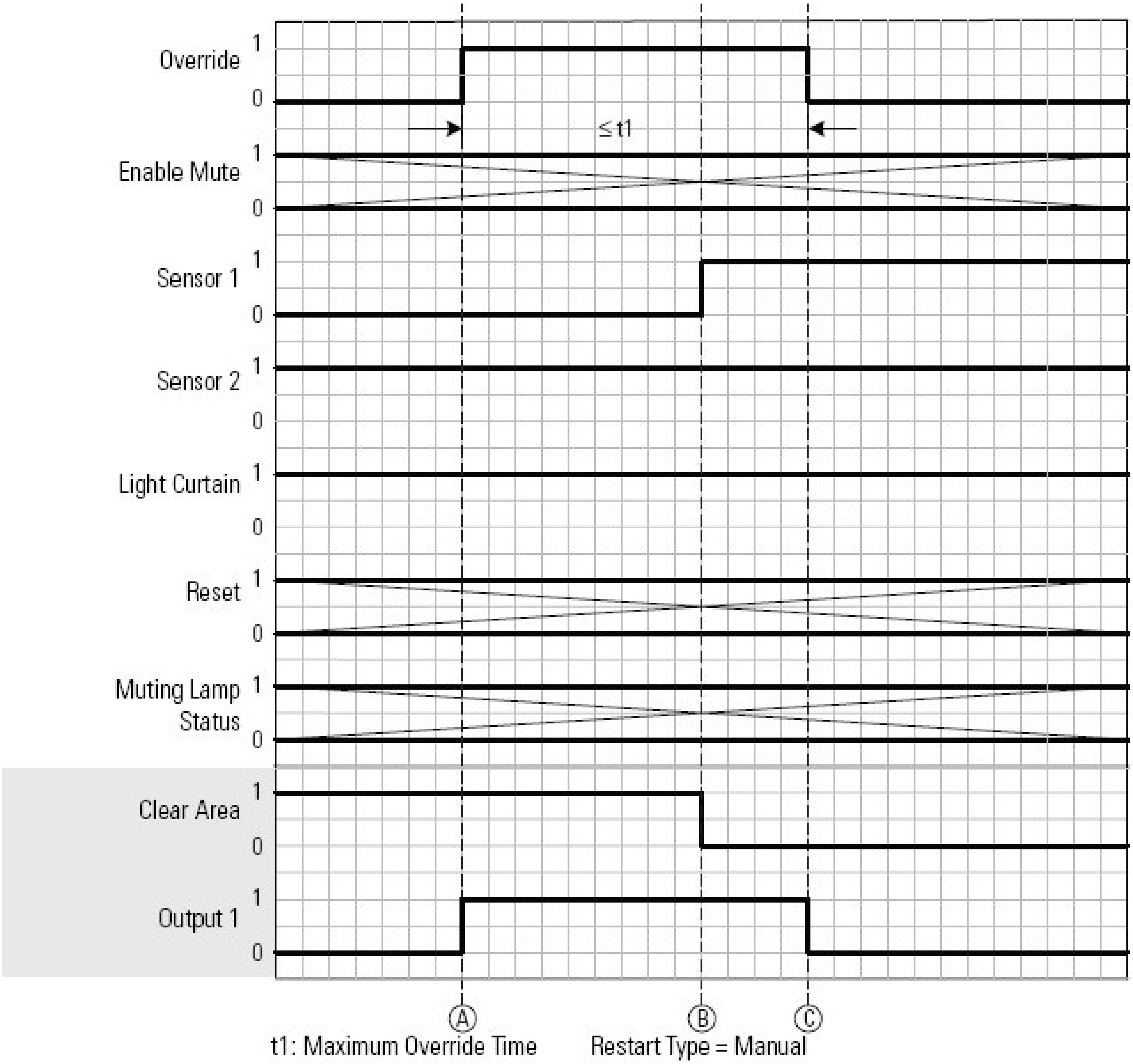


Override Operation

The override feature lets an operator manually energize Output 1 so that material can be cleared from the sensing field.

ATTENTION: The Override function may be used only with a hold-to-run device where the operator can see the point of hazard, that is, the light curtain sensing field.

At (A), the Override input turns ON (1). Output 1 is energized and the Maximum Override timer starts. At (B), the material clears Sensor 1 and the Clear Area output is turned OFF (0). At (C), the Override input turns OFF (0) within the Maximum Override time period. Output 1 is de-energized and the Maximum Override timer stops.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes

The fault codes are listed in hexadecimal format followed by decimal format.

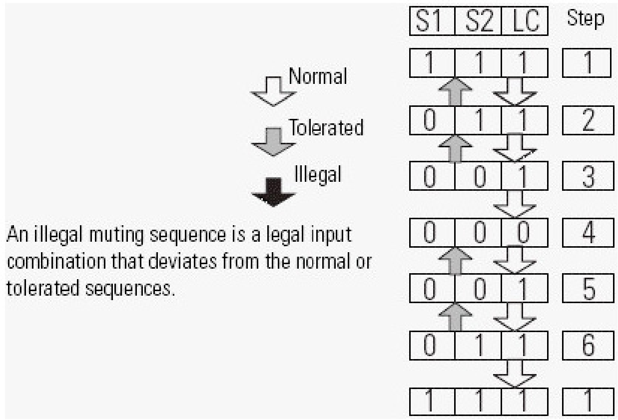
General Fault Codes

Fault Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status input went from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the logic used to source input status. • Reset the fault.

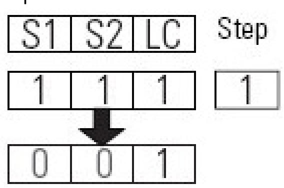
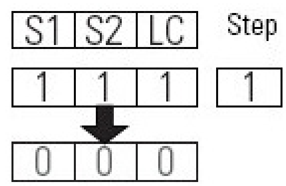
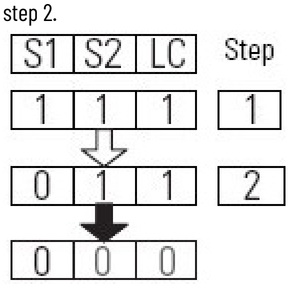
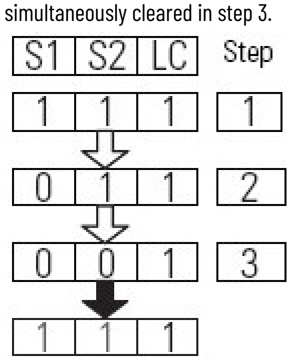
Sensor Input Pattern Fault Codes

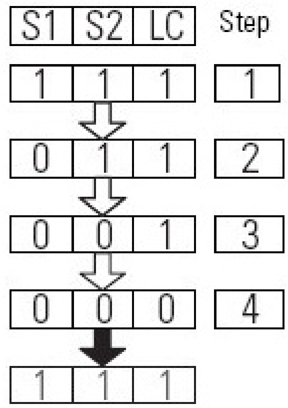
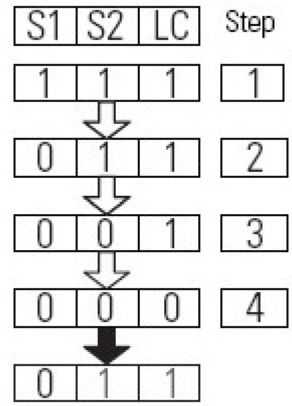
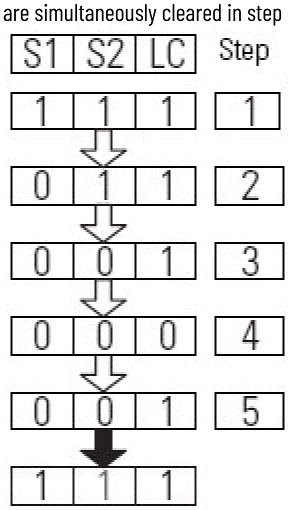
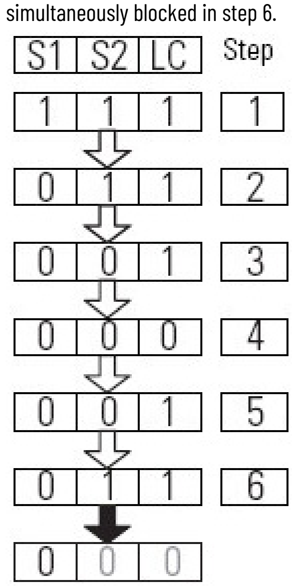
Fault Code	Description	Corrective Action
16#9600 38400	An illegal input pattern was detected. Sensor 1 and the Light Curtain are blocked and Sensor 2 cleared. S1 | S2 | LC 0 | 1 | 0	Sensor 2 should also be blocked • Check the Sensor 2 circuit. • Reset the fault.
16#9601H 38401	An illegal input pattern was detected. Sensor 2 and the Light Curtain are blocked and Sensor 1 is cleared. S1 | S2 | LC 1 | 0 | 0	Sensor 1 should also be blocked. • Check the Sensor 1 circuit. • Reset the fault.
16#9602 38402	An illegal input pattern was detected. Sensor 2 is blocked when Sensor 1 and the Light Curtain are cleared. S1 | S2 | LC 1 | 0 | 1	Sensor 2 should also be clear. Sensor 1 should be the first to be blocked. • Check the Sensor 2 circuit and the alignment of Sensors 1 and 2. • Reset the fault.
16#9603 38403	An illegal input pattern was detected. Sensor 1 and Sensor 2 are cleared and the Light Curtain is blocked. S1 | S2 | LC 1 | 1 | 0	The Light Curtain should not be blocked when Sensors 1 and 2 are clear. • Check the Light Curtain circuit. • Reset the fault.

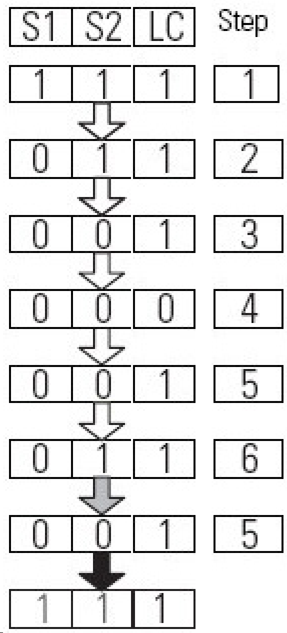
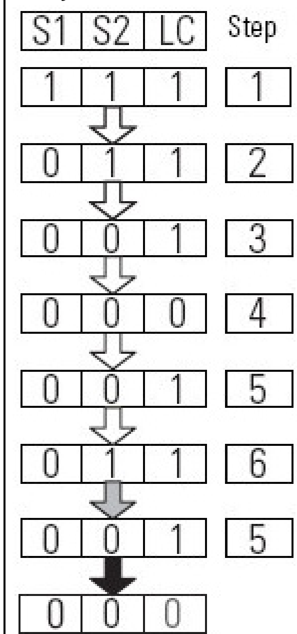
Normal and Tolerated Muting Sequences



Muting Sequence Fault Codes

Fault Code	Description	Fault Code	Description
16#9500 38144	An illegal muting sequence was detected when Sensor 1 (S1) and Sensor 2 (S2) are simultaneously blocked in step 1. 	16#9501 38145	An illegal muting sequence was detected when Sensor 1, Sensor 2, and the Light Curtain (LC) are simultaneously blocked in step 1. 
16#9502 38146	An illegal muting sequence was detected when Sensor 2 and the Light Curtain are simultaneously blocked in step 2. 	16#9503 381447	An illegal muting sequence was detected when Sensor 1 and Sensor 2 are simultaneously cleared in step 3. 

Fault Code	Description	Fault Code	Description
16#9504 38148	An illegal muting sequence was detected when Sensor 1, Sensor 2, and the Light Curtain are simultaneously cleared in step 4. 	16#9505 38149	An illegal muting sequence was detected when Sensor 2 and the Light Curtain are simultaneously cleared in step 4. 
16#9506 38150	An illegal muting sequence was detected when Sensor 1 and Sensor 2 are simultaneously cleared in step 5. 	16#9507 38151	An illegal muting sequence was detected when Sensor 2 and the Light Curtain are simultaneously blocked in step 6. 

Fault Code	Description	Fault Code	Description
16#9508 38152	An illegal muting sequence was detected after the sequence transitions from step 5 to step 6 to step 5 (a tolerated sequence) when Sensor 1 and Sensor 2 are cleared. 	16#9509 38153	An illegal muting sequence was detected after the sequence transitions from step 5 to step 6 to step 5 (a tolerated sequence) when the Light Curtain is blocked. 

To correct an invalid sequence fault, check the alignment of the sensors with regard to the material being moved and the system timing and then reset the fault.

Correcting Invalid Sequence Faults

Fault Code	Description	Corrective Action
16#9000 36864	The Light Curtain was muted for longer than the configured Maximum Mute Time.	The Maximum Mute Time parameter is set too short or there is an anomaly with the sensors.
16#9410 37904	Too much time has elapsed between Sensor 1 and Sensor 2 being blocked	The S1-S2 Time parameter is set too short or there is an anomaly with Sensor 2.
16#9411 37905	Too much time has elapsed between Sensor 2 and the Light Curtain being blocked.	The S2-LC Time parameter is set too short or there is an anomaly with Sensor 2.
16#9412 37906	Too much time has elapsed between the Light Curtain and Sensor 2 being cleared.	The S2-LC Time parameters is set too short or there is an anomaly with Sensor 2.
16#9413 37907	Too much time has elapsed between Sensor 2 and Sensor 1 being cleared.	The S1-S2 Time parameter is set too short or there is an anomaly with Sensor 2.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None
16#1 1	The Muting Lamp Status input is OFF (0).	• Check the muting lamp and replace it, if necessary. • If a muting lamp is not required, set the Muting Lamp Status input to ON (1).
16#5 5	The Reset input is held ON (1).	Set the Reset input to OFF (0).
16#20 32	The Input Status input was OFF (0) when the instruction started.	Check the I/O module connection or the logic used to source input status.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .ML, .CA and .FP are cleared to false.
Rung-condition-in is true	The instruction executes.
Postscan	Same as Rung-condition-in is false.

See also

Common Attributes on page 529

Index Through Arrays on page 540

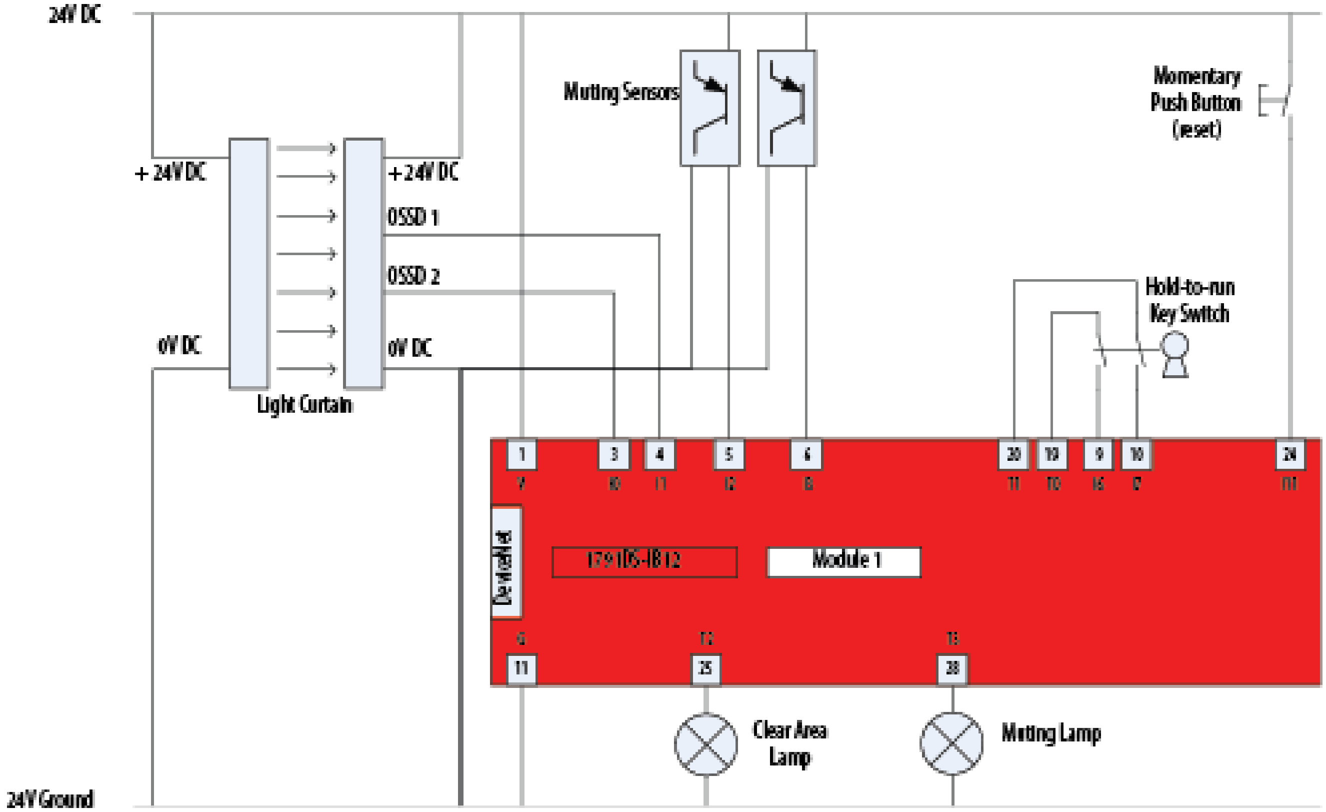
Two Sensor Asymmetrical Muting (TSAM) wiring and programming example on page 180

Two Sensor Asymmetrical Muting (TSAM) wiring and programming example

This example complies with ISO 13849-1 Category 4 operation. The standard control portion of the application is not shown.

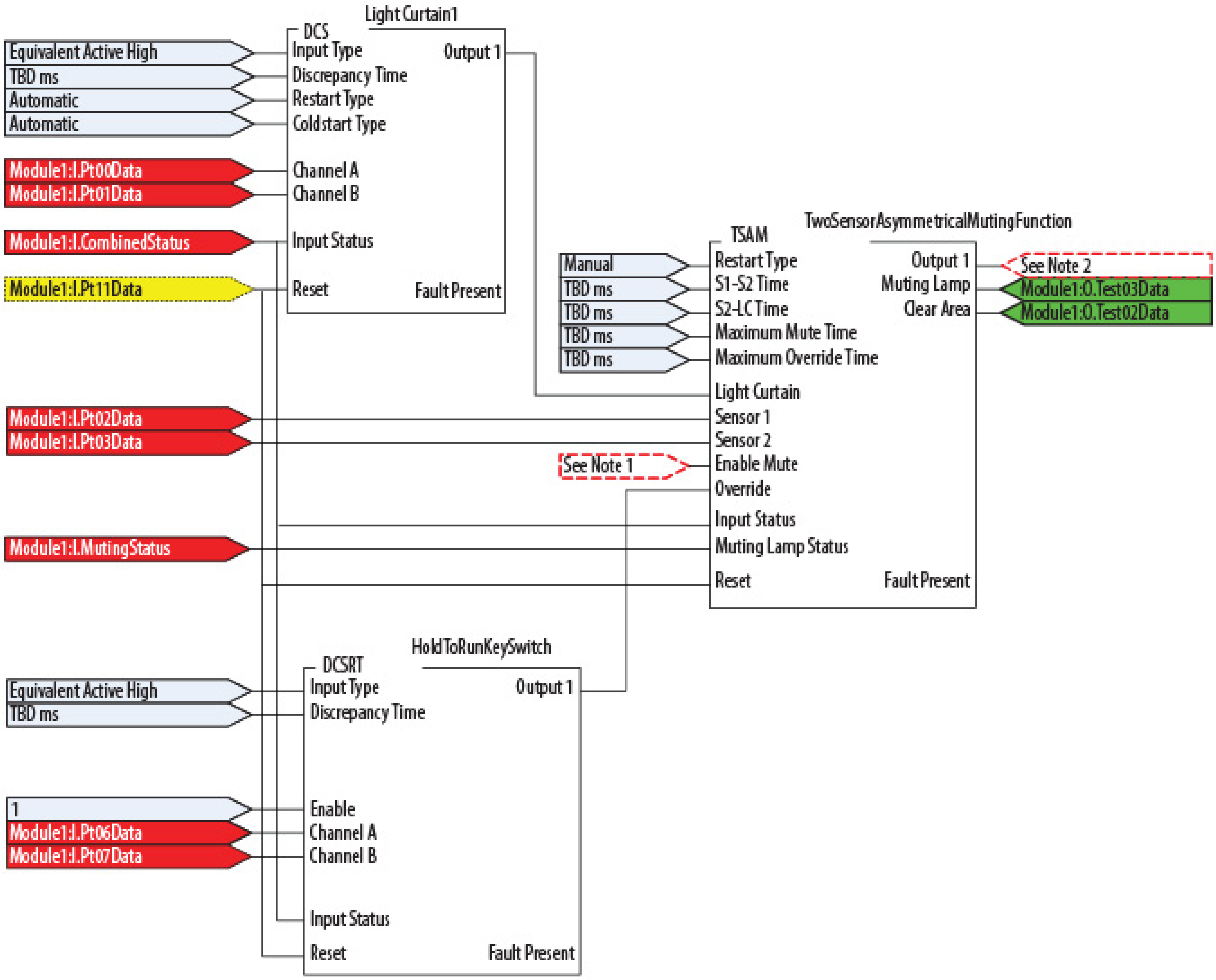
Wiring Example

This wiring diagram shows how to wire a light curtain and two muting sensors to a 1791DS-IB12 module to illustrate the use of the Two-sensor Asymmetrical Muting instruction. The application includes a hold-to-run switch and a momentary push button for reset.



Programming Example

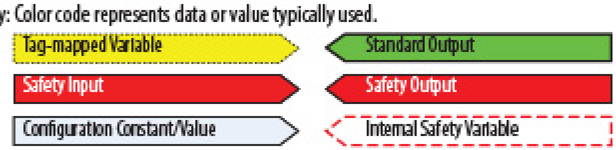
This programming diagram logically illustrates how the Two-sensor Asymmetrical Muting instruction is typically used with a DCI Stop (light curtain) and DCI Start (hold-to-run switch) instruction.



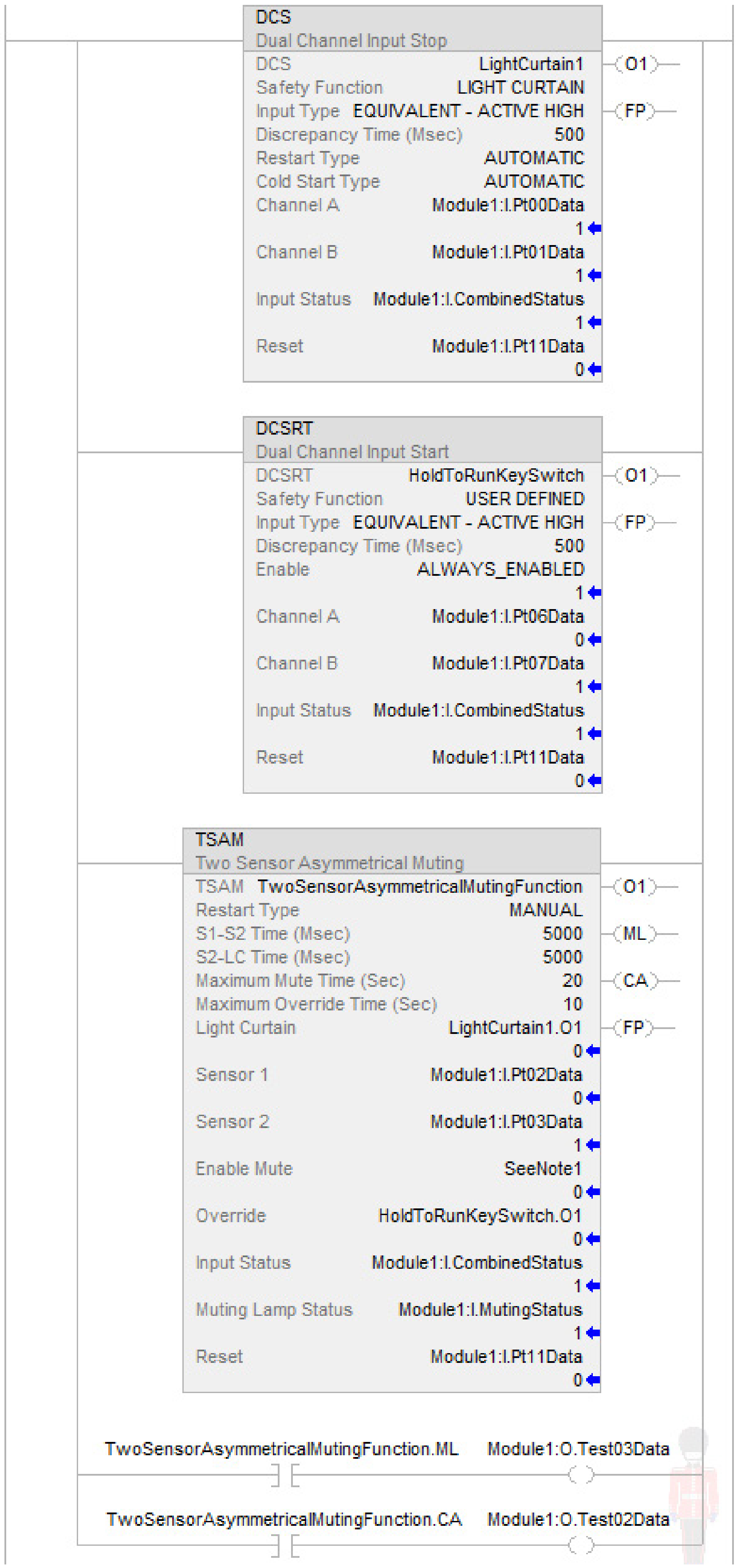
Note 1: This tag is an internal Boolean tag that represents the nonhazardous portion of the machine cycle. Its value is determined by other parts of the user application that are not shown in this example. When the protected hazard is present, this tag value should be False (0). When the protected hazard is not present, this tag value should be True (1). When the value of this tag is True (1), the muting instruction allows the light curtain to become muted only if the proper input sequence is detected. When the value of this tag is False (0), the muting instruction does not allow the light curtain to become muted, even if the proper input sequence is detected.

Note 2: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.

Key: Color code represents data or value typically used.



Ladder Diagram

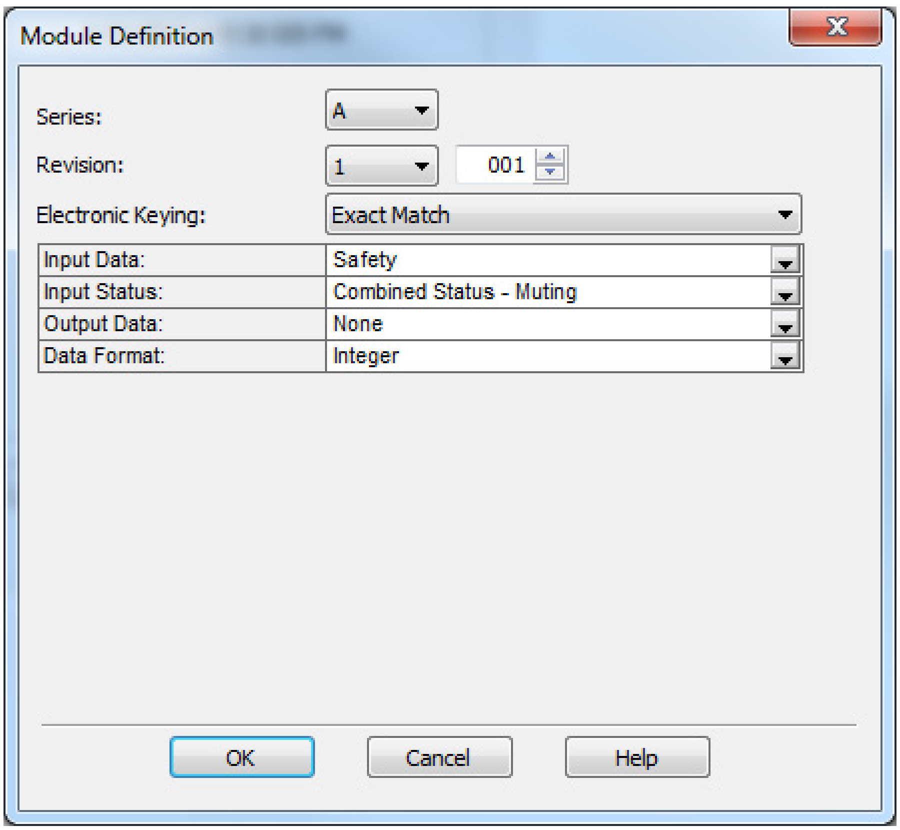


Tip: The tag in the preceding diagram is an internal Boolean tag that represents the nonhazardous portion of the machine cycle. Its value is determined by other parts of the user application that are not shown in this example. When the protected hazard is present, the tag value should be False (0). When the protected hazard is not present, this tag value should be true (1). When the value of the tag is true (1), the muting instruction allows the light curtain to become muted only if the proper input sequence is detected. When the value of the tag is False (0), the muting instruction does not allow the light curtain to become muted, even if the proper input sequence is detected.

The programming software is used to configure the input and output parameters of the Guard I/O module, as illustrated.

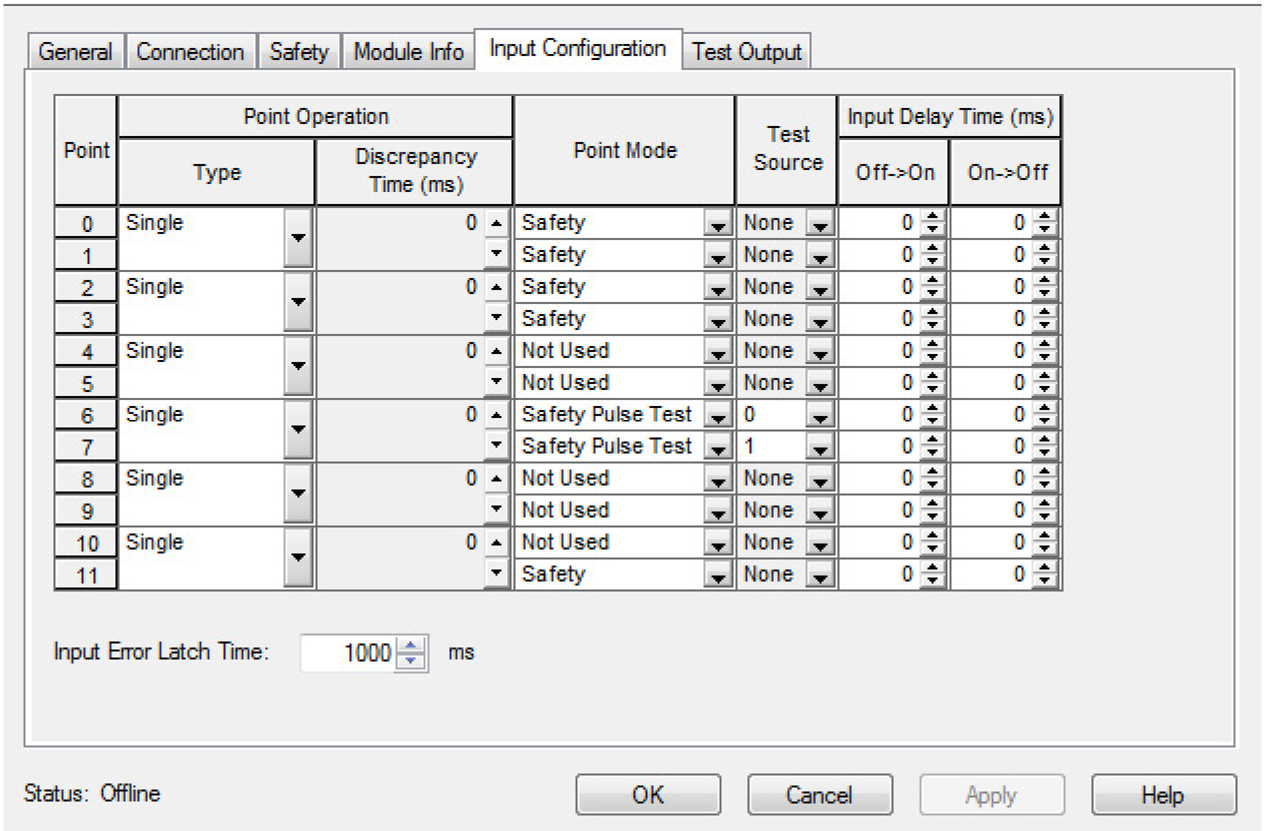
When defining the module, selecting Combined Status-Muting lets the muting lamp be monitored. Choosing Test for Output Data lets safety logic control Test Output 3 to drive the Muting Lamp and Test Output 2 to drive the Clear Area lamp.

Module Definition



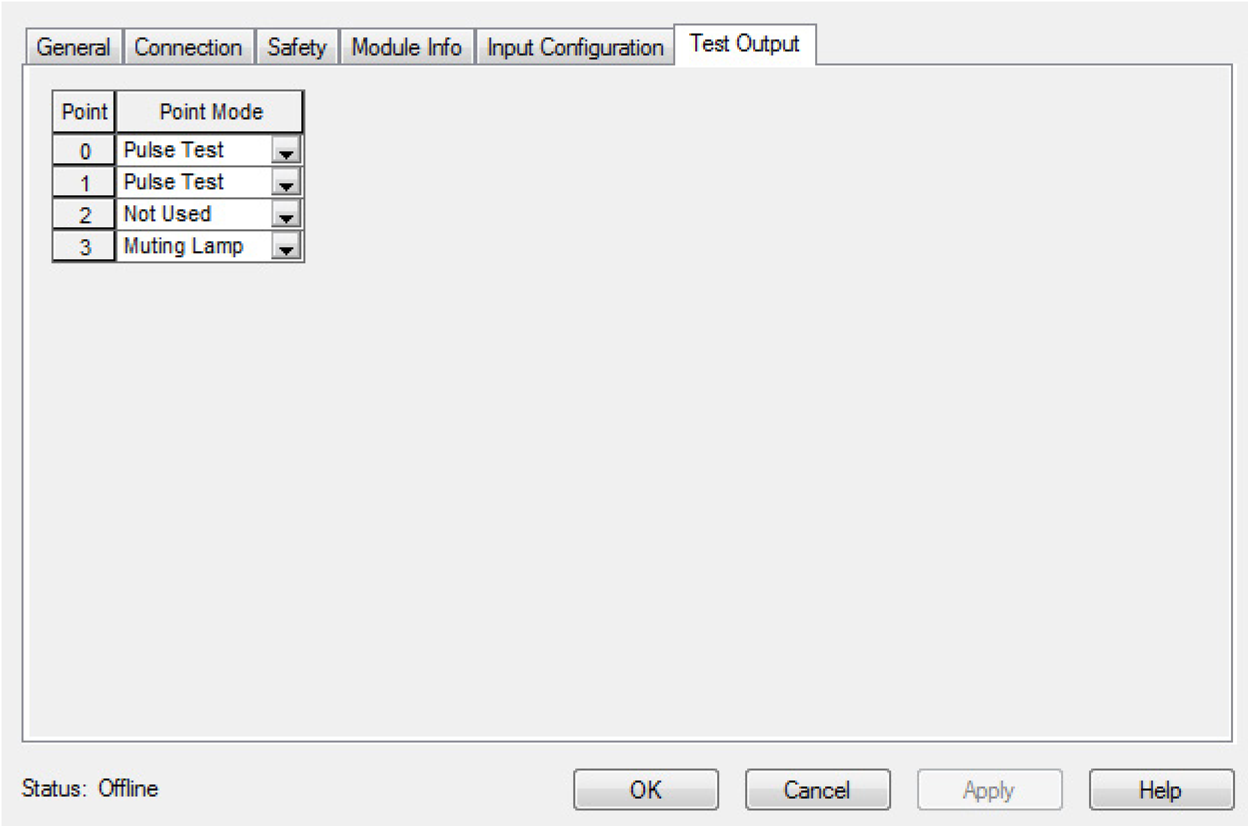
Rockwell Automation suggests the use of **Exact Match**, as shown. However, setting **Electronic Keying** to **Compatible Match** is allowed. The safety inputs that interface with the Light Curtain (Points 1 and 2) are not pulse-tested because the Light Curtain pulse-tests its own signals.

Module Input Configuration



Configuring Test Output 3 for Muting Lamp causes the I/O module to monitor the lamp that is connected to this output.

Module Test Output Configuration



See also

Two Sensor Asymmetrical Muting (TSAM) on page 165

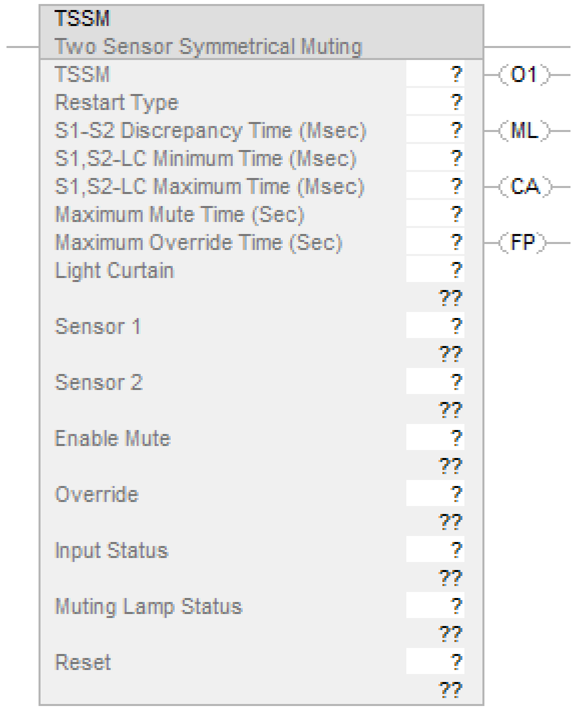
Two-sensor Symmetrical Muting (TSSM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

This instruction provides a temporary, automatic disabling of the protective function of a light curtain, which allows material to be transported through the light curtain sensing field without stopping the machine. Muting sensors differentiate between materials and personnel, and must act together along with the light curtain, in a specific switching sequence when the appropriate material passes the sensing field.

Available Languages

Ladder Diagram



Function Block

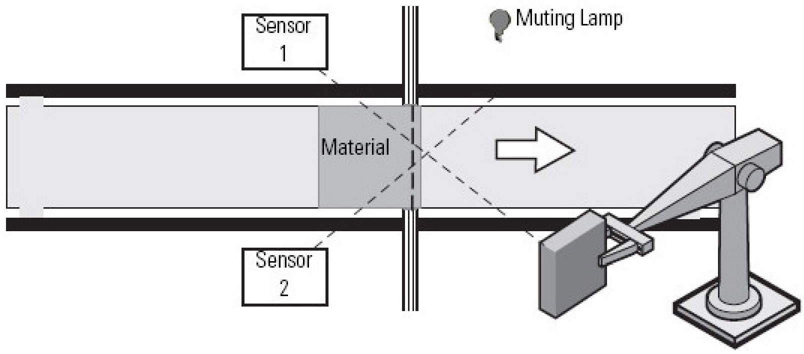
This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Two Sensor Symmetrical Muting Application

Two Sensor Symmetrical Muting uses two muting sensors arranged symmetrically on either side of the light curtain. Their sensors intersect at or just behind the light curtain in the center of the protected opening.



ATTENTION: The muting sensors must be arranged so a person cannot activate the muting sensors in the same switching sequence as the material and enter the area when a hazardous condition exists. Sensor setup must take into account material size, shape, and speed. Additional guarding may also be necessary.

Specific guarding requirements should be identified through a hazard or risk assessment of your application.

Operands

IMPORTANT Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

This table provides the parameters for this instruction. The parameters cannot be changed at runtime.

Parameter	Data Type	Format	Description
TSSM	MUTING_TWO_SENSOR_SYM	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.

Parameter	Data Type	Format	Description
Restart Type	BOOL	name	Configures Output 1 for either Manual or Automatic Restart. **MANUAL (0)** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1. **AUTOMATIC (1)** Output 1 is energized 50ms after all of the enabling conditions are met. **ATTENTION:** Automatic restart may only be used in application situations where you can prove that no unsafe conditions can occur as a result of its use.
S1S2 Discrepancy Time	DINT	immediate	The maximum amount of time the muting sensors (Sensor 1 and Sensor 2) may be inconsistent before a fault occurs. The valid range is 5 through 180,000 ms.
S1S2-LC Minimum Time	DINT	immediate	When material is entering the light curtain sensing field, this time specifies how long to wait before the material is allowed to block the Light Curtain after Sensor 1 and Sensor 2 have been blocked. When material is exiting the light curtain sensing field, this time specifies how long to wait before the material is allowed to clear Sensor 1 and Sensor 2 after clearing the Light Curtain. If the S1S2-LC Minimum Time is exceeded, a fault occurs. The valid range is 5 through 180,000 ms.
S1S2-LC Maximum Time	DINT	immediate	When material is entering the light curtain sensing field, this time specifies the maximum time to wait for the material to block the Light Curtain after Sensor 1 and Sensor 2 have been blocked. When material is exiting the light curtain sensing field, this time specifies the maximum time to wait for the material to clear Sensor 1 and Sensor 2 after clearing the Light Curtain. If the S1S2-LC Maximum Time is exceeded, a fault occurs. The valid range is 5 through 180,000 ms.
Maximum Mute Time	DINT	immediate	The maximum amount of time during which the instruction lets the protective function of the light curtain be disabled before generating a fault. The valid range is 0 through 3600 s. Setting this input to 0 disables the Maximum Mute timer.
Maximum Override Time	DINT	immediate	The maximum amount of time that the instruction lets the override feature energize the Output 1 output. The valid range is 0 through 30 s. Setting this input to 0 disables the Maximum Override timer.

This table provides the input parameters for this instruction.

Parameter	Data Type	Format	Description
Light Curtain	BOOL	tag	An input channel with OFF (0) as its safe state, this input represents the current state of the physical light curtain. You are responsible for properly conditioning this input. Typically conditioning is accomplished by using Dual Channel Input Stop instruction controlling a light curtain. ON (1): The light curtain is clear. OFF (0): The light curtain is blocked.
Sensor 1	BOOL	tag	One of two muting sensors, Sensor 1 must be blocked or cleared within the S1S2 Discrepancy Time of Sensor 2 being blocked or cleared. ON (1): Sensor 1 is clear. OFF (0): Sensor 1 is blocked.
Sensor 2	BOOL	tag	One of two muting sensors, Sensor 2 must be blocked or cleared within the S1S2 Discrepancy Time of Sensor 1 being blocked or cleared. ON (1): Sensor 2 is clear. OFF (0): Sensor 2 is blocked.
Enable Mute	BOOL	immediate tag	This input allows the protective function of the light curtain to be disabled (muted) when the correct muting sequence occurs. ON (1): The protective function of the light curtain is disabled when the correct muting sequence occurs. OFF (0): The protective function of the light curtain is always enabled.
Override	BOOL	tag	This input allows a temporary bypass of the muting instruction's function. OFF (0): Override function is disabled. OFF (0) -> ON (1): Output 1 is energized regardless of the status of the Input Status input or the existence of faults. Output 1 remains energized while the Override input remains ON (1) or until the Maximum Override timer expires. **ATTENTION:** Activation of the override function requires the use of a hold-to-run device where the operator can see the point of hazard, that is, the light curtain sensing field.
Input Status	BOOL	immediate tag	If the instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If the instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.

Parameter	Data Type	Format	Description
Muting Lamp Status	BOOL	immediate tag	This input represents the status of the muting lamp. ON (1): The muting lamp is operating properly. The light curtain's protective function is disabled (muted) after the correct muting sequence is followed. OFF (0): The muting lamp is defective or missing. The light curtain's protective function is always enabled.
Reset[1]	BOOL	tag	This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset. Output 1 is energized when the Restart Type is Manual. Output 1 is not energized at the same time faults are cleared.

[1] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the Reset_Signal tag in this example to reset your signal tag name. Then use the OSF Instruction Bit tag as the reset source for the instruction.

This table provides the output parameters for this instruction.

Parameter	Data Type	Description
Output 1 (O1)	BOOL	ON (1): The light curtain sensing field is not obstructed, the light curtain is being muted, or the light curtain is being overridden. OFF (0): The light curtain sensing field is obstructed.
Muting Lamp (ML)	BOOL	This output indicates the status of the light curtain's protective function. ON (1): The light curtain's protective function is disabled. OFF (0): The light curtain's protective function is enabled.
Clear Area (CA)	BOOL	This output indicates when the light curtain sensing field must be cleared (all muting sensors and the light curtain are ON) before processing can continue. ON (1): The light curtain sensing field must be cleared. OFF (0): The light curtain sensing field is clear.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes for the list of fault codes. This parameter is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes for a list of diagnostic codes. This parameter is not safety-related.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.

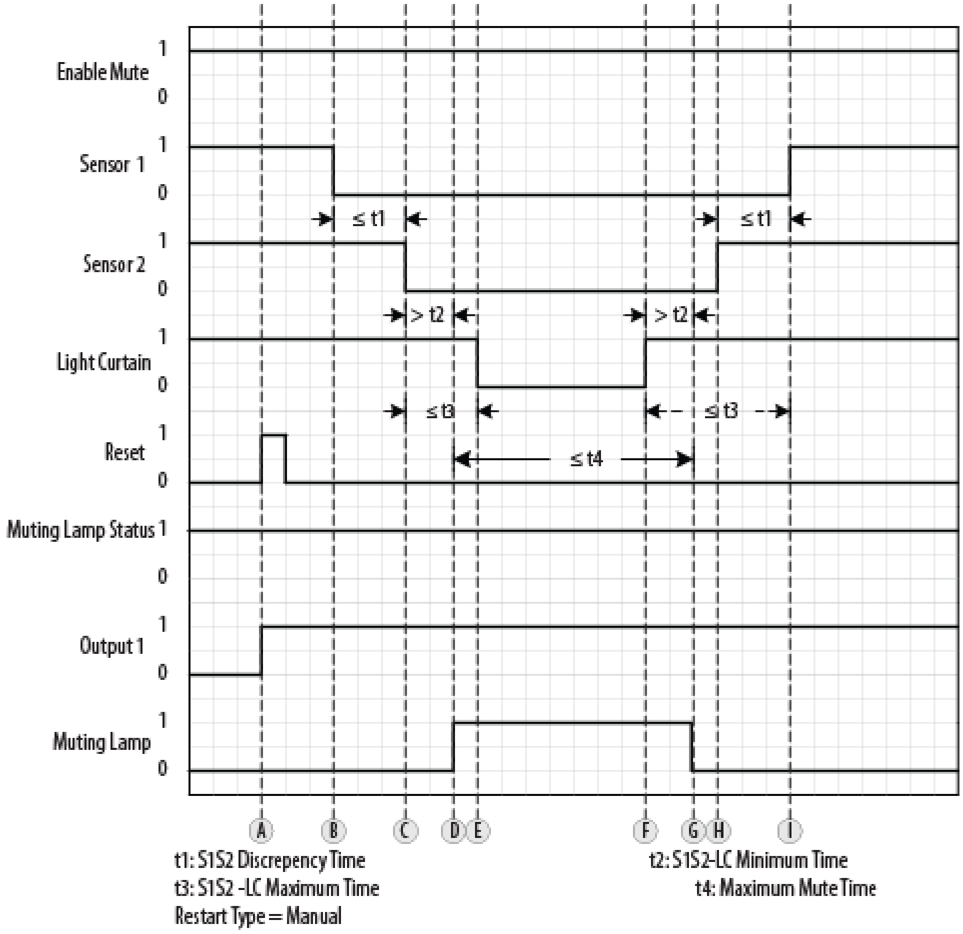
IMPORTANT Do not write to any instruction output tag under any circumstance.

Operation

Normal Operation

One sequence of muting sensor and light-curtain input transitions lets the protective function of the light curtain be disabled (muted). That sequence must start with both of the muting sensors (S1, S2) and the light curtain in their ON (1) state. This indicates that the light-curtain sensing field is clear of all personnel and material.

At (A), the Sensors and the Light Curtain are cleared and the Output 1 output is energized when the Reset input turns ON (1). The material blocks Sensor 1 at (B), starting the S1S2 Discrepancy timer. At (C), the material blocks Sensor 2, stopping the S1S2 Discrepancy timer and starting the S1S2-LC Minimum, the S1S2-LC Maximum, and the Maximum Mute timers. At (D), the S1S2-LC Minimum time period expires, starting the Maximum Mute timer and turning the Muting Lamp output ON (1). At (E), the material blocks the Light Curtain within the S1S2-LC Maximum time period, stopping the S1S2-LC Maximum timer. From (E) to (F), Output 1 remains energized while the material passes through the Light Curtain. At (F), the material clears the Light Curtain and the S1S2-LC Minimum timer starts. At (G), the S1S2-LC Minimum time period expires. The Muting Lamp output turns OFF (0) and the Maximum Mute timer is stopped, indicating that muting is disabled. The material clears Sensor 2 at (H), starting the S1S2 Discrepancy timer. At (I), the material clears Sensor 1 within the S1S2-LC Maximum time period, stopping the S1S2 Discrepancy timer.

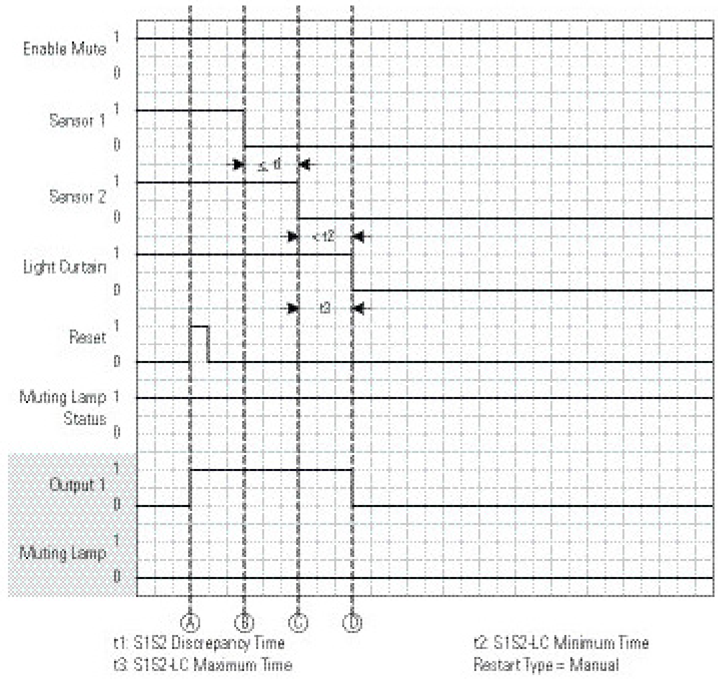


Invalid Sequence

Any input sequence other than the normal operation sequence results in Output 1 being de-energized.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), the material blocks Sensor 1, starting the S1S2 Discrepancy timer. The material blocks Sensor 2 at (C), stopping the S1S2 Discrepancy timer, starting the S1S2-LC Minimum timer and the S1S2 -LC Maximum timer. At (D), the

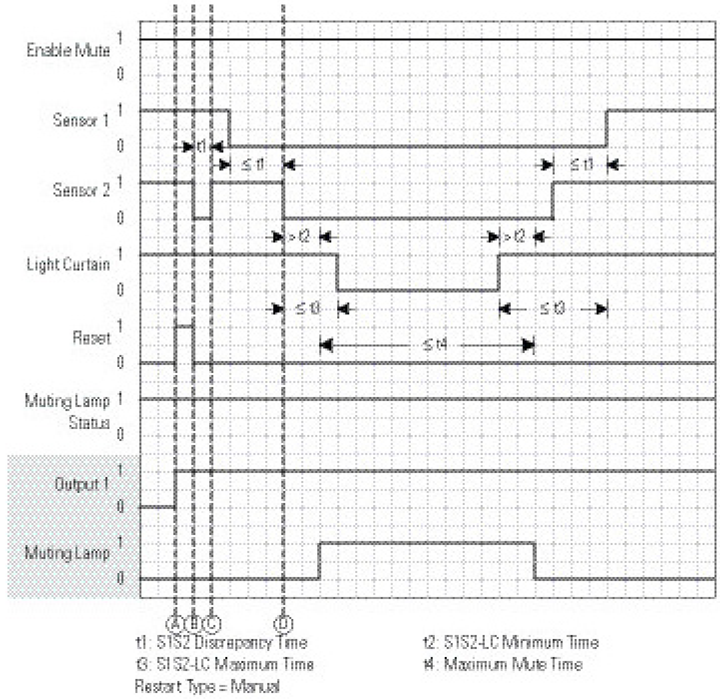
Light Curtain is blocked during the S1S2-LC Minimum Time period, causing Output 1 to be de-energized. The S1S2-LC Maximum timer stops.



Tolerated Sequence

The Two-sensor Symmetrical Muting (TSSM) instruction tolerates application dynamics that might cause an input to oscillate due to over-travel or load vibration.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), Sensor 2 turns OFF (0), starting the S1S2 Discrepancy timer. Sensor 2 turns ON (1) at (C), stopping the S1S2 Discrepancy timer. At (D), the material completely blocks Sensor 2, turning it OFF (0), and the normal muting sequence continues. A sensor may glitch, as illustrated from (B) to (C), as a result of over-travel or load vibration. As long as the final input sequence is valid, the instruction lets the muting function occur.

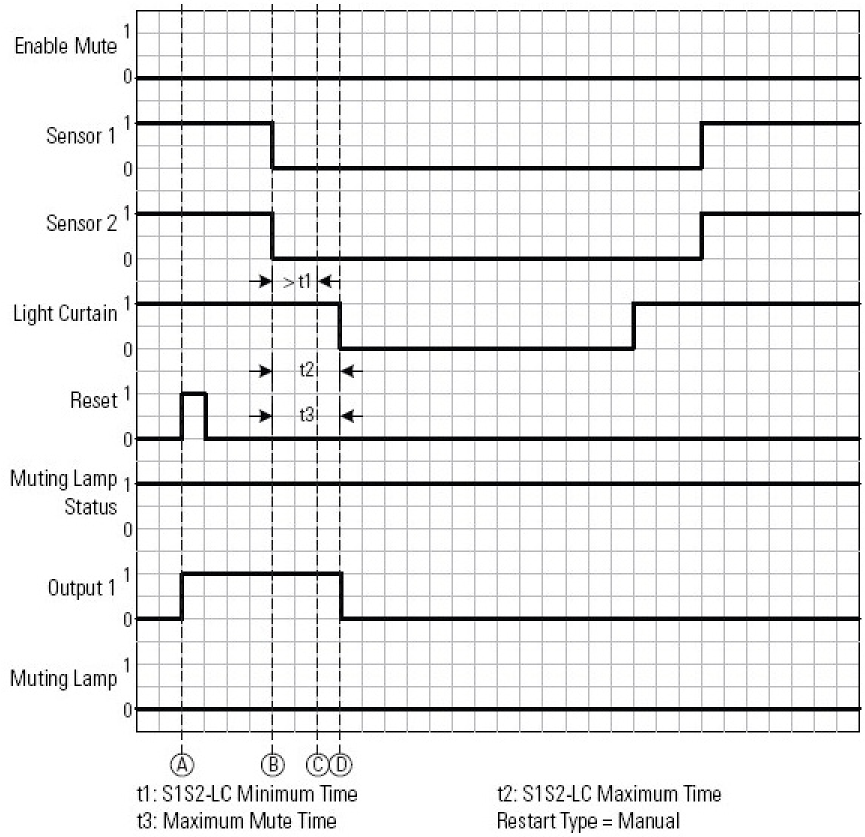


Dangerous Portion of Cycle

The Enable Mute input enables or disables the protective function of the light curtain. When the Enable Mute input is OFF (0), the protective function of the light curtain is enabled and material may not pass through the light curtain sensing field.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), the material blocks Sensor 1 and Sensor 2, turning them OFF (0) and starting the S1S2-LC Minimum, the S1S2-LC Maximum, and the Maximum Mute timers. Because the Enable Mute input is OFF (0), muting is disabled and the Muting Lamp output remains OFF (0). At (C), the S1S2-LC Minimum time period expires. The material blocks the Light Curtain at (D), and Output 1 is de-energized.

If the application does not have parts of its cycle where it is unacceptable for material to pass through the light curtain, you can disable this feature by setting the Enable Mute input to a constant value of ON (1).

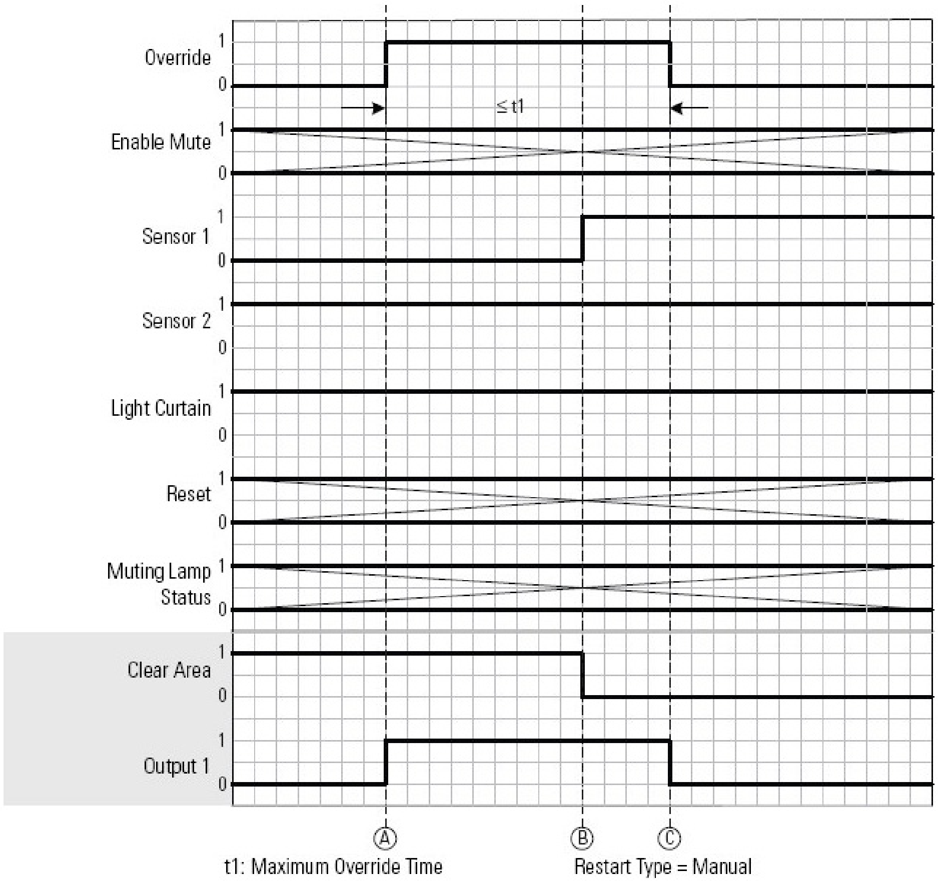


Override Operation

The override feature lets an operator manually energize Output 1 so that material can be cleared from the light curtain sensing field.

ATTENTION: The Override function may be used only with a hold-to-run device where the operator can see the point of hazard, that is, the light curtain sensing field.

At (A), the Override input turns ON (1). Output 1 is energized and the Maximum Override timer starts. At (B), the material clears Sensor 1 and the Clear Area output turns OFF (0). At (C), the Override input turns OFF (0) within the Maximum Override time period. Output 1 is de-energized and the Maximum Override timer stops.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes

The fault codes are listed in hexadecimal format followed by decimal format.

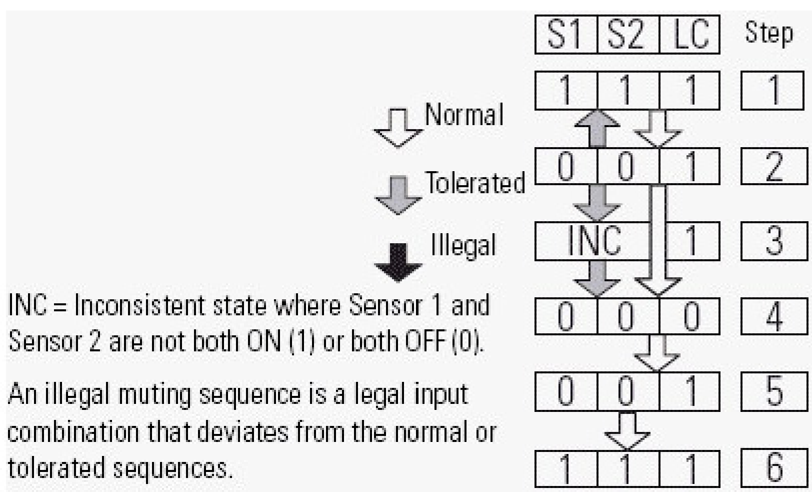
General Fault Codes

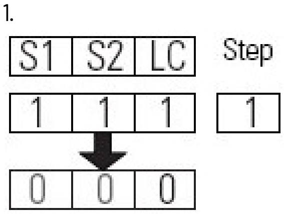
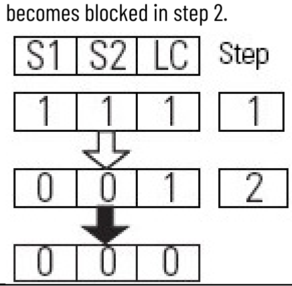
Fault Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status input went from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the logic used to source input status. • Reset the fault.

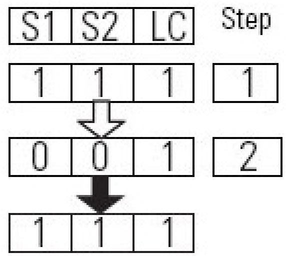
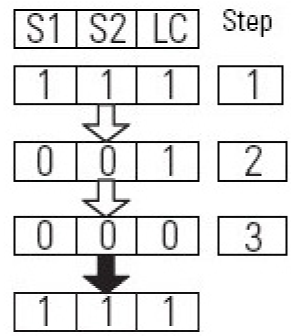
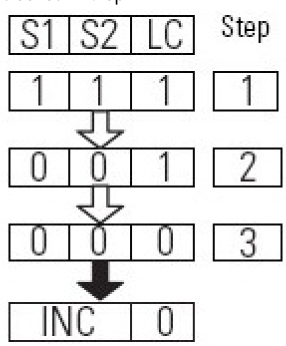
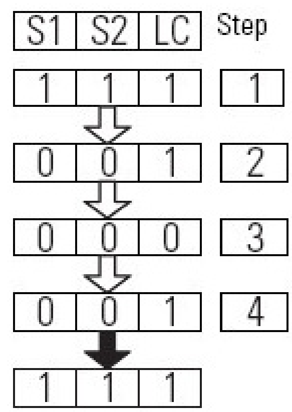
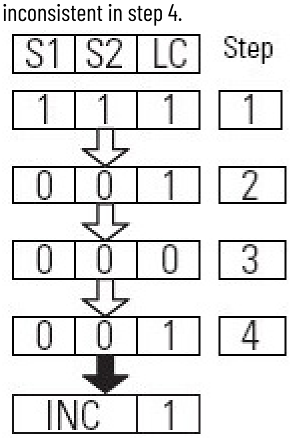
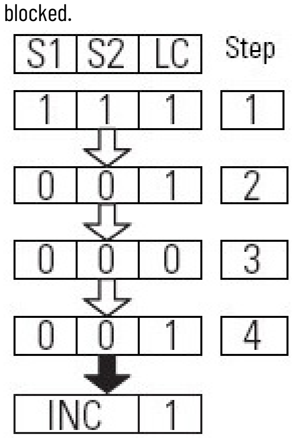
Input Pattern Fault Codes

Fault Code	Description	Corrective Action
16#9A00 39424	An illegal input pattern was detected. Sensor 1 and the Light Curtain are blocked and Sensor 2 cleared. S1 S2 LC 0 1 0	Sensor 2 should also be blocked. • Check the Sensor 2 circuit. • Rest the fault.
16#9A01 39425	An illegal input pattern was detected. Sensor 2 and the Light Curtain are blocked and Sensor 1 is cleared. S1 S2 LC 1 0 0	Sensor 1 should also be blocked. • Check the Sensor 1 circuit. • Reset the fault.
16#9A02 39426	An illegal input pattern was detected. Sensor 1 and Sensor 2 are cleared and the Light Curtain is blocked. S1 S2 LC 1 1 0	The Light Curtain should not be blocked when Sensors 1 and 2 are clear. • Check the Light Curtain circuit. • Reset the fault.

Muting Sequence Faults



Fault Code	Description	Fault Code	Description
16#9900 39168	An illegal muting sequence was detected when Sensor 1, Sensor 2, and the Light Curtain are simultaneously blocked in step 1. 	16#9901 39169	An illegal muting sequence was detected while the S1S2-LC Minimum timer is timing and the Light Curtain becomes blocked in step 2. 

Fault Code	Description	Fault Code	Description
16#9902 39170	An illegal muting sequence was detected after the S1S2-LC Minimum Time expires and Sensor 1 and Sensor 2 are simultaneously cleared in step 2. 	16#9903 39171	An illegal muting sequence was detected when Sensor 1, Sensor 2, and the Light Curtain are simultaneously cleared in step 3. 
16#9904 39172	An illegal muting sequence was detected when Sensor 1 and Sensor 2 became inconsistent while the Light Curtain was blocked in step 4. 	16#9905 39173	An illegal muting sequence was detected while the LC-S1S2 Minimum timer is timing and Sensor 1 and Sensor 2 are cleared in step 4. 
16#9906 39174	An illegal muting sequence was detected while the LC-S1S2 Minimum timer is timing and Sensor 1 and Sensor 2 become inconsistent in step 4. 	16#9907 39175	An illegal muting sequence was detected while the S1S2 Discrepancy timer is timing in step 2 (a tolerated sequence) when Sensor 1, Sensor 2, and the light curtain are simultaneously blocked. 

To correct an invalid sequence fault, check the alignment of the sensors with regard to the material being moved and the system timing and then reset the fault.

Correcting Invalid Sequence Faults

Fault Code	Description	Corrective Action
16#9000 36864	The Light Curtain was muted for longer than the configured Maximum Mute Time.	The Maximum Mute Time parameter is set too short or there is an anomaly with the sensors.
16#9810 38928	Too much time has elapsed between Sensor 1 and Sensor 2 becoming consistent.	The S1S2 Discrepancy Time parameter is set too short or there is an anomaly with the sensors.
16#9811 38929	Too much time has elapsed between Sensor 1 and Sensor 2 being blocked and the Light Curtain being blocked.	The S1S2-LC Maximum Time parameter is set too short or there is an anomaly with the sensors.
16#9812 38930	Too much time has elapsed between the Light Curtain being cleared and Sensor 1 and Sensor 2 being cleared.	

Diagnostic Codes

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None
16#01 1	The Muting Lamp Status input is OFF (0).	• Check the muting lamp and replace it, if necessary. • If a muting lamp is not required, set the Muting Lamp Status input to ON (1).
16#05 5	The Reset input is held ON (1).	Set the Reset input to OFF (0).
16#20 32	The Input Status input was OFF (0) when the instruction started.	Check the I/O module connection or the logic used to source input status.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .ML, .CA and .FP are cleared to false.

Condition/State	Action Taken
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung-condition-in is false.

See also

Common Attributes on page 529

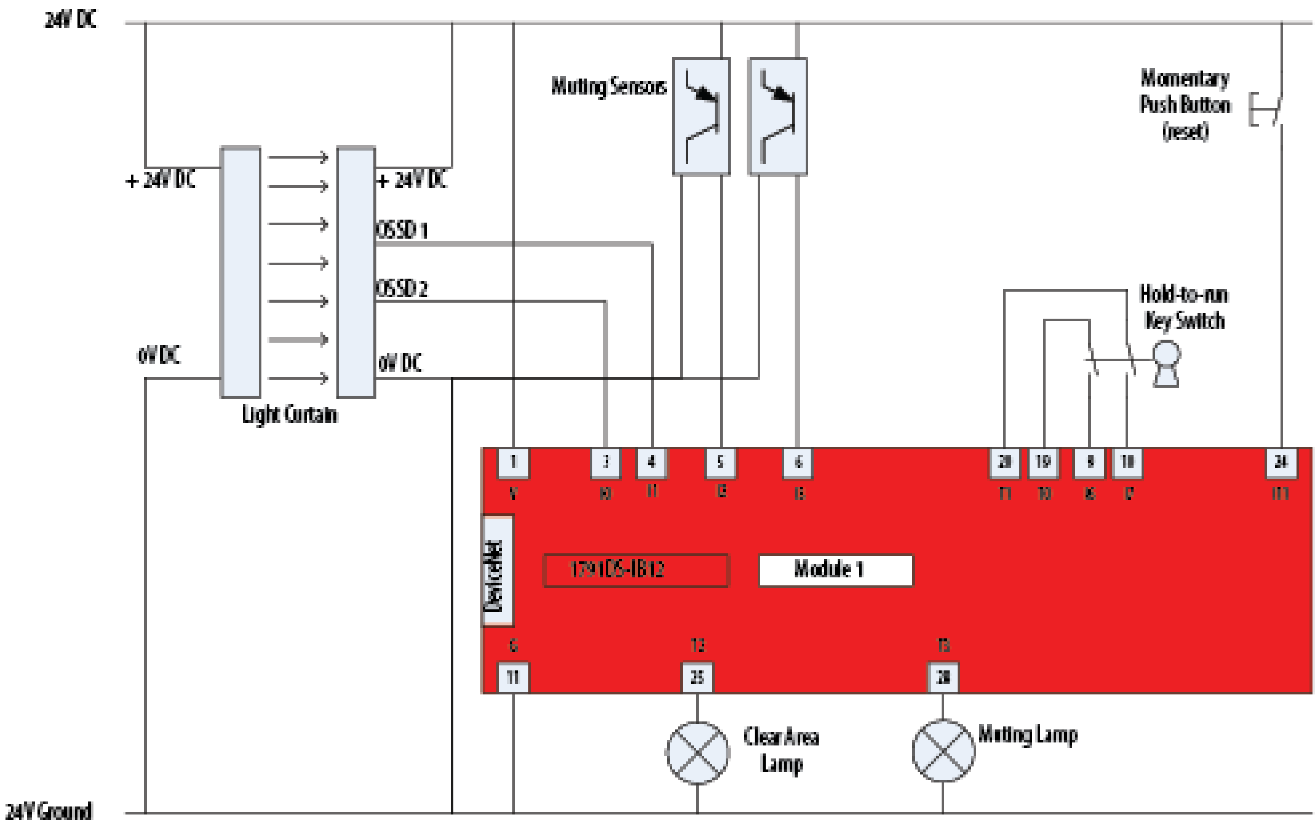
Index Through Arrays on page 540

Two Sensor Symmetrical Muting (TSSM) wiring and programming example on page 201

Two Sensor Symmetrical Muting (TSSM) wiring and programming example

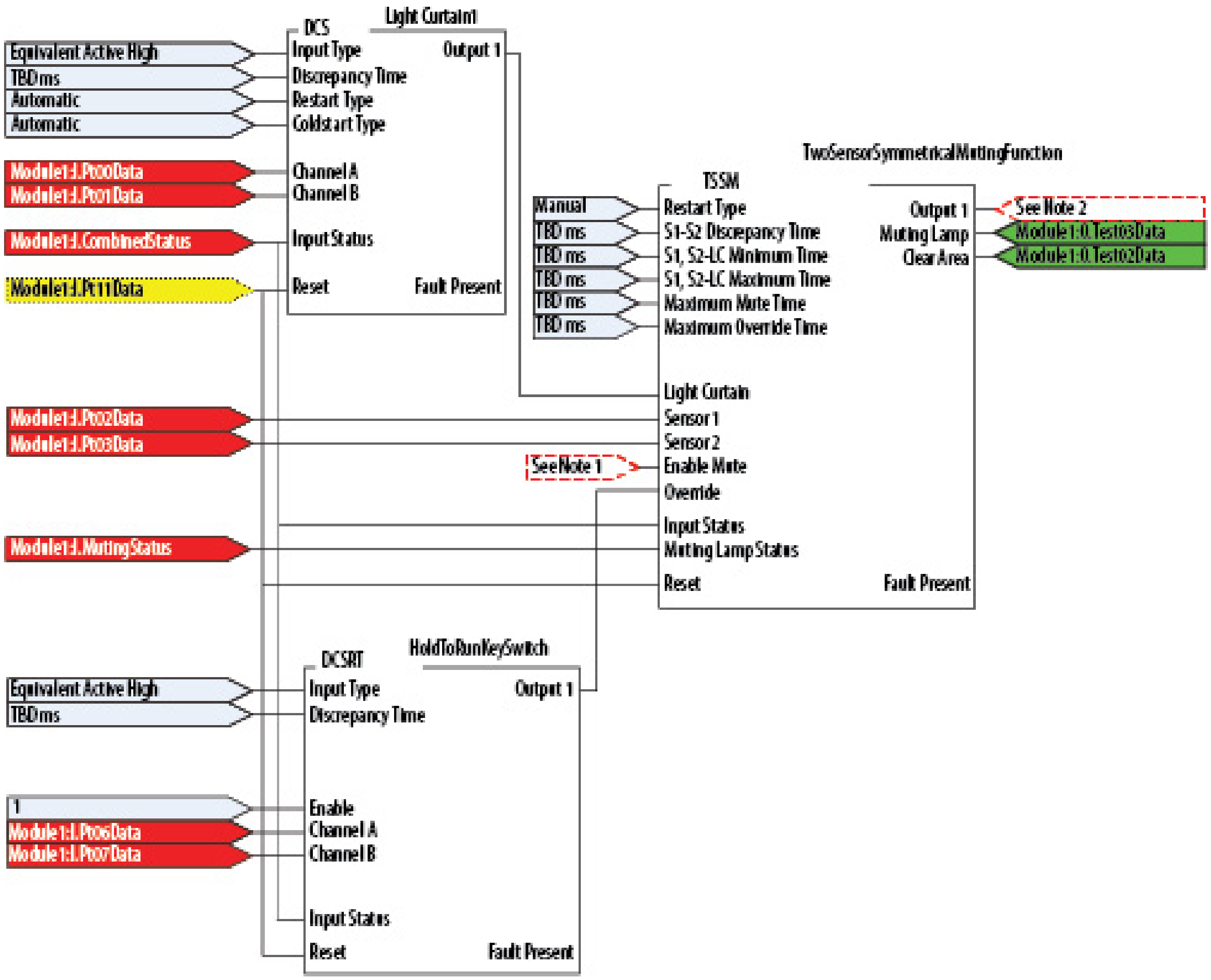
This example complies with ISO 13849-1 Category 4 operation. The standard control portion of the application is not shown.

This wiring diagram shows how to wire a light curtain and two muting sensors to a 1791DS-IB12 module to illustrate the use of the Two Sensor Symmetrical Muting instruction.



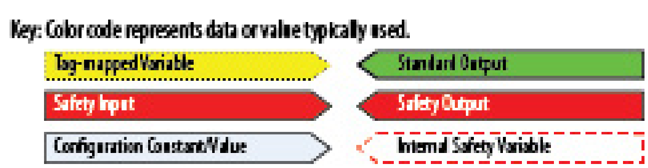
Programming Example

This programming diagram logically illustrates how the Two Sensor Symmetrical Muting instruction is typically used with a DCI Stop (light curtain) and DCI Start (hold-to-run switch) instruction.

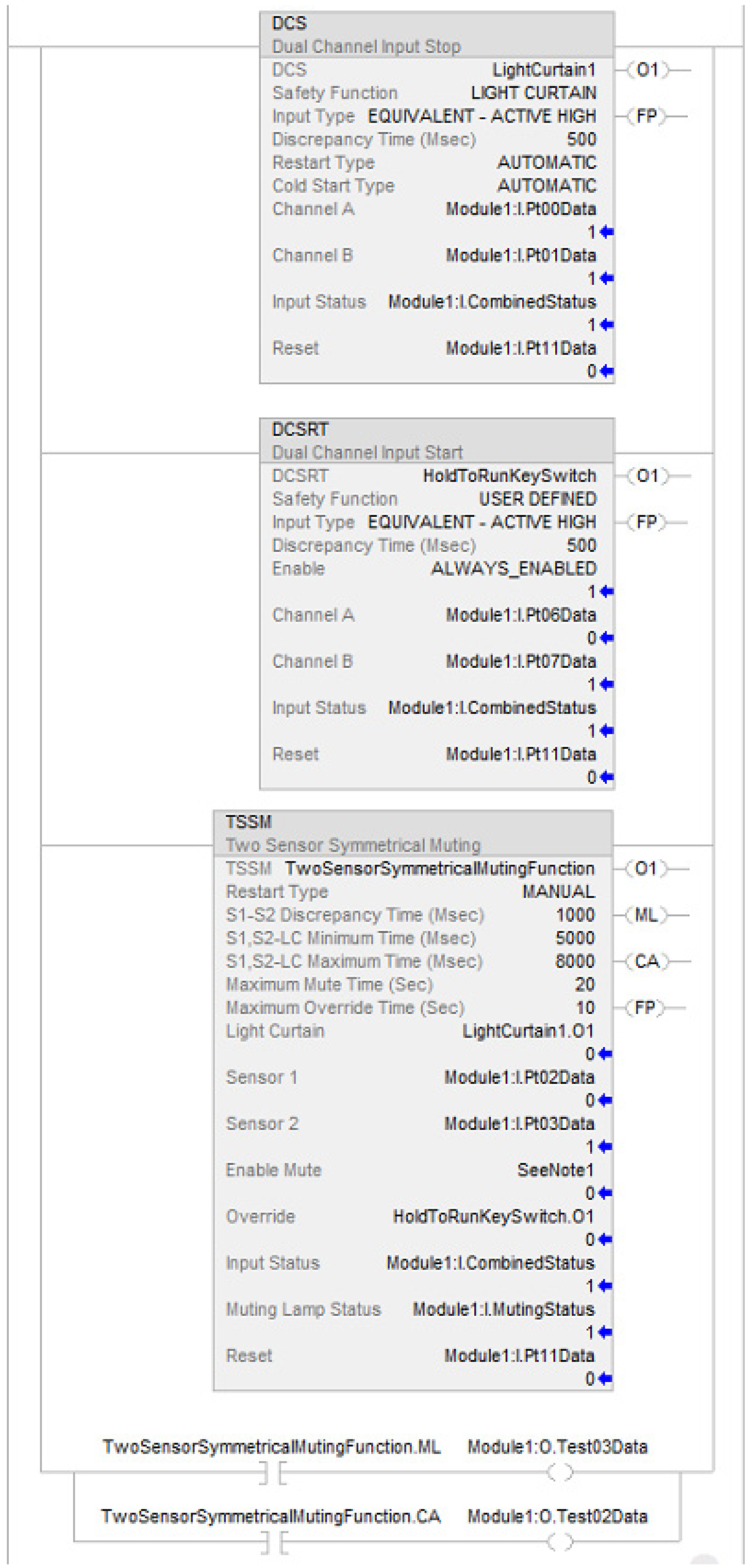


Note 1: This tag is an internal Boolean tag that represents the nonhazardous portion of the machine cycle. Its value is determined by other parts of the user application that are not shown in this example. When the protected hazard is present, this tag value should be False (0). When the protected hazard is not present, this tag value should be True (1). When the value of this tag is True (1), the muting instruction allows the light curtain to become muted only if the proper input sequence is detected. When the value of this tag is False (0), the muting instruction does not allow the light curtain to become muted, even if the proper input sequence is detected.

Note 2: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.



Ladder Diagram

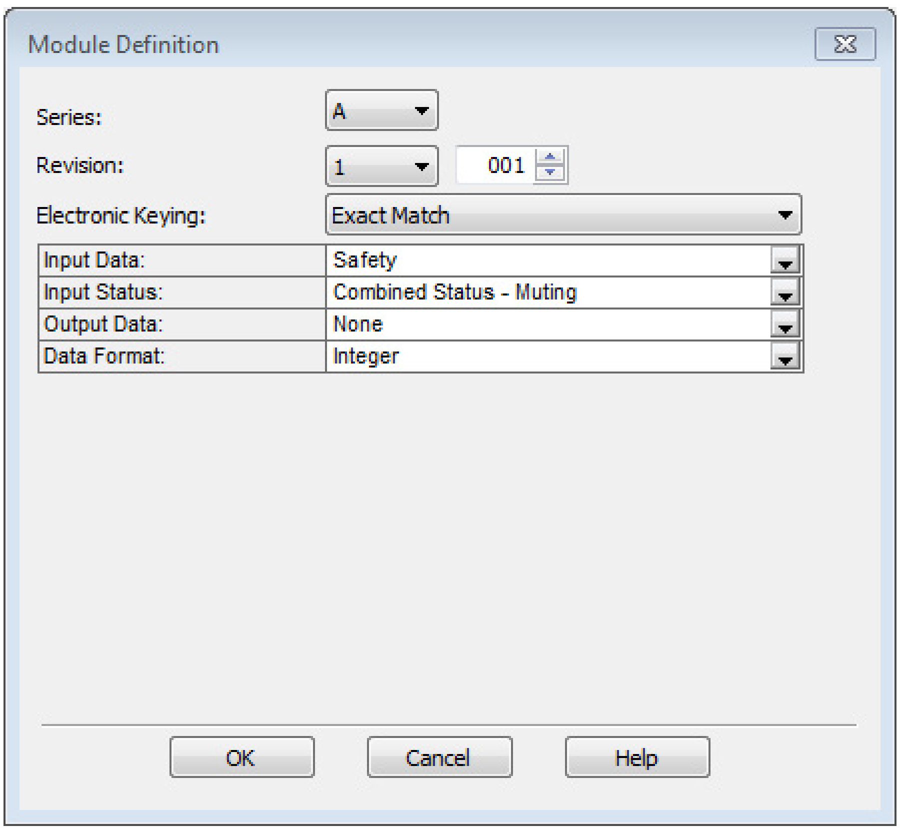


Tip: The tag in the preceding diagram is an internal Boolean tag that represents the nonhazardous portion of the machine cycle. Its value is determined by other parts of the user application that are not shown in this example. When the protected hazard is present, the tag value should be False (0). When the protected hazard is not present, this tag value should be true (1). When the value of the tag is true (1), the muting instruction allows the light curtain to become muted only if the proper input sequence is detected. When the value of the tag is False (0), the muting instruction does not allow the light curtain to become muted, even if the proper input sequence is detected.

The programming software is used to configure the input and output parameters of the Guard I/O module, as illustrated.

When defining the module, setting the Input Status to Combined Status-Muting provides the smallest input packet possible and lets the muting lamp status be monitored. Choosing Test for Output Data lets safety logic control Test Output 3 to drive the Muting Lamp and Test Output 2 to drive the Clear Area Lamp.

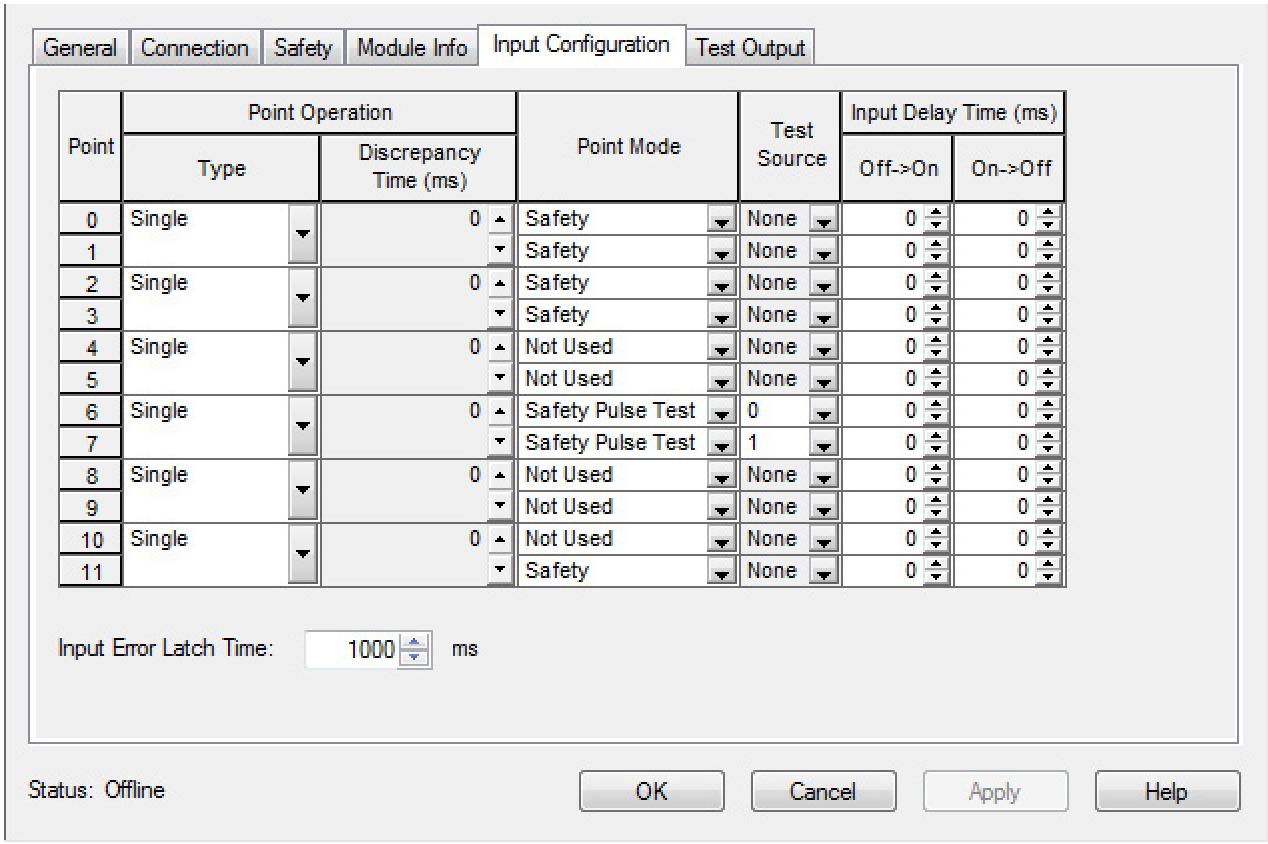
Module Definition



Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. You also select **Compatible Match**.

The safety inputs that interface with the Light Curtain (Points 1 and 2) are not pulse-tested because the Light Curtain pulse-tests its own signals.

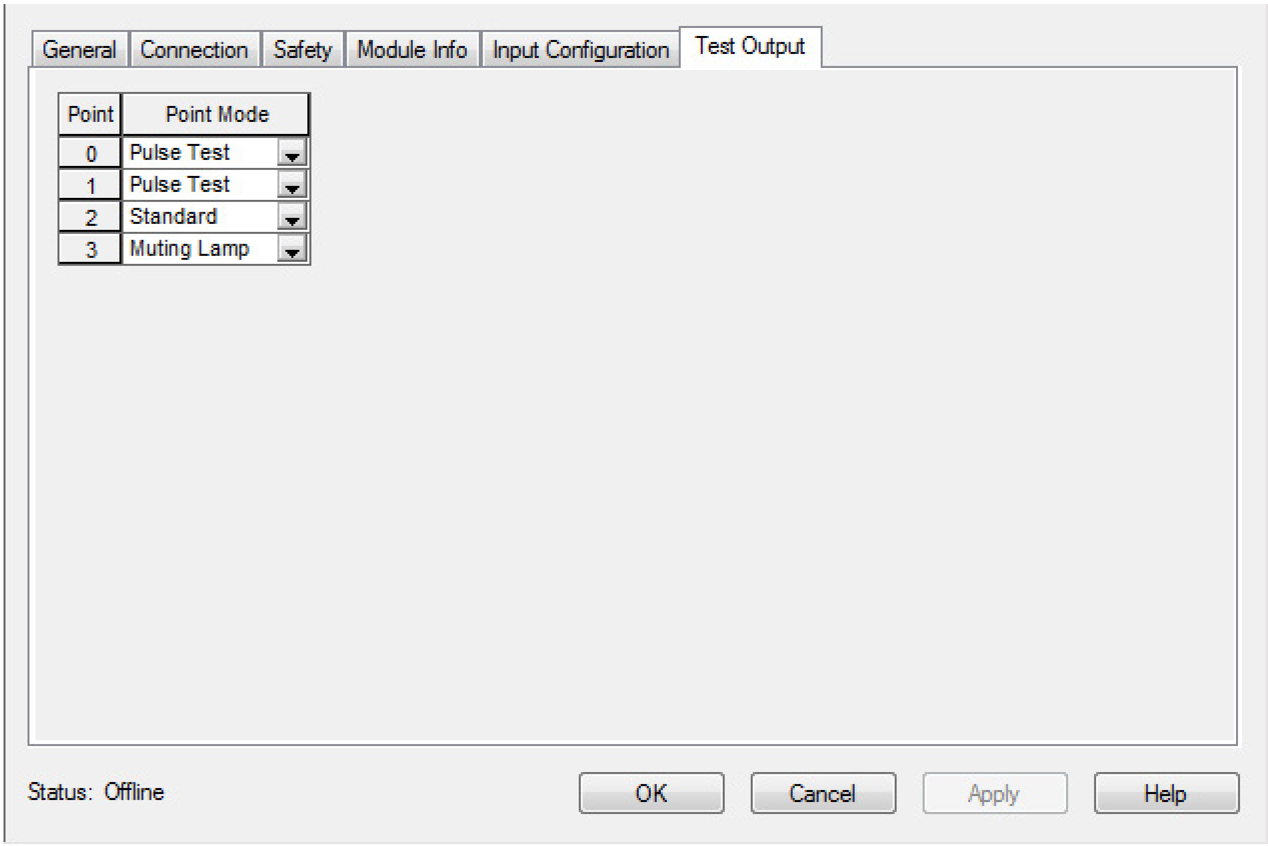
Module Input Configuration



Point	Point Operation: Type	Point Operation: Discrepancy Time (ms)	Point Mode	Test Source	Input Delay Time (ms): Off->On	Input Delay Time (ms): On->Off
0	Single	0	Safety	None	0	0
1			Safety	None	0	0
2	Single	0	Safety	None	0	0
3			Safety	None	0	0
4	Single	0	Not Used	None	0	0
5			Not Used	None	0	0
6	Single	0	Safety Pulse Test	0	0	0
7			Safety Pulse Test	1	0	0
8	Single	0	Not Used	None	0	0
9			Not Used	None	0	0
10	Single	0	Not Used	None	0	0
11			Safety	None	0	0

Configuring Test Output 3 for Muting Lamp causes the I/O module to monitor the lamp that is connected to this output.

Module Test Output Configuration



See also

Two-sensor Symmetrical Muting (TSSM) on page 186

Four Sensor Bi-Directional Muting (FSBM)

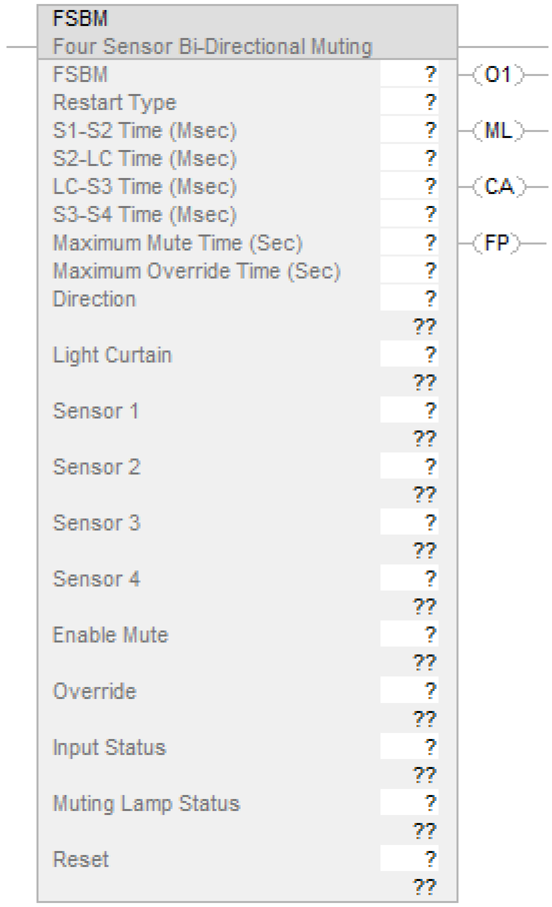
This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

This instruction provides a temporary, automatic disabling of the protective function of a light curtain, which allows material to be transported through the light curtain sensing field without stopping the machine. Muting sensors differentiate between materials and personnel and must act together along with the light curtain, in a specific switching sequence when the appropriate material passes the sensing field.

The Direction input sets the expected direction from which the material passes through the sensing field. Once this direction is established, and providing the proper sequencing of the sensors and light curtain is maintained, bidirectional movement of the material is permitted.

Available Languages

Ladder Diagram



Function Block

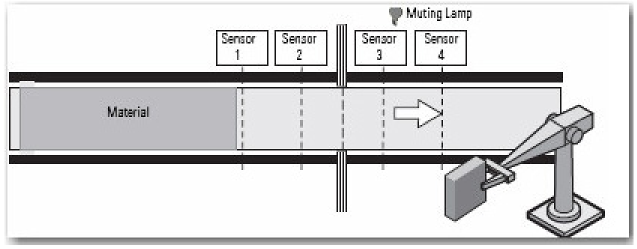
This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Four Sensor Bi-Directional Muting Application

Four-Sensor Bi-Directional Muting uses four muting sensors arranged sequentially before and after the light curtain's center of the protected opening.



ATTENTION: The muting sensors must be arranged so a person cannot activate the muting sensors in the same switching sequence as the material and enter the area when a hazardous condition exists. Sensor setup must take into account material size, shape, and speed. Additional guarding may also be necessary.

Specific guarding requirements should be identified through a hazard or risk assessment of the application.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The FSBM structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands that are used to configure the instruction.

Operand	Data Type	Format	Description
FSBM	MUTING_FOUR_SENSOR_BDIR	tag	Data structure required for proper operation of instruction.
Restart Type	BOOL	list item	This input configures O1 (Output 1) for either manual or automatic restart. **MANUAL (0)** A transition of the reset input from OFF (0) to ON (1), while all of the Output 1 enabling conditions are met, is required to energize Output 1. **AUTOMATIC (1)** Output 1 is energized 50 ms when all of the enabling conditions are met. **ATTENTION:** Only use Automatic Restart in application situations where it is determined that no unsafe conditions will occur from its use.

Operand	Data Type	Format	Description
S1-S2 Time	DINT	immediate	The maximum amount of time allowed between Sensor 1 being blocked and Sensor 2 being blocked before a fault occurs. The valid range is 5 through 180,000 ms. Setting this input to 0 disables the S1-S2 timer.
S2-LC Time	DINT	immediate	The maximum amount of time allowed between Sensor 2 being blocked and the Light Curtain being cleared before a fault occurs. The valid range is 5 through 180,000 ms. Setting this input to 0 disables the S2-LC timer.
LC-S3 Time	DINT	immediate	The maximum amount of time allowed between Sensor 3 being blocked and the Light Curtain being blocked before a fault occurs. The valid range is 5 through 180,000 ms. Setting this input to 0 disables the LC-S3 timer.
S3-S4 Time	DINT	immediate	The maximum amount of time allowed between Sensor 3 being blocked and Sensor 4 being blocked before a fault occurs. The valid range is 5 through 180,000 ms. Setting this input to 0 disables the S3-S4 timer.
Maximum Mute Time	DINT	immediate	The maximum amount of time during which the instruction lets the protective function of the light curtain be disabled before generating a fault. The valid range is 0 through 3600 s. Setting this input to 0 disables the Maximum Mute timer.
Maximum Override Time	DINT	immediate	The maximum amount of time that the instruction lets the override feature energize the Output 1 output. The valid range is 0 through 30 s. Setting this input to 0 disables the Maximum Override timer.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Direction	BOOL	immediate tag	This input specifies the sequencing direction. ON (1): Forward. The muting sequence begins with the blocking of Sensor 1. OFF (0): Reverse. The muting sequence begins with the blocking of Sensor 4.
Light Curtain	BOOL	tag	An input channel with OFF (0) as its safe state, this input represents the current state of the physical light curtain. This input must be properly conditioned. Use the Dual Channel Input Stop instruction controlling a light curtain to accomplish this. ON (1): The light curtain is clear. OFF (0): The light curtain is blocked.
Sensor 1	BOOL	tag	One of four muting sensors. When material is moving in the forward direction, it is the first sensor to be blocked and cleared. When material is moving in the reverse direction, it is the fourth to be blocked and cleared. ON (1): Sensor 1 is clear. OFF (0): Sensor 1 is blocked.

Operand	Data Type	Format	Description
Sensor 2	BOOL	tag	One of four muting sensors. When material is moving in the forward direction, it is the second sensor to be blocked and cleared. When material is moving in the reverse direction, it is third to be blocked and cleared. ON (1): Sensor 2 is clear. OFF (0): Sensor 2 is blocked.
Sensor 3	BOOL	tag	One of four muting sensors. When material is moving in the forward direction, it is the third sensor to be blocked and cleared. When material is moving in the reverse direction, it is second to be blocked and cleared. ON (1): Sensor 3 is clear. OFF (0): Sensor 3 is blocked.
Sensor 4	BOOL	tag	One of four muting sensors. When material is moving in the forward direction, it is the fourth sensor to be blocked and cleared. When material is moving in the reverse direction, it is first to be blocked and cleared. ON (1): Sensor 4 is clear. OFF (0): Sensor 4 is blocked.
Enable Mute	BOOL	immediate tag	This input allows the protective function of the light curtain to be disabled (muted) when the correct muting sequence occurs. ON (1): The protective function of the light curtain is disabled when the correct muting sequence occurs. OFF (0): The protective function of the light curtain is always enabled.
Override	BOOL	tag	This input allows a temporary bypass of the muting instruction's function. Output 1 is energized regardless of the status of the Input Status input or the existence of faults. OFF (0): Output 1 is disabled. OFF (0) -> ON (1): Output 1 is energized regardless of the status of the Input Status input or the existence of faults. Output 1 remains energized while the Override input remains ON (1) or until the Maximum Override timer expires. **ATTENTION:** Activation of the override function requires the use of a hold-to-run device where the operator can see the point of hazard, that is, the light curtain sensing field.
Input Status	BOOL	immediate tag	If the instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If the instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Muting Lamp Status	BOOL	immediate tag	This input represents the status of the muting lamp. ON (1): The muting lamp is operating properly. The light curtain's protective function is disabled (muted) after the correct muting sequence is followed. OFF (0): The muting lamp is defective or missing. The light curtain's protective function is always enabled.

Operand	Data Type	Format	Description
Reset[1]	BOOL	tag	This input clears instruction and circuit faults provided the fault condition is not present. OFF (0) -> ON (1): The FP (Fault Present) and Fault Code outputs are reset. Output 1 is energized when the Restart Type is manual. Output 1 is not energized at the same time faults are cleared.

[1] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the 'Reset_Signal' tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains the instruction outputs.

Operand	Data Type	Description
Output 1 (O1)	BOOL	ON (1): The light curtain sensing field is not obstructed, the light curtain is being muted, or the light curtain is being overridden. OFF (0): The light-curtain sensing field is obstructed or the muting sensors sequence is incorrect.
Muting Lamp (ML)	BOOL	ON (1): The light curtain's protective function is disabled. OFF (0): The light curtain's protective function is enabled.
Clear Area (CA)	BOOL	This status output indicates when the light-curtain sensing field and all muting sensors must be cleared (ON) before processing can continue. ON (1): The light curtain sensing field must be cleared. OFF (0): Normal operation
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes for a list of diagnostic codes. This operand is not safety-related.
Fault Code	DINT	This output indicates the type of fault that occurred. See the FSBM General Fault Codes for the list of fault codes. This operand is not safety-related.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01, .ML, .CA and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung-condition-in is false.

Operation

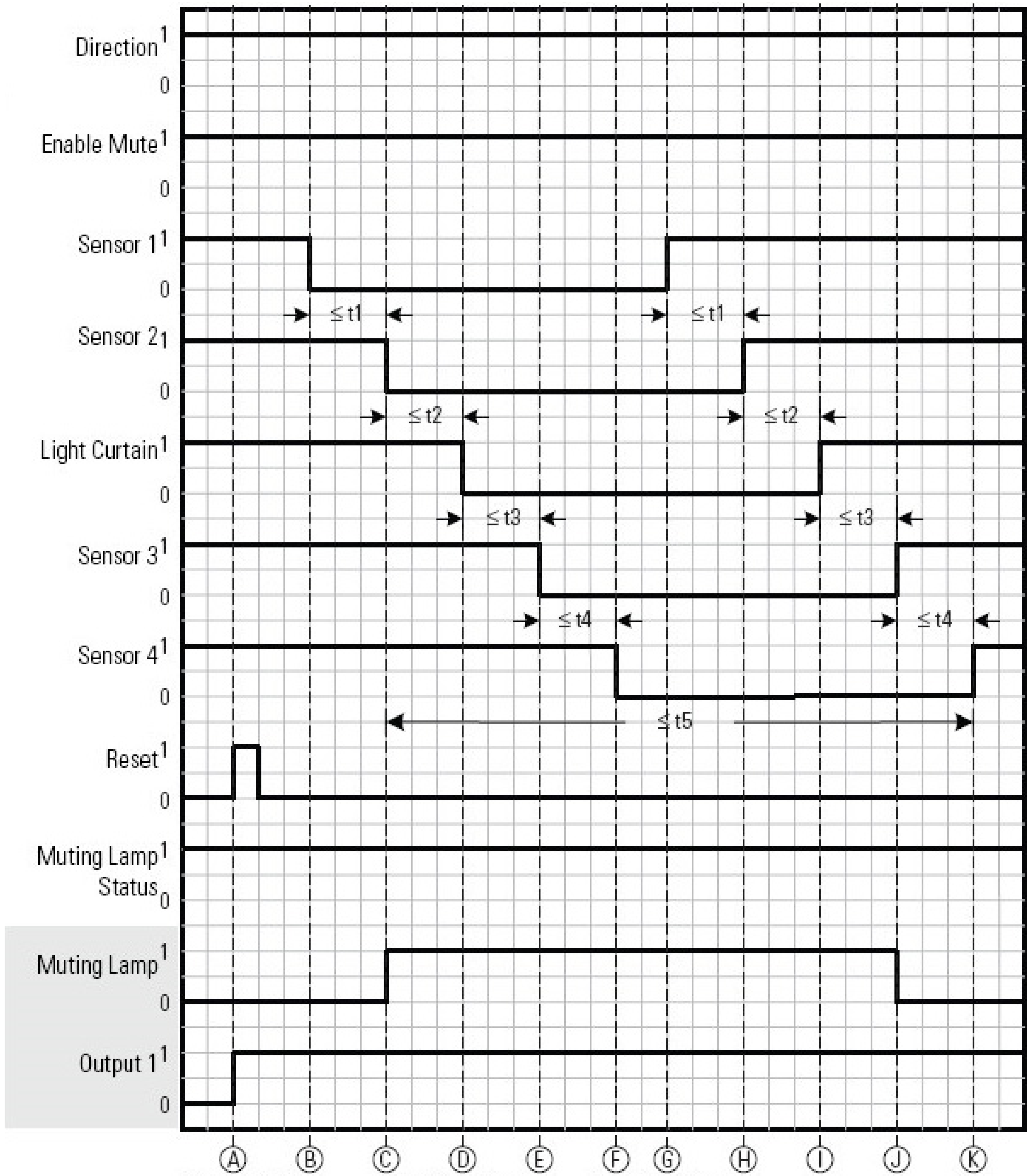
Normal Operation

One forward direction and one reverse direction sequence of muting sensor and light-curtain input transitions let the protective function of the light curtain be disabled (muted). Both sequences start with the four muting sensors and the light curtain in their ON (1) state. This indicates that the light-curtain sensing field is clear of all personnel and material.

At (A), when Sensors 1 through 4 and the Light Curtain are clear, the Output 1 output is energized when the Reset input turns ON (1). At (B), material blocks Sensor 1, starting the S1-S2 timer. At (C), the material blocks Sensor 2, stopping the S1-S2 timer. The S2-LC and Maximum Mute timers start. The Muting Lamp turns ON (1), indicating that muting is enabled. At (D), the material blocks the Light Curtain, stopping the S2-LC timer and starting the LC-S3 timer. At (E), the material blocks Sensor 3, stopping the LC-S3 timer and starting the S3-S4 timer. At (F), the material blocks Sensor 4, stopping the S3-S4 timer. The material is blocking all of the Sensors and the Light Curtain. From (G) through (K), the material clears the sensors and the Light Curtain in the same order in which they were blocked, starting and stopping the timers, until the material clears all of the sensors and the Light Curtain.

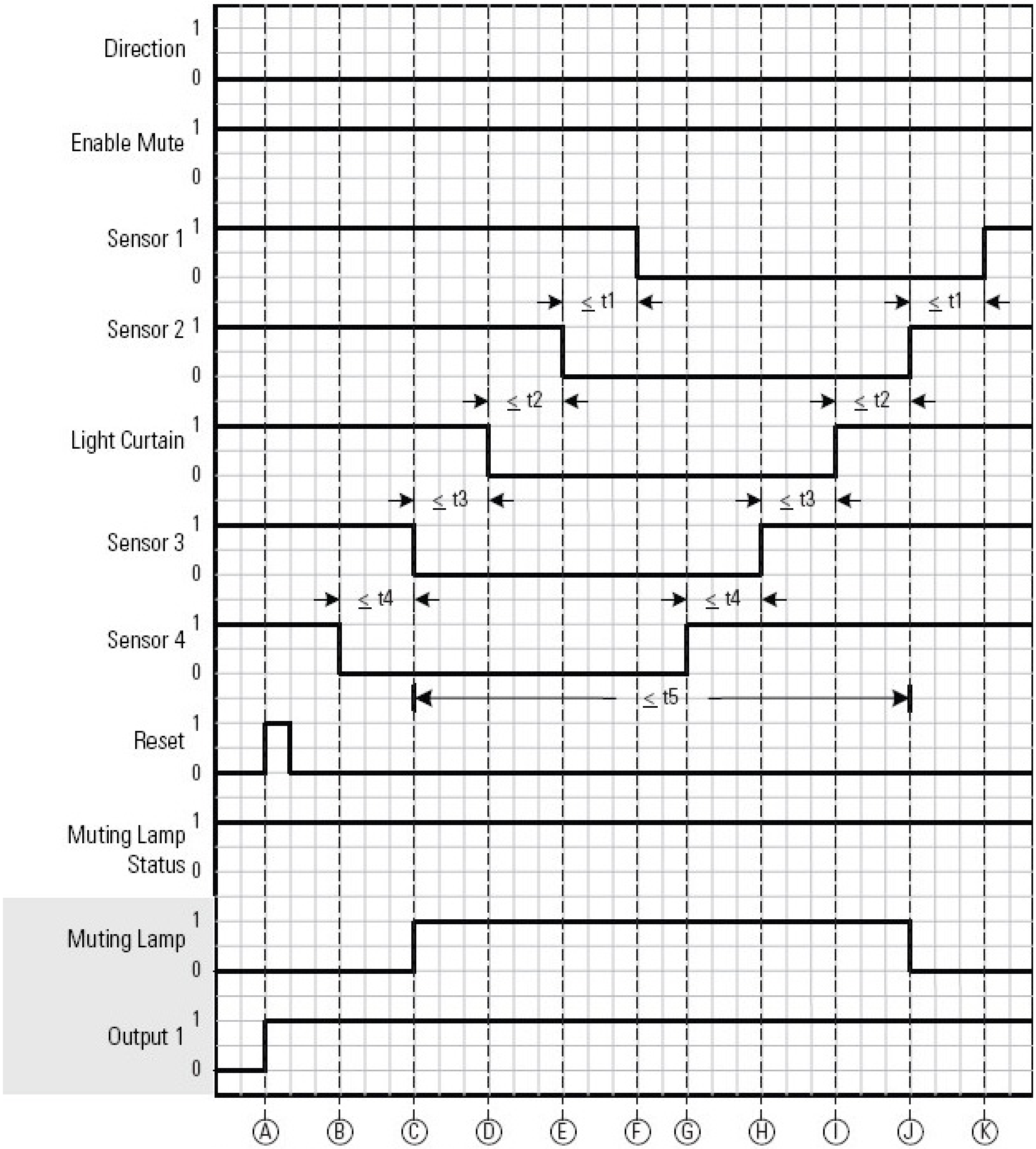
The following diagrams shows the sequence as described for the forward and reverse directions.

Normal Operation, Forward Direction



t1: S1-S2 Time
t2: S2-LC Time
t3: LC-S3 Time
t4: S3-S4 Time
t5: Maximum Mute Time
Restart Type = Manual

Normal Operation, Reverse Direction

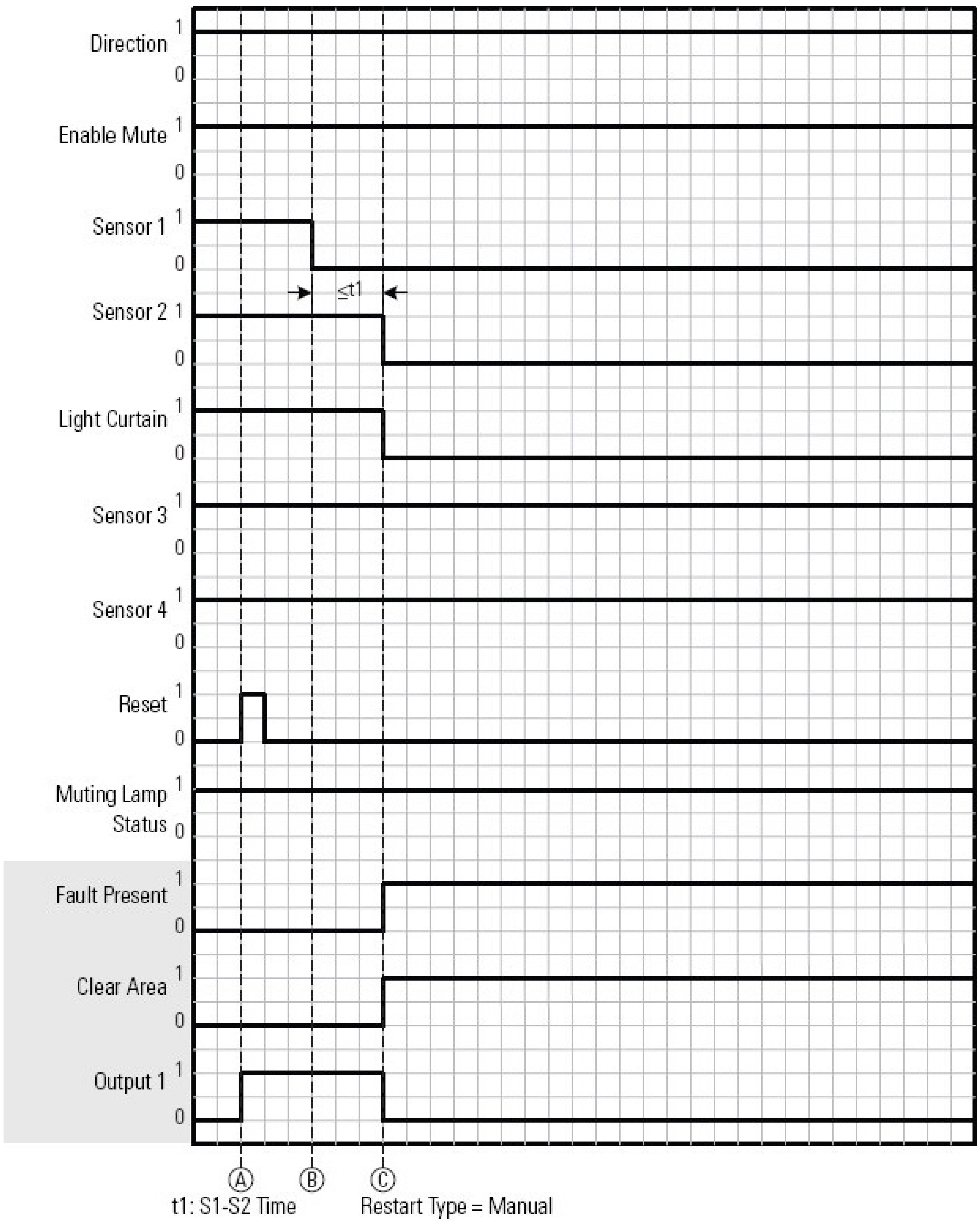


t1: S1-S2 Time t2: S2-LC Time
t3: LC-S3 Time t4: S3-S4 Time
t5: Maximum Mute Time
Restart Type = Manual

Invalid Sequence

Any input sequence other than the normal operation sequence results in Output 1 being de-energized.

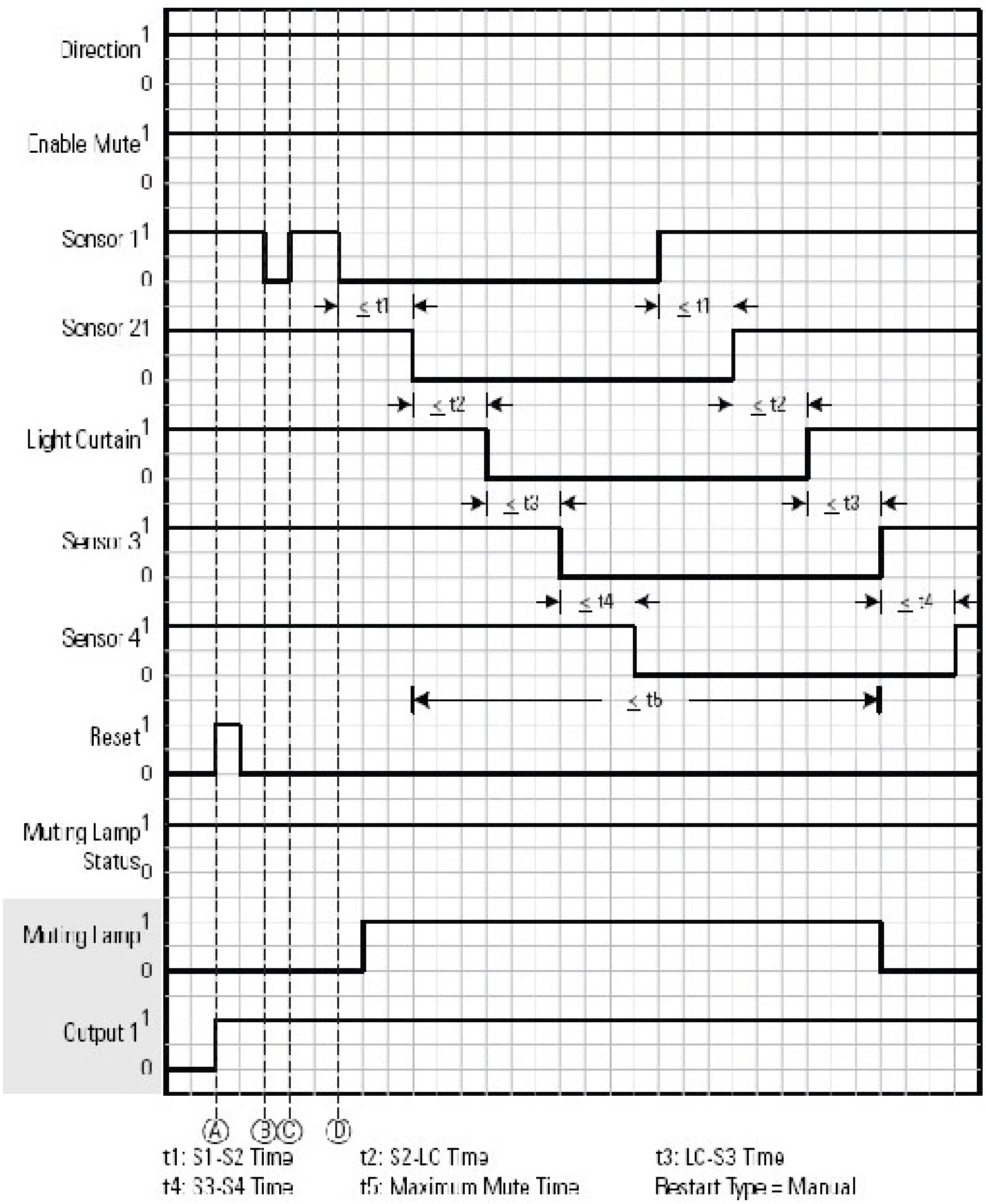
At (A), Output 1 is energized just as in a normal sequence of operation. At (B), the material blocks Sensor 1, starting the S1-S2 timer. At (C), the material simultaneously blocks Sensor 2 and the Light Curtain, stopping the S1-S2 timer. Output 1 is de-energized and the Clear Area and Fault Present outputs turn ON (1). The override feature can be used to clear the material from the sensing field and turn the Clear Area output OFF (0).



Tolerated Sequence

The Four-sensor Bidirectional Muting (FSBM) instruction tolerates application dynamics that might cause an input to oscillate due to over-travel or load vibration.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), Sensor 1 turns OFF (0), starting the S1-S2 timer. At (C), Sensor 1 turns ON, stopping the S1-S2 timer. At (D), the material completely blocks Sensor 1, turning it OFF (0) and the normal muting sequence continues. A sensor may glitch, as illustrated from (B) to (C), as a result of over-travel or load vibration. As long as the final input sequence is valid, the instruction lets the muting function occur.

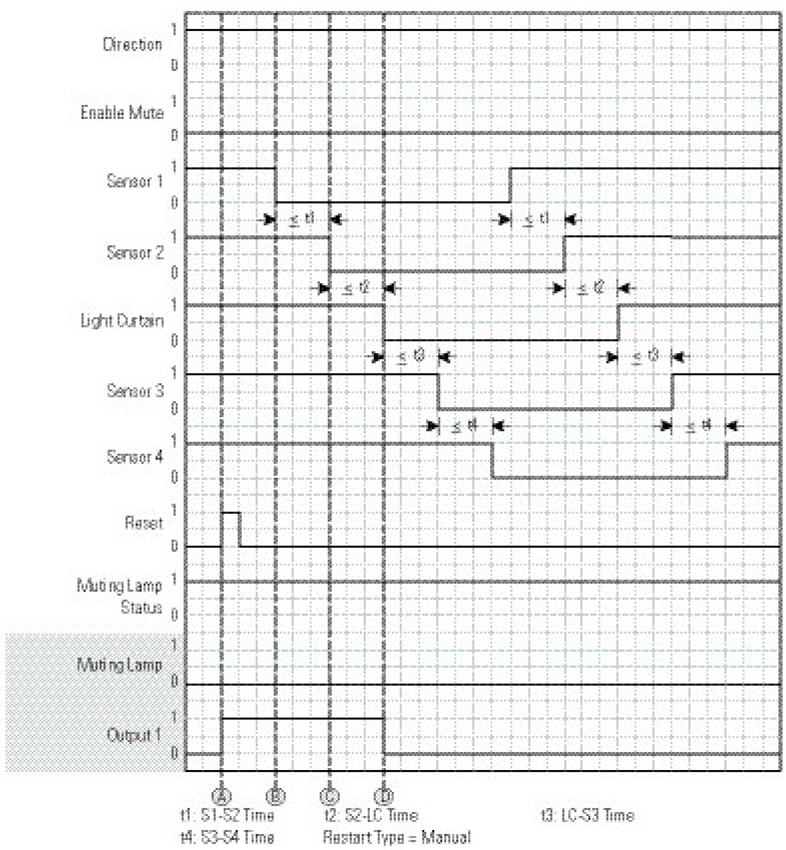


Dangerous Portion of Cycle

The Enable Mute input enables or disables the protective function of the light curtain. When the Enable Mute input is OFF (0), the protective function of the light curtain is enabled and material may not pass through the light curtain sensing field.

At (A), Output 1 is energized just as in a normal sequence of operation. At (B), the material blocks Sensor 1, starting the S1-S2 timer. At (C), the material blocks Sensor 2, stopping the S1-S2 timer and starting the S2-LC timer. Because the Enable Mute input is OFF(0), muting is disabled and the Muting Lamp output remains OFF (0). The material blocks the Light Curtain at (D), stopping the S2-LC timer. Output 1 is de-energized because the Enable Mute input is OFF (0)

If the application does not have parts of its cycle where it is unacceptable for material to pass through the light curtain, disable this feature by setting the Enable Mute input to a constant value of ON (1).

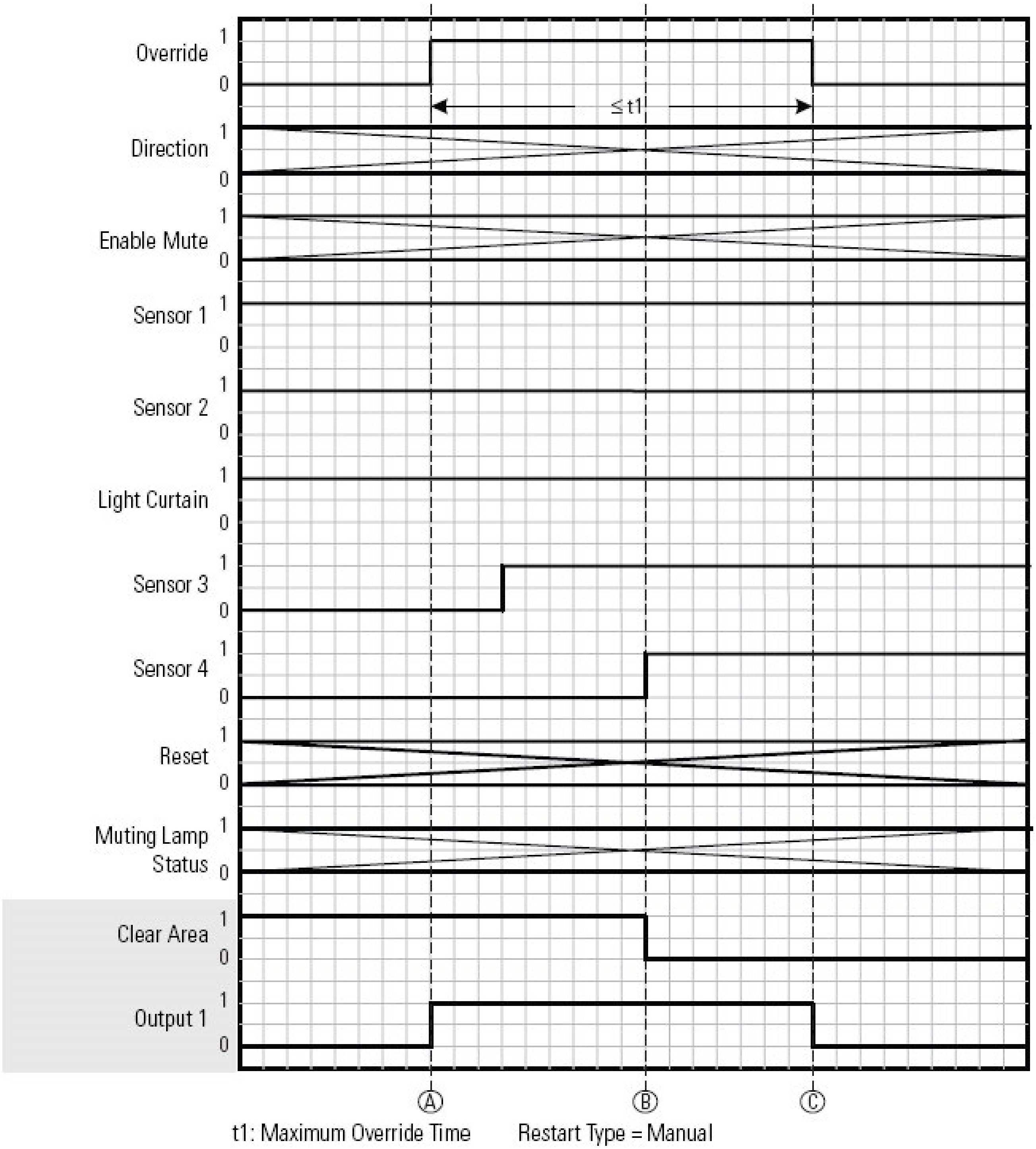


Override Operation

The override feature enables an operator to manually energize Output 1 so that material can be cleared from the light curtain sensing field.

ATTENTION: Only use the Override function may be used only with a hold-to-run device where the operator can see the point of hazard, that is, the light curtain sensing field.

At (A), the Override input turns ON (1). Output 1 is energized and the Maximum Override timer starts. At (B), the material clears Sensor 3 and Sensor 4 and the Clear Area output turns OFF (0). At (C), the Override input turns OFF (0) within the Maximum Override time period. Output 1 is de-energized and the Maximum Override timer stops.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes

The fault codes are listed in hexadecimal format followed by decimal format.

General Fault Codes

Fault Code	Description	Corrective Action
00	No fault.	None.
16#20 32	The Input Status input went from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection or the logic used to source input status. • Reset the fault.

Illegal Input Faults

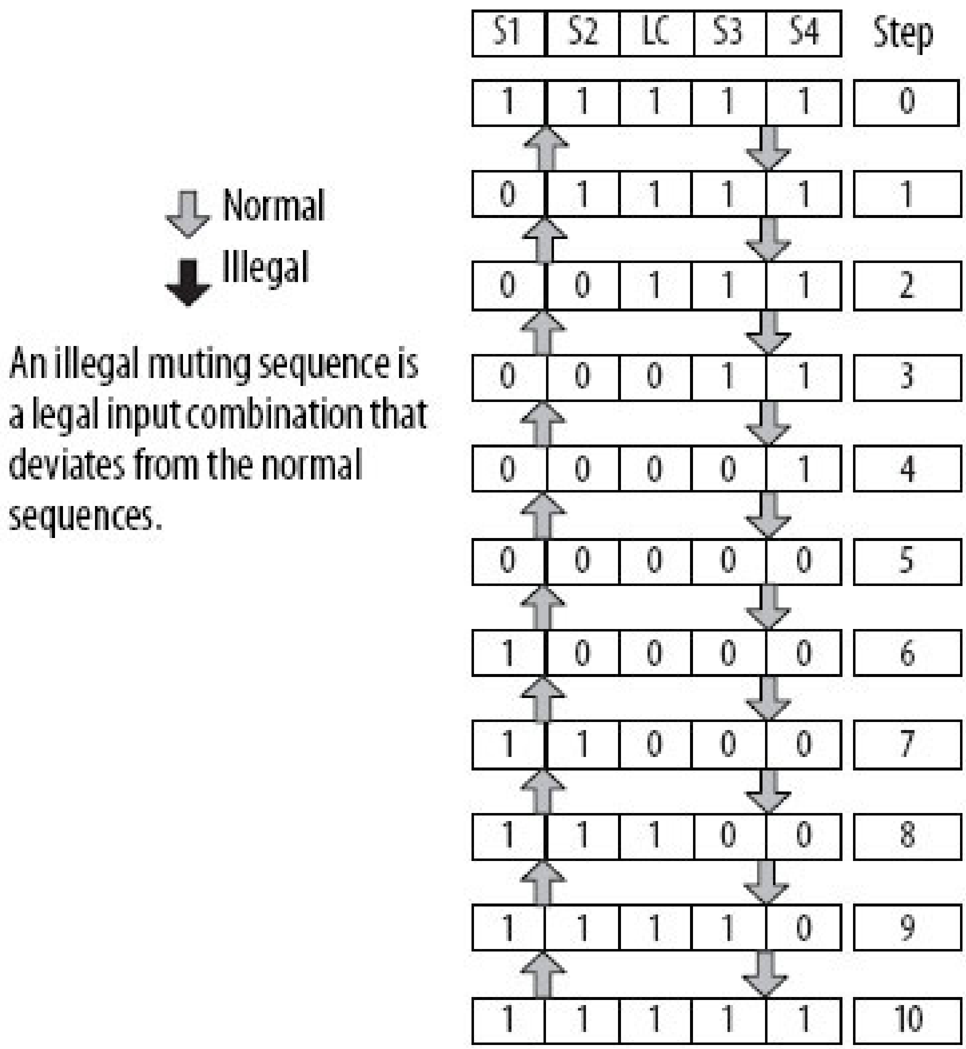
Fault Code	Description	S1	S2	LC	S3	S4
16#9200 37376	The Light Curtain, Sensors 1, 2, and 4 are blocked, while Sensor 3 is clear.	0	0	0	1	0
16#9201 37377	Sensors 1, 2, 3, and 4 are blocked and the Light Curtain is clear.	0	0	1	0	0
16#9202 37378	Sensors 1, 2, and 3 are blocked and the Light Curtain and Sensor 4 are clear.	0	0	1	0	1
16#9203 37379	Sensors 1, 2, and 4 are blocked and the Light Curtain and Sensor 3 are clear.	0	0	1	1	0
16#9204 37380	Sensors 1, 3, and 4 and the Light Curtain are blocked and Sensor 2 is clear.	0	1	0	0	0
16#9205 37381	Sensors 1, 3, and the Light Curtain are blocked and sensors 2 and 4 are clear.	0	1	0	0	1
16#9206 37382	Sensors 1, 4 and the Light Curtain are blocked and Sensors 2 and 3 are clear.	0	1	0	1	0
916#207 37383	Sensor 1 and the Light Curtain are blocked and Sensors 2, 3, and 4 are clear.	0	1	0	1	1
16#9208 37384	Sensor 2 and the Light Curtain are blocked and Sensors 1, 3, and 4 are clear.	0	1	1	0	0
16#9209 37385	Sensors 1 and 3 are blocked and Sensors 2 and 4 and the Light Curtain are clear.	0	1	1	0	1
16#920A 37386	Sensors 1 and 4 are blocked and Sensors 2 and 3 and the Light Curtain are clear.	0	1	1	1	0
16#920B 37387	Sensors 2 and 3 and the Light Curtain are blocked and Sensors 1 and 4 are clear.	1	0	0	0	1
16#920C 37388	Sensors 2 and 4 and the Light Curtain are blocked and Sensors 1 and 3 are clear.	1	0	0	1	0
16#920D 37389	Sensor 2 and the Light Curtain are blocked and Sensors 1, 3, and 4 are clear.	1	0	0	1	1

Fault Code	Description	S1	S2	LC	S3	S4
16#920E 37390	Sensors 2, 3, and 4 are blocked and Sensor 1 and the Light Curtain are clear.	1	0	1	0	0
16#920F 37391	Sensors 2 and 3 are blocked and Sensors 1 and 4 and the Light Curtain are clear.	1	0	1	0	1
16#9210 37392	Sensors 2 and 4 are blocked and Sensors 1 and 3 and the Light Curtain are clear.	1	0	1	1	0
16#9211 37393	Sensor 2 is blocked and Sensors 1, 3, and 4 and the Light Curtain are clear.	1	0	1	1	1
16#9212 37394	Sensor 3 and the Light Curtain are blocked and Sensors 1, 2, and 4 are clear.	1	1	0	0	1
16#9213 37395	Sensor 4 and the Light Curtain are blocked and Sensors 1, 2, and 3 are clear.	1	1	0	1	0
16#9214 37396	The Light Curtain is blocked and Sensors 1, 2, 3, and 4 are clear.	1	1	0	1	1
16#9215 37397	Sensor 3 is blocked and Sensors 1, 2, and 4 and the Light Curtain are clear.	1	1	1	0	1

To recover from an illegal input fault:

1. Check that the sensors and the light curtain are properly aligned, are applied to the appropriate instruction inputs, and are not being improperly blocked.
2. Reset the fault.

Normal Muting Sequences



An illegal muting sequence was detected in step 0 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9100 37120	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 ↓ 0 0 1 1 1	16#9101 37121	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 ↓ 0 0 0 1 1	16#9102 37122	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 ↓ 0 0 0 0 1
16#9103 37123	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 ↓ 0 0 0 0 0	16#9104 37124	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 ↓ 1 0 0 0 0	16#9105 37125	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 ↓ 1 1 0 0 0

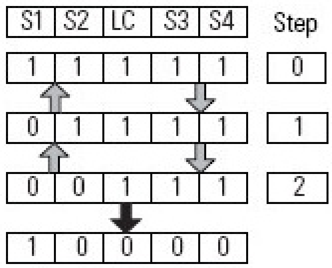
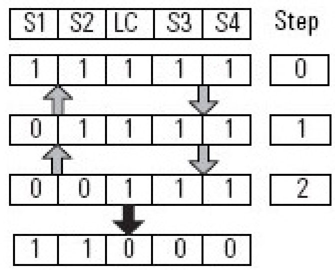
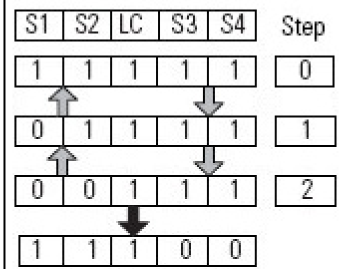
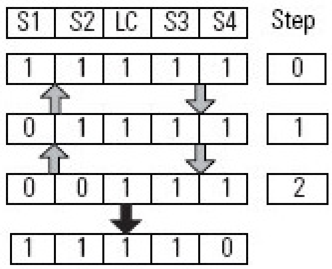
Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9106 37126	S1 S2 S3 S4 S5 — Step 1 1 1 1 1 — 0 ↓ 1 1 1 0 0				

An illegal muting sequence was detected in step 1 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

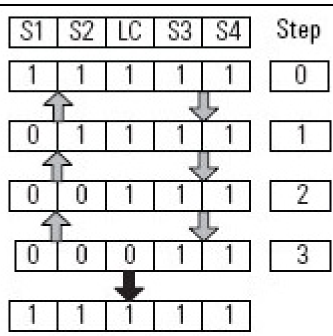
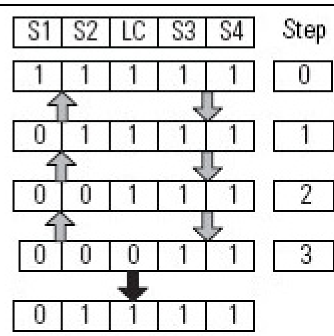
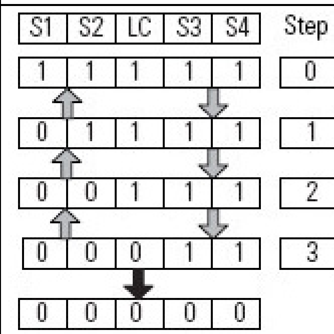
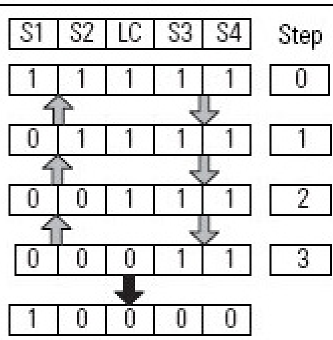
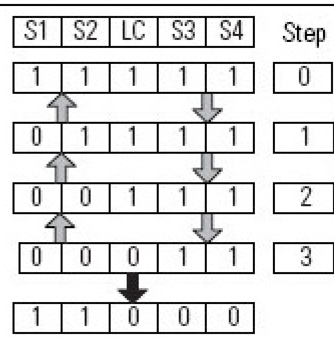
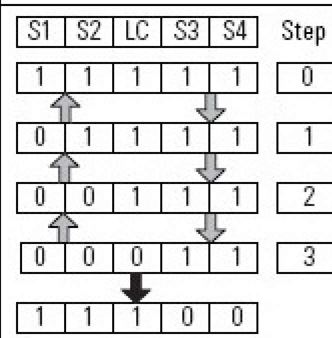
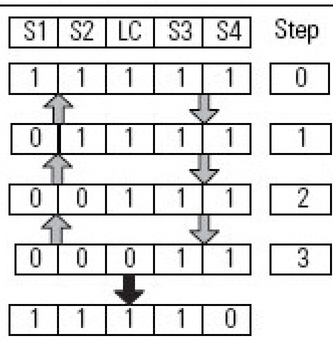
Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9110 37136	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 0 0 0 1 1	16#9111 37137	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 0 0 0 0 1	16#9112 37138	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 0 0 0 0 0
16#9113 37139	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 1 0 0 0 0	16#9114 37140	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 1 1 0 0 0	16#9115 37141	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 1 1 1 0 0
16#9116 37142	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 ↓ 1 1 1 1 0				

An illegal muting sequence was detected in step 2 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9120 37152	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 ↓ 1 1 1 1 1	16#9121 37153	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 ↓ 0 0 0 0 1	16#9122 37154	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 ↓ 0 0 0 0 0

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9123 37155		16#9124 37156		16#9125 37157	
16#9126 37158					

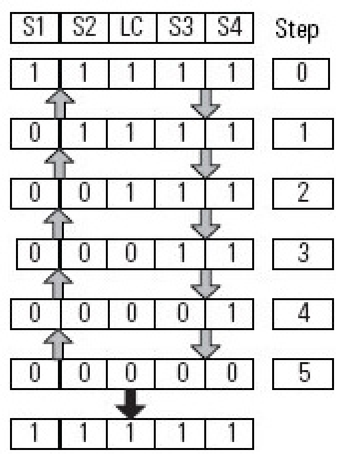
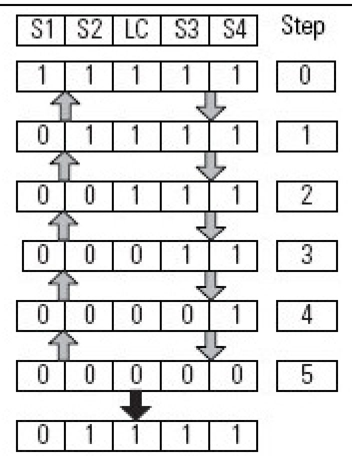
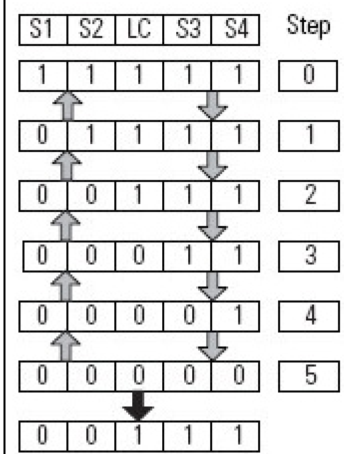
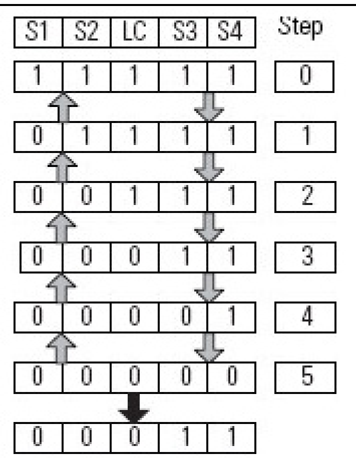
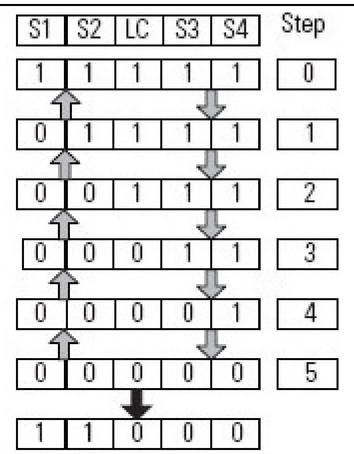
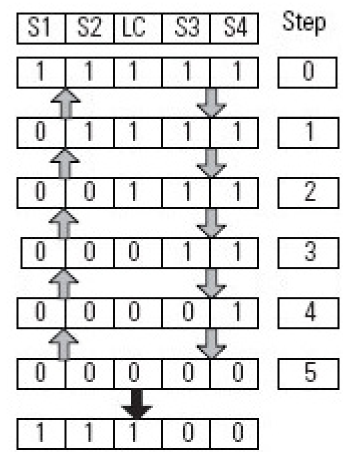
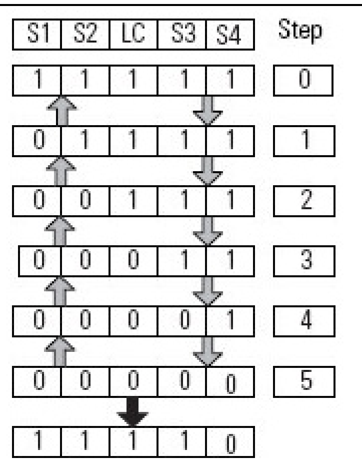
An illegal muting sequence was detected in step 3 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9130 37168		16#9131 37169		16#9132 37170	
16#9133 37171		16#9134 37172		16#9135 37173	
16#9136 37174					

An illegal muting sequence was detected in step 4 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9140 37184	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 1 1 1 1 1	16#9141 37185	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 0 1 1 1 1	16#9142 37186	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 0 0 1 1 1
16#9143 37187	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 1 0 0 0 0	16#9144 37188	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 1 1 0 0 0	16#9145 37189	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 1 1 1 0 0
16#9146 37190	S1 S2 LC S3 S4 Step 1 1 1 1 1 0 0 1 1 1 1 1 0 0 1 1 1 2 0 0 0 1 1 3 0 0 0 0 1 4 1 1 1 1 0				

An illegal muting sequence was detected in step 5 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9150 37200		16#9151 37201		16#9152 37202	
16#9153 37203		16#9154 37204		16#9155 37205	
16#9156 37206					

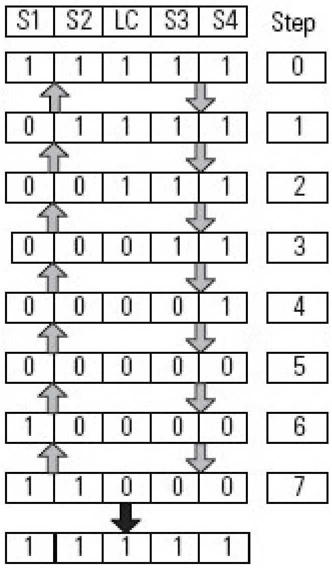
An illegal muting sequence was detected in step 6 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence
16#9160 37216	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 1 1 1
16#9161 37217	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 0 1 1 1 1
16#9162 37218	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 0 0 1 1 1
16#9163 37219	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 0 0 0 1 1
16#9164 37220	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 0 0 0 0 1
16#9165 37221	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 1 0 0
16#9166 37222	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 1 1 0

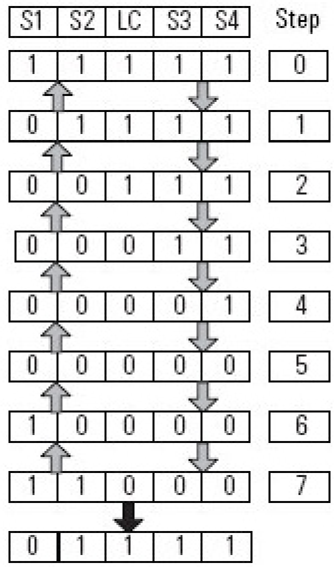
An illegal muting sequence was detected in step 7 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code | **Sequence**

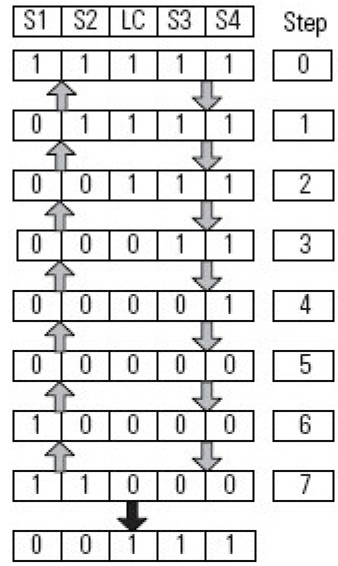
16#9170
37232



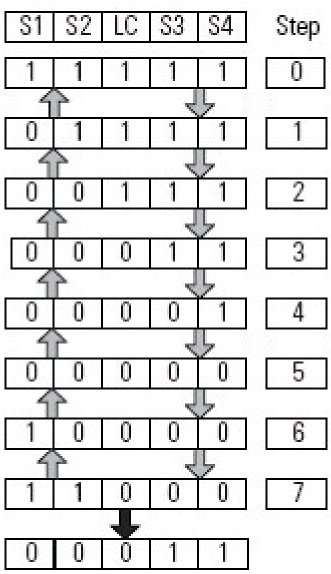
16#9171
37233



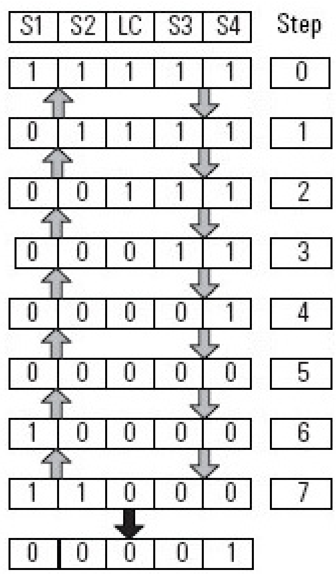
16#9172
37234



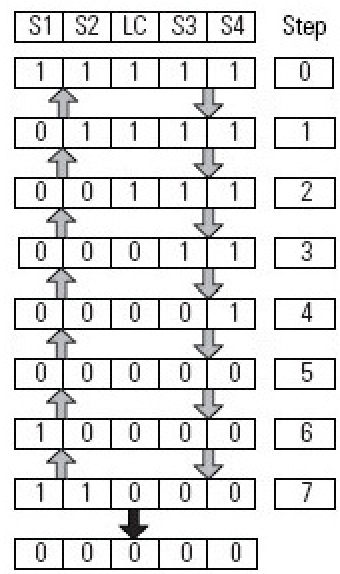
16#9173
37235



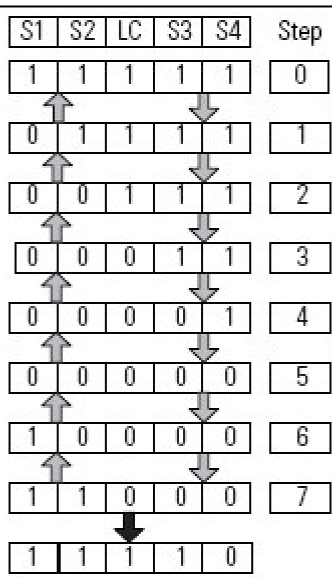
16#9174
37236



16#9175
37237



16#9176
37238



An illegal muting sequence was detected in step 8 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence (S1 S2 LC S3 S4 — Step)	Fault Code	Sequence (S1 S2 LC S3 S4 — Step)	Fault Code	Sequence (S1 S2 LC S3 S4 — Step)
16#9180 37248	1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 1	16#9181 37249	1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 0 1 1 1 1	16#9182 37250	1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 0 0 1 1 1
16#9183 37251	1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 0 0 0 1 1	16#9184 37252	1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 0 0 0 0 1	16#9185 37253	1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 0 0 0 0 0

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9186 37254	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 0 0 0 0				

An illegal muting sequence was detected in step 9 when the Sensors and the Light Curtain transitioned to one of the following invalid sequence states.

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9190 37264	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 0 1 1 1 1	16#9191 37265	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 0 0 1 1 1	16#9192 37266	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 0 0 0 1 1

Fault Code	Sequence	Fault Code	Sequence	Fault Code	Sequence
16#9193 37267	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 0 0 0 0 1	16#9194 37268	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 0 0 0 0 0	16#9195 37269	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 1 0 0 0 0
16#9196 37270	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 — 1 0 0 1 1 1 — 2 0 0 0 1 1 — 3 0 0 0 0 1 — 4 0 0 0 0 0 — 5 1 0 0 0 0 — 6 1 1 0 0 0 — 7 1 1 1 0 0 — 8 1 1 1 1 0 — 9 1 1 0 0 0				

An illegal muting sequence was detected when Sensor 1 or Sensor 4 transitioned to one of the following invalid sequence states. The first sensor blocked does not correspond to the value of the Direction input.

Fault Code	Sequence	Fault Code	Sequence
16#91A1 37281	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 1 1 1 1 0 Direction = 1 (forward)	16#91A0 37280	S1 S2 LC S3 S4 — Step 1 1 1 1 1 — 0 0 1 1 1 1 Direction = 0 (Reverse)

To recover from invalid sequence faults 16#9100...16#9196, check the alignment of the sensors with regard to the material being moved and the system timing and then reset the fault.

To recover from invalid sequence faults 16#91A0 and 16#91A1, check the value of the Direction input operand with respect to the movement of the material and reset the fault.

Correcting Invalid Sequence Faults

Fault Code	Description	Corrective Action
16#9000 36864	The Light Curtain was muted for longer than the configured Maximum Mute Time.	The Maximum Mute Time operand is set too short or there is an anomaly with the sensors.
16#9010 36880	Too much time elapsed between Sensor 1 and Sensor 2 being blocked.	The S1-S2 Time operand may be set too short or there may be a problem with Sensor 2 (forward direction) or Sensor 1 (reverse direction).
16#9011 38881	Too much time elapsed between Sensor 2 and the Light Curtain being blocked.	The S2-LC Time operand may be set too short or there may be a problem with the Light Curtain (forward direction) or Sensor 2 (reverse direction).
16#9012 36882	Too much time elapsed between the Light Curtain and Sensor 3 being cleared.	The LC-S3 Time operand may be set too short or there may be a problem with Sensor 3 (forward direction) or the Light Curtain (reverse direction).
16#9013 36883	Too much time elapsed between Sensor 3 and Sensor 4 being cleared.	The S3-S4 Time operand may be set to short or there may be a problem with Sensor 4 (forward direction) or Sensor 3 (reverse direction).

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
00	No fault.	None
16#01 1	The Muting Lamp Status input is OFF (0).	Check the muting lamp and replace it, if necessary. If a muting lamp is not required, set the Muting Lamp Status input to ON (1).
16#05 5	The Reset input is held ON (1)	Set the Reset input to OFF (0).
16#20 32	The Input Status input was OFF (0) when the instruction started.	Check the I/O module connection or the logic used to source input status.

See also

Index Through Arrays on page 540

[Four Sensor Bi-Directional Muting (FSBM) wiring and programming example](#) on [page 233](#)

[Status and Safety input and output for safety instructions](#) on [page 21](#)

Four Sensor Bi-Directional Muting (FSBM) wiring and programming example

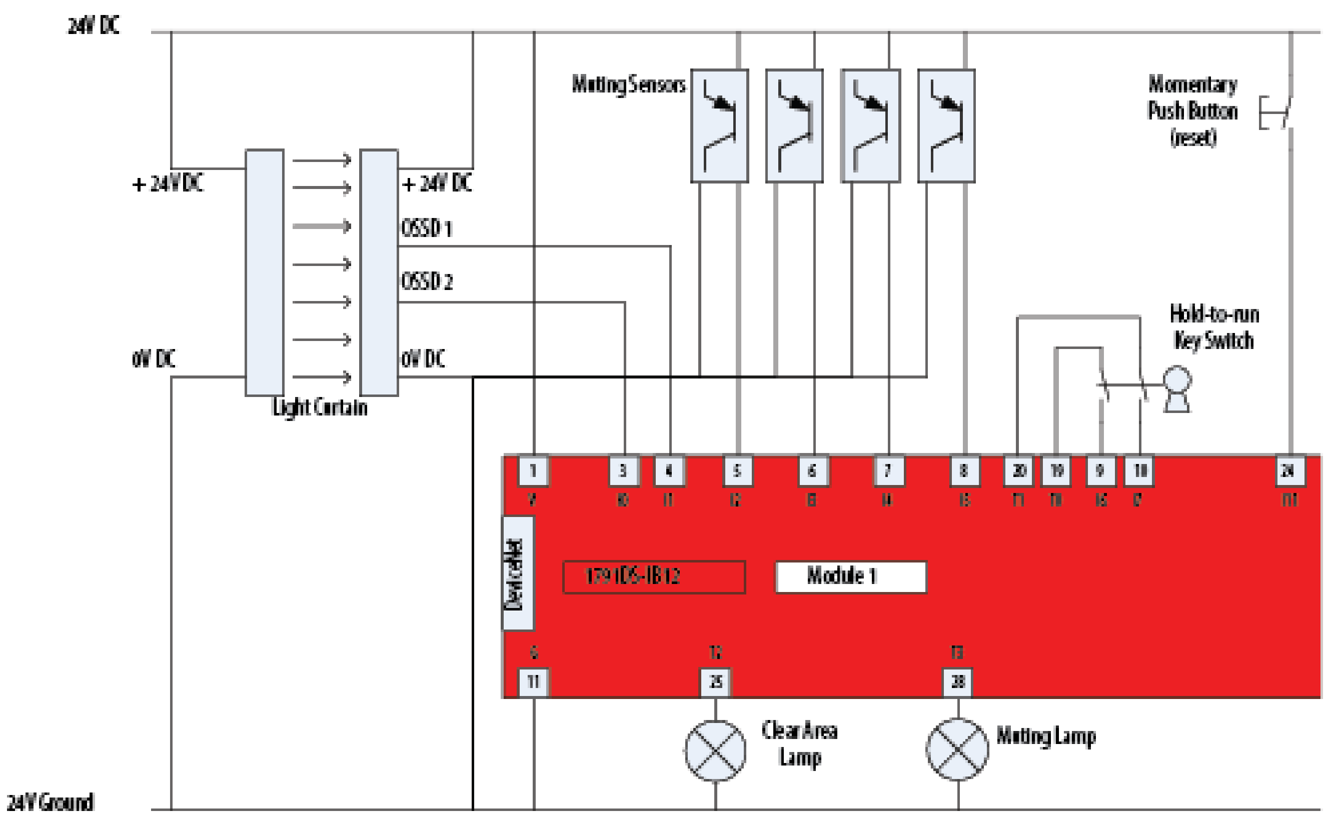
This section demonstrates how to wire the Guard I/O module and program the instruction in the safety control portion of an application.

This application example complies with ISO 13849-1, Category 4 operation.

Tip: The standard control portion of the application is not shown in the following diagram.

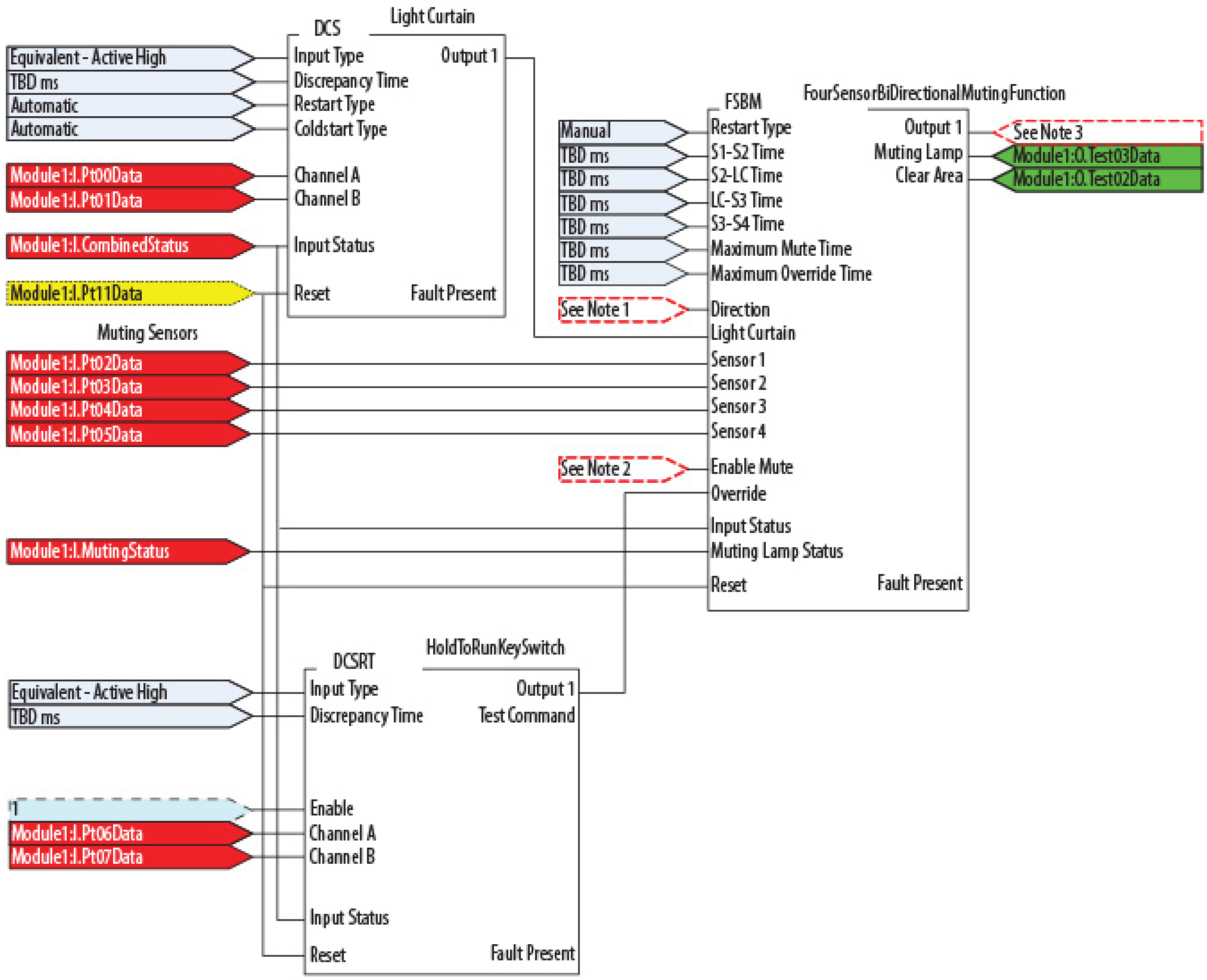
Wiring Diagram

The wiring diagram shows how to wire a light curtain and four muting sensors to a 1791DS-IB12 module to illustrate the use of the Four-Sensor Bidirectional Muting instruction. The application includes a hold-to-run switch and a momentary push button for reset.



Programming Example

The programming diagram shows the Four-Sensor Bidirectional Muting instruction used with a DCI Stop (light curtain) and DCI Start (hold-to-run switch) instruction.

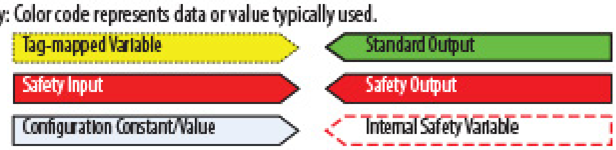


Note 1: This tag is an internal Boolean tag that represents the direction of travel. Its value is determined by other parts of the user application that are not shown in this example. If the direction is Forward (0) the sensors sequence is S1, S2, LC, S3, S4. If the direction is Reverse (1), the sensor sequence is S4, S3, LC, S2, S1.

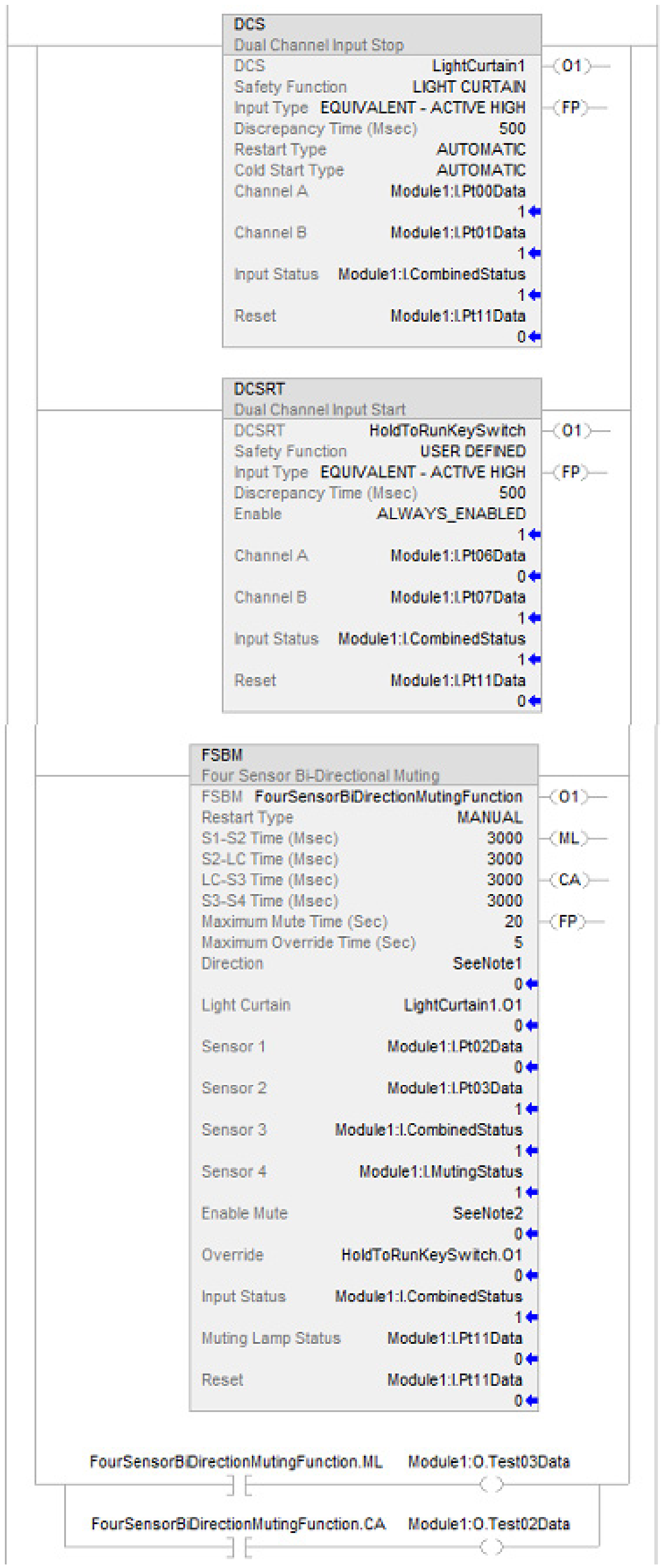
Note 2: This tag is an internal Boolean tag representing the nonhazardous portion of the machine cycle. Its value is determined by other parts of the user application that are not shown in this example. When the protected hazard is present, this tag value should be False (0). When the protected hazard is not190 present, this tag value should be True (1). When the value of this tag is True (1), the muting instruction allows the light curtain to become muted only if the proper input sequence is detected. When the value of this tag is False (0), the muting instruction does not allow the light curtain to become muted, even if the proper input sequence is detected.

Note 3: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.

Key: Color code represents data or value typically used.



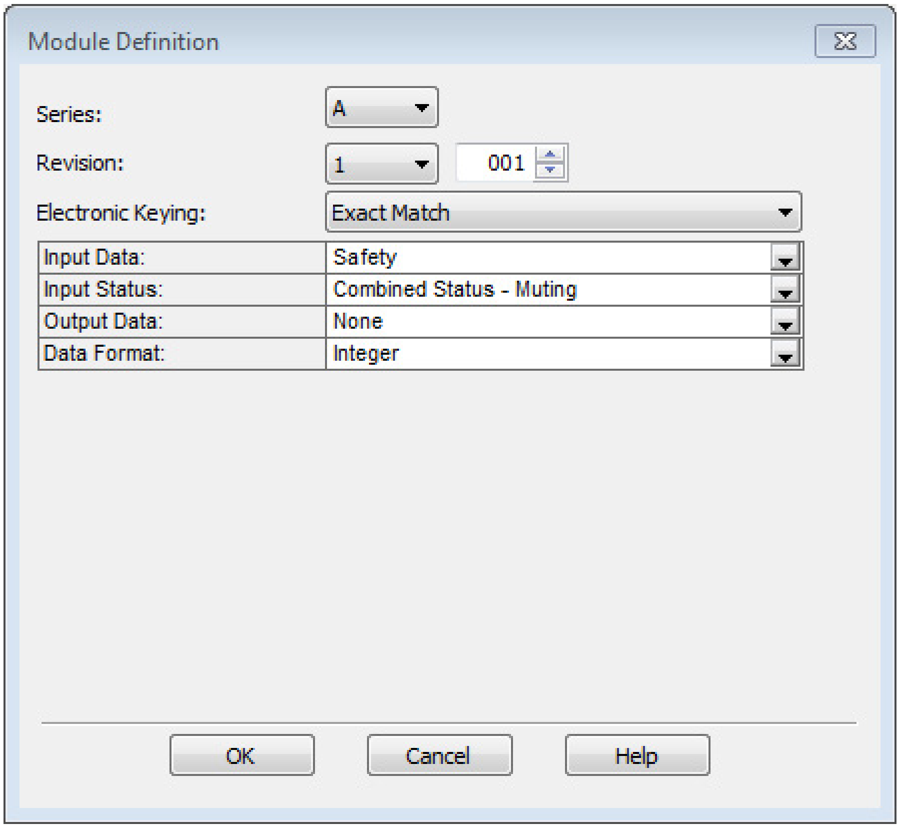
Ladder Diagram



Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.

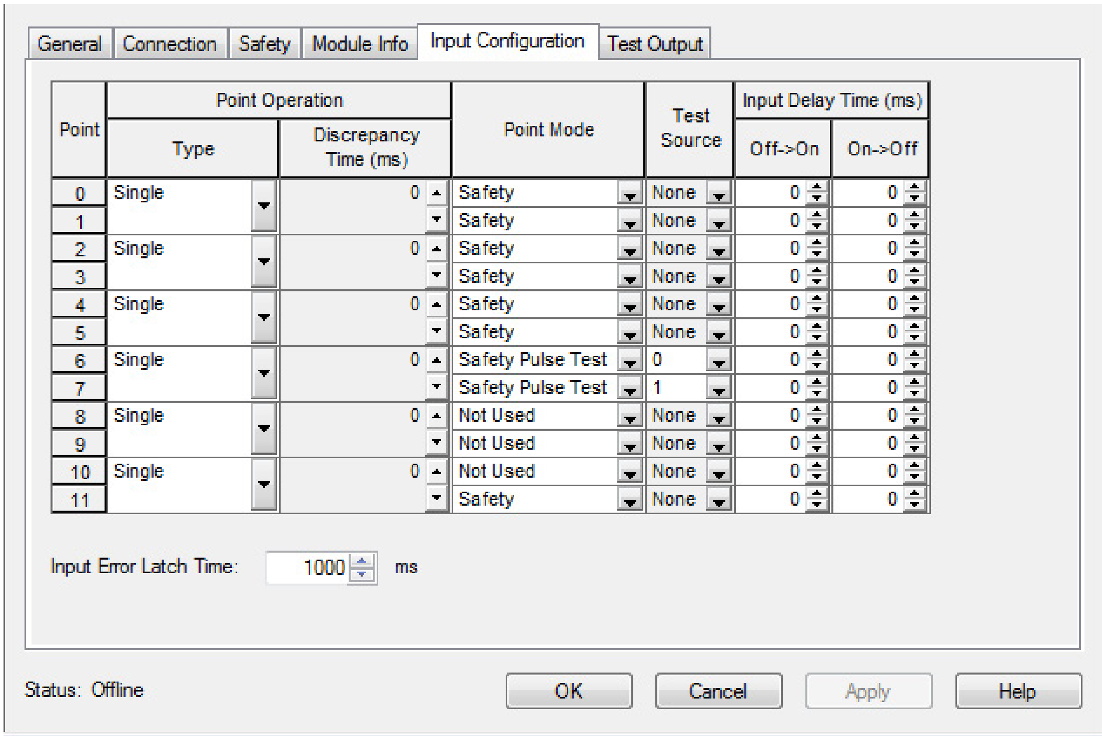
When defining the module, setting the Input Status to Combined Status-Muting provides the smallest input packet possible and lets the muting lamp status be monitored. Choosing Test for Output Data lets safety logic control Test Output 3 to drive the Muting Lamp and Test Output 2 to drive the Clear Area Lamp.



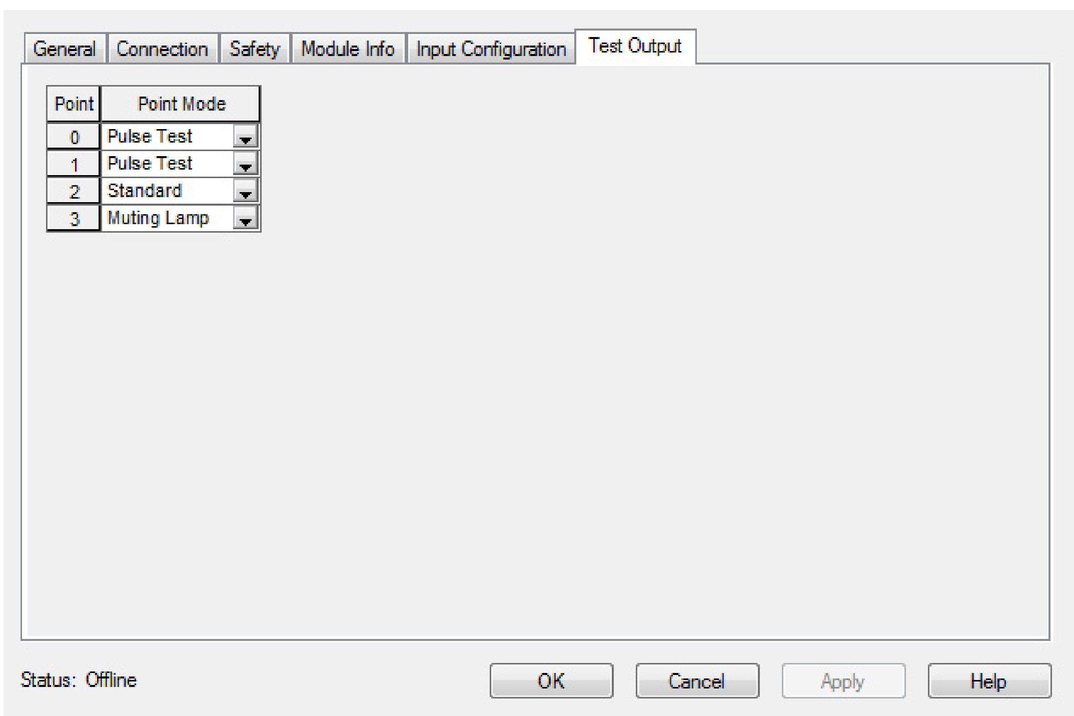
Rockwell Automation suggests using Exact Match, as shown. However, setting Electronic Keying to Compatible Match is allowed.

The safety inputs that interface with the Light Curtain (Points 1 and 2) are not pulse-tested because the Light Curtain pulse-tests its own signals.

Module Input Configuration



Configuring Test Output 3 for Muting Lamp causes the I/O module to monitor the lamp that is connected to this output.



See also

Four-sensor Bi-Directional Muting (FSBM) on page 206

Metal Form Instructions

Metal Form Instructions

In the controller organizer, recognize safety programs by the red bar that is incorporated into the icons. The red bar indicates the program will execute in safety memory.

The buttons for instructions that function as part of a safety program, or are supported by a safety program, have a red triangle in the right corner of each button.

Available Instructions

Ladder Diagram

CPM	CBIM	CBSSM	CBCM	CSM	EPMS	AVC	MMVC	MVC

Function Block

Not available

Structured Text

Not available

Safety application instructions are intended for use within a safety system that has a controller and I/O modules. These instructions are intended for Safety Integrity Level (SIL) 3, PLe/Category (CAT) 4 applications.

If you want to	Use this instruction
Use to determine the slide position of the press.	CPM
Use for press applications where minor slide adjustments are required, such as press setup.	CBIM
Use in single-cycle press applications.	CBSSM
Use for press applications where continuous operation is desired.	CBCM
Monitor motion for the starting, stopping, and running operations of a camshaft.	CSM
Monitor eight safety inputs to control one of the either outputs corresponding to the active input.	EPMS
Control an auxiliary value that is used in conjunction with a main valve.	AVC

If you want to	Use this instruction
Use to manually drive a valve during maintenance operations.	MMVC
Control and monitor a main valve.	MVC

The Safety controller is part of a De-Energize to Trip system. This means that all of its outputs are set to zero when a fault is detected.

See also

Safety Instructions on page 15

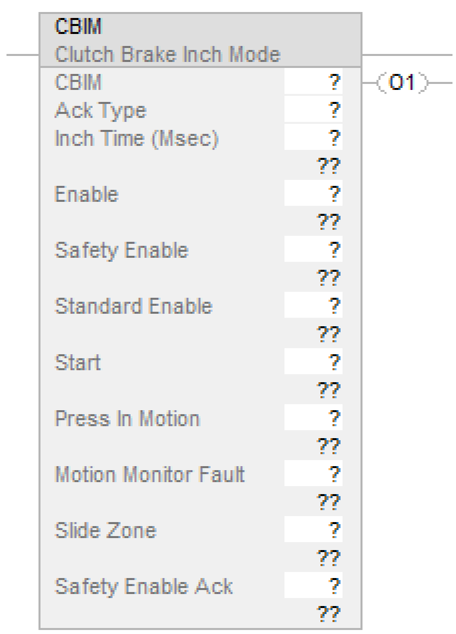
Clutch Brake Inch Mode (CBIM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Clutch Brake Inch Mode (CBIM) instruction is used in press applications where minor slide adjustments are required, for example, during press set up. During inch-mode operation, the flywheel is driven at a very low speed by either the main motor or another drive mechanism.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

WARNING: Do not use automatic acknowledgment when access within the danger zone can go undetected. This instruction, configured for automatic acknowledgment, must be used in combination with other instructions, at least one of which must fulfill the manual reset requirement. Reset controls must be located within sight, but out of reach of the danger zone. See section 5.4.1.3 of EN692-2005 for details

ATTENTION: This instruction is specified with the intent that the Slide Zone input is sourced only by the Slide Zone output of the Crankshaft Position Monitor (CPM) instruction or application logic that satisfies the Slide Zone requirements listed in the Inputs table in this instruction.

This instruction is specified with the intent that the Enable input is sourced only by an Ox output[1] of the Eight Position Mode Selector (EPMS) instruction that is not already sourcing the Enable input of another Clutch Brake Inch Mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), or Clutch Brake Continuous Mode (CBCM) instruction

[1] Where x = 1 through 8

WARNING: Per Section 5.5.2 of EN692-2005; facilities shall be provided to allow the movement of the slide during tool-setting, maintenance and lubrication to be carried out with guards and protective devices in position and operational (see 5.3.2).

Where this implementation is not practicable, at least one of the following facilities shall be provided:

a. Rotation of the crankshaft by hand, with power isolated

b. Slow speed (equal or less than 10 mm/s) and hold-to-run control device

c. Two-hand control device in accordance with 5.5.9 and arranged so that it cannot be used for production, for example, when the cycle stops at least three times during one revolution of the crankshaft.

d. Using the Inching device.

The Inch Time parameter can be configured to fulfill the requirements of stopping 3 times during a press cycle as specified in 5.5.2 c of EN692-2005.

Operands

IMPORTANT Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameters that are used to configure the instruction. These parameters cannot be changed at runtime.

Parameter	Data Type	Format	Description
CBIM	CB_INCH_MODE	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.
Ack Type	BOOL	name	This parameter specifies how to acknowledge a Safety Enable OFF (0) to ON (1) transition. This acknowledgment must be made before Output 1 can be energized. **Automatic**: The acknowledgment is made automatically when the Safety Enable input transitions from OFF (0) to ON (1). **Manual**: The acknowledgment is made when Safety Enable Ack transitions from OFF (0) to ON (1) after the Safety Enable input transitions from OFF (0) to ON (1).
Inch Time	DINT	immediate	This parameter selects the amount of time Output 1 is allowed to remain energized while the Start input is ON (1). Output 1 is de-energized when the Start input transitions from ON (1) to OFF (0) while the timer is timing. The valid range is 0 to 5000 ms. A value of 0 disables the timer.

The following table explains the instruction inputs.

Parameter	Data Type	Format	Description
Enable	BOOL	tag	This input is the signal to activate this instruction. For example, by an Eight Position Mode Selector (EPMS) 0x output, where x=1 to 8. ON (1): The instruction is selected and operational. OFF (0): The instruction is not operating. All instruction outputs are de-energized.
EnableSafety Enable	BOOL	tag	This input represents the status of safety-related permissive devices such as E-stops, light curtains, or safety gates. ON (1): Permissive devices are actively guarding the danger zone. Permits the energizing of Output 1. OFF (0): Permissive devices are in a state that doesn't allow Output 1 to be energized.
Standard Enable	BOOL	tag	Indicates the state of non safety-related permissive devices. ON (1): Permits the energizing of Output 1. OFF (0): Prevents the energizing of Output 1. This parameter is not safety-related.
Start	BOOL	tag	Input to start press movement. ON (1): Energize Output 1 if all input conditions have been met. OFF (0): Output 1 is de-energized.

<table>
<tr><th>Parameter</th><th>Data Type</th><th>Format</th><th>Description</th></tr>
<tr><td>Press In Motion</td><td>BOOL</td><td>tag</td><td>This input is typically sourced by Output 1 of the Camshaft Monitor (CSM) instruction or by user application logic. Feedback from the press safety valve needs to be included in the building of this signal.
ON (1): Indicates that the press is moving.
OFF (0): Indicates that the press is stopped.</td></tr>
<tr><td>Slide Zone</td><td>DINT</td><td>tag</td><td>This input represents the position of the slide and the position information status. It is sourced by the Crankshaft Position Monitor (CPM) instruction's Slide Zone output or user application logic that provides the following bit-mapped information.
Bit 0: Status
OFF (0) - The Slide Zone information is invalid. Prevents the energizing of Output 1 on an initial start or immediately stops the press.
ON (1) - Slide Zone information is valid.
Bits 1 and 2: Slide Zone
The following table lists how Bits 0 to 2 are used to represent the valid slide zones.
<table>
<tr><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th>Slide Zone</th><th>Decimal Value</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Down</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Up</td><td>3</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Top</td><td>5</td></tr>
</table>
Bits 3 to 31: Unused; Set to 0.</td></tr>
<tr><td>Motion Monitor Fault</td><td>BOOL</td><td>tag</td><td>Stops the press immediately when a press motion problem has been detected. This input is sourced by inverting the state of the Fault Present output of the Camshaft Monitor (CSM) instruction or application logic that performs motion diagnostics.
ON (1): Indicates that press motion is valid. Permits Output 1 to be energized.
OFF (0): Indicates that a press motion problem exists. Prevents Output 1 from being energized or immediately de-energizes Output 1.</td></tr>
<tr><td>Safety Enable Ack</td><td>BOOL</td><td>tag</td><td>This input is required when the configured Ack Type is Manual.
OFF (0) - Input is Off
OFF (0)->ON (1): This transition acknowledges that the Safety Enable input has transitioned from OFF (0) to ON (1).
ON (1) - Input is On</td></tr>
</table>

The following table explains the instruction outputs.

Parameter	Data Type	Description
Output 1 (O1)	BOOL	Instruction Output **Tip:** Use this output to source the Actuate input of the Main Valve Control instruction. ON (1): The output is energized. OFF (0): The output is de-energized. See CBIM – Energizing Output 1 and CBIM – De-energizing Output 1 below for details.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the CBIM – Diagnostic Codes below for a list of diagnostic codes. This parameter is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Energizing Output 1

Output 1 is energized only when the Start input transitions from OFF (0) to ON (1) and all of these conditions are met:

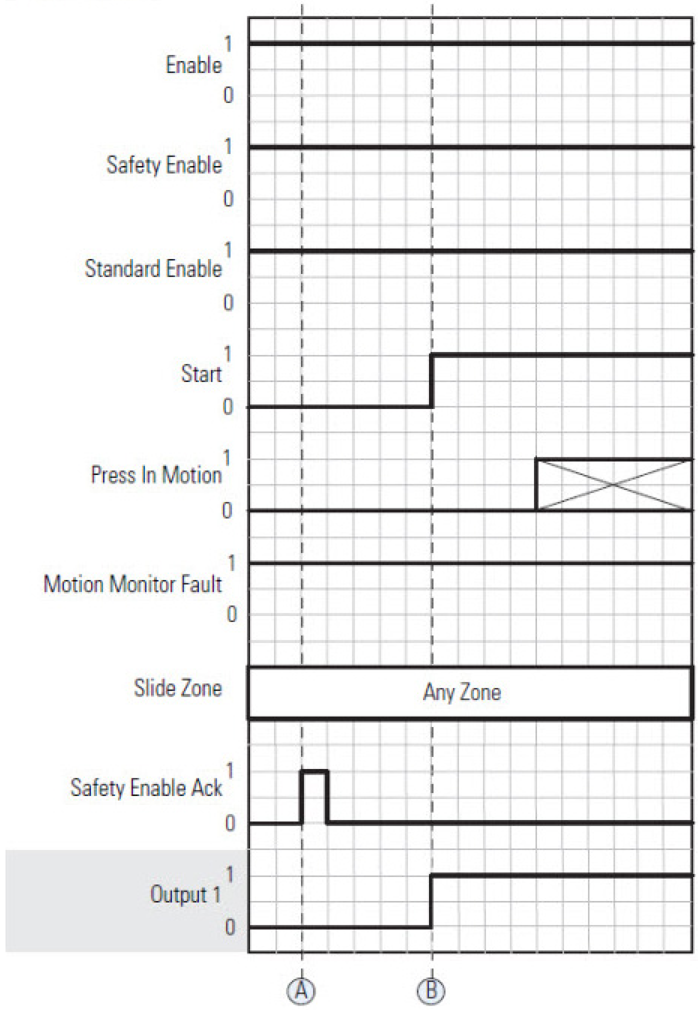
- The Enable input is ON (1).
- The Safety Enable input has been acknowledged.
- The Standard Enable input is ON (1).
- The Motion Monitor Fault input is ON (1).
- The Press In Motion input is OFF (0).
- The Safety Enable Ack input is OFF (0).

IMPORTANT If the Ack Type is Manual, an acknowledgment of the Safety Enable input is required when the Enable input transitions from OFF (0) to ON (1) and before the Start input turns ON (0).

WARNING: When the configured Ack Type is Automatic, Output 1 is energized when the Safety Enable, Standard Enable, Press In Motion, and Motion Monitor Fault inputs return to the active or valid state at the same time the Start input transitions from OFF (0) to ON (1).

ATTENTION: The cam switches that determine slide position are monitored by the CPM instruction. This instruction uses the Slide Zone output of the CPM instruction as a representation of the cam switches that determine slide position.

This diagram demonstrates the acknowledgment of the Safety Enable input, at (A). Output 1 is energized when the Start input transitions from OFF (0) to ON (1) at (B) and all input conditions have been met. The safety enable acknowledgment only needs to be made once while the Safety Enable input is ON (1) when the configured Ack Type is Manual.



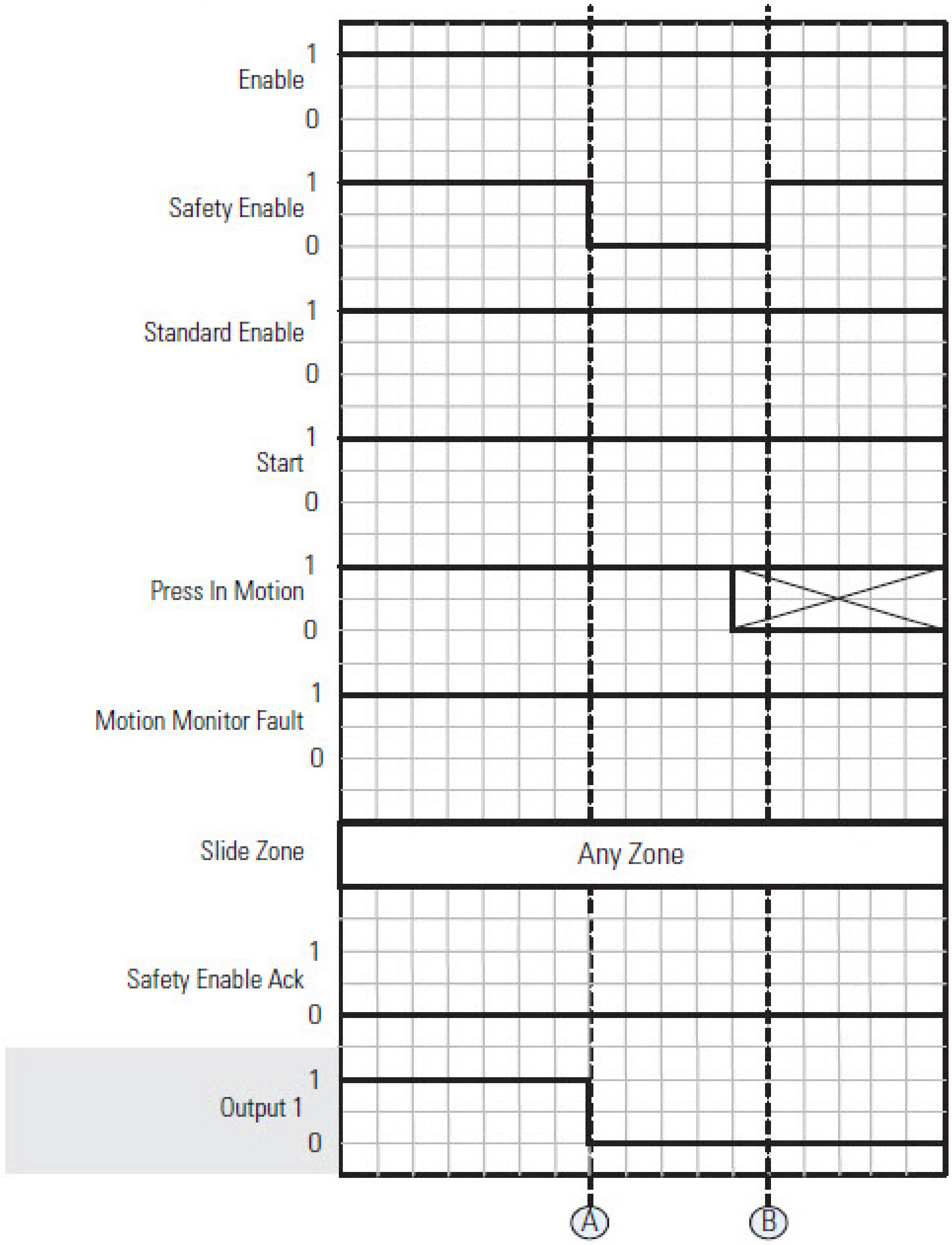
De-energizing Output 1

Once energized, Output 1 is de-energized when one or more of the following occurs:

- The Enable input transitions from ON (1) to OFF (0).
- The Start input transitions from ON (1) to OFF (0).
- The Safety Enable input transitions from ON (1) to OFF (0).
- The Standard Enable input transitions from ON (1) to OFF (0).
- The slide moves to the Top zone.
- The Inch timer expires.
- The Monitor Motion Fault input transitions from ON (1) to OFF (0).

The Press In Motion input is not checked to de-energize Output 1. It is only checked to energize Output 1.

The following diagram demonstrates the de-energizing of Output 1 when the Safety Enable input transitions from ON (1) to OFF (0) at (A). An acknowledgment of the Safety Enable input is required when the Safety Enable input transitions from OFF (0) to ON (1) at (B) before Output 1 can be re-energized.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Diagnostic Codes and Corrective Actions

Diagnostics 16#2001…16#2009 are detected when attempting to start press movement by energizing Output 1. Diagnostics 16#2021 to 16#202A are used to diagnose the reason for stopping press movement by de-energizing Output 1.

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
00	No fault.	None.
16#2000 8192	Not used by this instruction.	
16#2001 8193	Output 1 failed to energize when the Start input turned ON (1) due to the Press In Motion input being ON (1).	• Wait for the press to come to a complete stop before initiating press movement. • Verify that the device is monitoring press movement is working correctly. • Verify that only one mode of operation is selected. This diagnostic is cleared when the Press In Motion input turns OFF (0).
16#2002 8194	Output 1 failed to energize when the Start input turned ON (1) prior to the acknowledgment of the Safety Enable input.	• Verify that the active opto-electronic protective devices (AOPDs) and electro-sensitive protective equipment (ESPEs) used to source the Safety Enable input are protecting their respective areas. • Then, to clear the diagnostic for manual Ack Types, acknowledge the Safety Enable input by turning the Safety Enable Ack input ON (1). • For automatic Ack Types, this diagnostic is cleared when the Safety Enable input turns ON (1).
16#2003 8195	Output 1 failed to energize when the Start input turned ON (1) due to the Standard Enable input being OFF (0).	Verify that the devices used to source the Standard Enable input are functioning properly. This diagnostic is cleared when the Standard Enable input is ON (1).
16#2008 8196	Output 1 failed to energize when the Start input turned ON (1) due to the Motion Monitor Fault input being OFF (0).	Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement. This diagnostic is cleared when the motion monitor functions are properly monitoring motion and the Motion Monitor Fault input is ON (1).
16#2009 8197	Manual Ack Type: Output 1 failed to energize when the Start input turned ON (1) due to the Safety Enable Ack input being ON (1). Automatic Ack Type: N/A	Turn the Safety Enable Ack input OFF (0). This diagnostic is cleared when the Safety Enable Ack input turns OFF (0).
16#2021 8225	Output 1 is de-energized due to the Motion Monitor Fault input turning OFF (0).	Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement. This diagnostic is cleared at the next attempt to begin press movement.

Diagnostic Code	Description	Corrective Action
16#2022 8226	Not used by this instruction.	
16#2023 8227	Output 1 is de-energized due to the Safety Enable input turning OFF (0).	Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas. This diagnostic is cleared at the next attempt to begin press movement.
16#2024 8228	Output 1 is de-energized due to the Standard Enable input turning OFF (0).	Verify that the devices and application logic used to source the Standard Enable input are functioning properly. This diagnostic is cleared at the next attempt to begin press movement.
16#2025 8229	Output 1 is de-energized due to the Start input turning OFF (0).	Output 1 is de-energized when the Start input turns OFF (0) regardless of slide zone. This diagnostic is cleared at the next attempt to begin press movement.
16#2026 8230	Output 1 is de-energized because the Inch Mode timer timed out.	Output 1 is always de-energized when Inch Mode timer times out. Verify that the Inch Time parameter value is correct for your application. This diagnostic is cleared at the next attempt to begin press movement.
16#2027 8231	Not used by this instruction.	
16#2028 8232		
16#2029 8233		
16#202A 8234	Output 1 is de-energized due to the slide entering the Top zone.	Output 1 is always de-energized when the slide enters the Top zone. This diagnostic is cleared at the next attempt to begin press movement.

Affects Math Status Flags

No

Major / Minor Faults

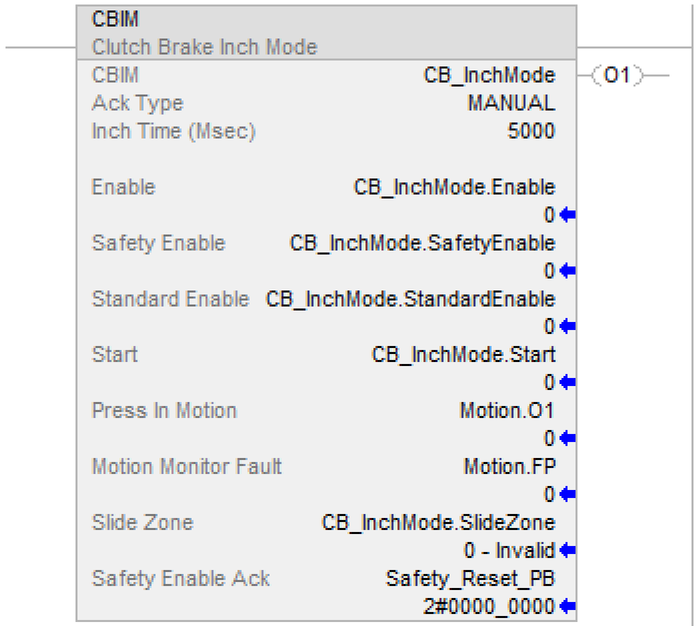
None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false
Rung-condition-in is false	The .01 is cleared to false. The Diagnostic Code output is set to 0.

Condition/State	Action Taken
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in is false

Examples



See also

Index Through Arrays on page 540

Clutch Brake Wiring and Programming Example on page 313

Clutch Brake Continuous Mode (CBCM) on page 260

Clutch Brake Single Stroke Mod (CBSSM) on page 249

Crankshaft Position Monitor (CPM) on page 278

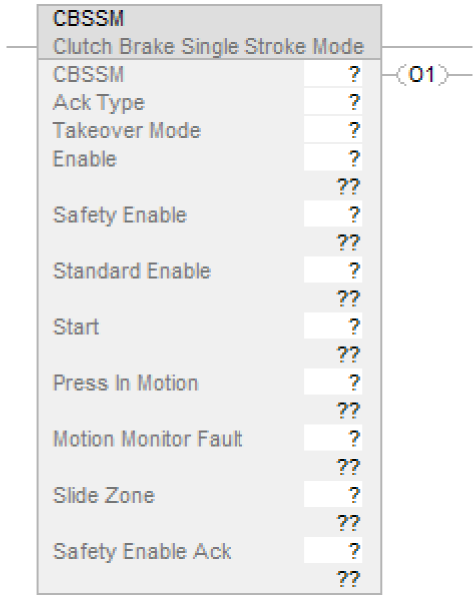
Clutch Brake Single Stroke Mode (CBSSM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Clutch Brake Single Stroke Mode (CBSSM) instruction is used in single-cycle press applications.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

WARNING: Do not use automatic acknowledgment when access within the danger zone can go undetected. This instruction, when configured for automatic acknowledgment, must be used in combination with other instructions, at least one of which must fulfill the manual reset requirement.

Reset controls must be located within sight, but out of reach of the danger zone.

See section 5.4.1.3 of EN692-2005 for details.

ATTENTION: This instruction is specified with the intent that the Slide Zone input is sourced only by the Slide Zone output of the Crankshaft Position Monitor (CPM) instruction or application logic that satisfies the Slide Zone requirements listed in this instruction.

This instruction is specified with the intent that the Enable input is sourced only by an Ox output[1] of the Eight Position Mode Selector (EPMS) instruction that is not already sourcing the Enable input of another (CBIM), Clutch Brake Single Stroke Mode (CBSSM), or Clutch Brake Continuous Mode (CBCM) instruction.

1 Where x = 1 through 8

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The CBSSM structure contains internal state information. If any of the configuration operands are changed while in run mode, the state information must be re-initialized by making the rung-condition-in false.

The following table provides the operands used to configure the instruction.

<table>
<tr><th>Operand</th><th>Data Type</th><th>Format</th><th colspan="2">Description</th></tr>
<tr><td>CBSSM</td><td>CB_SINGLE_STROKE_MODE</td><td>tag</td><td colspan="2">Data structure required for proper operation of instruction.</td></tr>
<tr><td rowspan="3">Ack Type</td><td rowspan="3">BOOL</td><td rowspan="3">list item</td><td colspan="2">This operand specifies how to acknowledge a Safety Enable OFF (0) to ON (1) transition. This acknowledgment must be made before Output 1 can be energized.</td></tr>
<tr><td>AUTOMATIC (1)</td><td>The acknowledgment is made automatically when the Safety Enable input transitions from OFF (0) to ON (1).</td></tr>
<tr><td>MANUAL (0)</td><td>The acknowledgment is made when Safety Enable Ack transitions from OFF (0) to ON (1) after the Safety Enable input transitions from OFF (0) to ON (1).</td></tr>
<tr><td rowspan="3">Takeover Mode</td><td rowspan="3">BOOL</td><td rowspan="3">list item</td><td colspan="2">This operand determines where the press is stopped when the Safety Enable and/or Start input transitions from ON (1) to OFF (0) while the slide is in the Up zone.
Important: When using this instruction with Takeover Mode Enabled, safety devices that are continuously active, such as E-stops, must directly drive the Enable operand of the CBSSM instruction. The application developer is responsible for determining the safety devices that are not continuously active, such as certain light curtains, two-hand run stations, and others, which may be used to drive the Safety Enable operand and can be muted during press upstroke.</td></tr>
<tr><td>ENABLED (1)</td><td>The press is stopped when the slide enters the Top zone.</td></tr>
<tr><td>DISABLED (0)</td><td>The press is stopped immediately.</td></tr>
</table>

The following table explains the instruction inputs.

<table>
<tr><th>Operand</th><th>Data Type</th><th>Format</th><th>Description</th></tr>
<tr><td>Enable</td><td>BOOL</td><td>tag</td><td>This input is the signal to activate this instruction; for example, by an Eight Position Mode Selector (EPMS) Ox output, where x = 1 through 8.
ON (1): The instruction is selected and operational.
OFF (0): The instruction is not operating. All instruction outputs are de-energized.</td></tr>
<tr><td>Safety Enable</td><td>BOOL</td><td>tag</td><td>This input represents the status of safety-related permissive devices such as E-stops, light curtains or safety gates.
ON (1): Permissive devices are actively guarding the danger zone. Permits the energizing of Output 1.
OFF (0): Permissive devices are in a state that doesn't allow Output 1 to be energized.</td></tr>
<tr><td>Standard Enable</td><td>BOOL</td><td>tag</td><td>Indicates the state of non safety-related permissive devices.
ON (1): Permits the energizing of Output 1.
OFF (0): Prevents the energizing of Output 1.
This operand is not safety-related.</td></tr>
<tr><td>Start</td><td>BOOL</td><td>tag</td><td>Input to start press movement.
ON (1): Energize Output 1 if all input conditions have been met.
OFF (0): Output 1 is de-energized.</td></tr>
<tr><td>Press In Motion</td><td>BOOL</td><td>tag</td><td>Source this input by Output 1 of the Camshaft Monitor (CSM) instruction or by user application logic. Feedback from the press safety valve needs to be included in the building of this signal.
ON (1): Indicates that the press is moving.
OFF (0): Indicates that the press is stopped.</td></tr>
<tr><td>Slide Zone</td><td>DINT</td><td>tag</td><td>This input represents the position of the slide and the position information status. It is sourced by the Crankshaft Position Monitor (CPM) instruction's Slide Zone output or user application logic that provides the following bit-mapped information.
Bit 0: Status
OFF (0) - The Slide Zone information is invalid. Prevents the energizing of Output 1 on an initial start or immediately stops the press.
ON (1) - Slide Zone information is valid.
Bits 1 and 2: Slide Zone
The following table lists how Bits 0 to 2 are used to represent the valid slide zones.
<table>
<tr><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th>Slide Zone</th><th>Decimal Value</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Down</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Up</td><td>3</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Top</td><td>5</td></tr>
</table>
Bits 3 through 31: Unused: Set to 0.</td></tr>
<tr><td>Motion Monitor Fault</td><td>BOOL</td><td>tag</td><td>Stops the press immediately when a press motion problem has been detected. This input is sourced by inverting the Fault Present output coming from the Camshaft Monitor (CSM) instruction or application logic that performs motion diagnostics.
ON (1): Indicates that press motion is valid. Permits Output 1 to be energized.
OFF (0): Indicates that a press motion problem exists. Prevents Output 1 from being energized or immediately de-energizes Output 1.</td></tr>
<tr><td>Safety Enable Ack</td><td>BOOL</td><td>tag</td><td>This input is required when the configured Ack Type is Manual.
OFF (0)->ON (1): Acknowledges that the Safety Enable input has transitioned from OFF (0) to ON (1).</td></tr>
</table>

The following table explains the instruction outputs.

Operand	Data Type	Description
Output 1 (O1)	BOOL	Output used to source the Actuate input of the Main Valve Control (MVC) instruction. ON (1): The output is energized. OFF (0): The output is de-energized. See Energizing Output 1 and De-energizing Output 1.
Diagnostic Code	DINT	This operand is not safety-related. See Diagnostic Codes.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1 is cleared to false. The Diagnostic Code output is set to 0.
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in is false.

Operation

Energizing Output 1

Output 1 is energized only when the Start input transitions from OFF (0) to ON (1) and all of these conditions are met:

- The Enable input is ON (1).
- The Safety Enable input has been acknowledged.
- The Standard Enable input is ON (1).
- The Slide Zone input represents the Top zone.

- The Motion Monitor Fault input is ON (1).
- The Press In Motion input is OFF (0).
- The Safety Enable Ack input is OFF (0).

IMPORTANT	If the Ack Type is Manual, an acknowledgment of the Safety Enable input is required when the Enable input transitions from OFF (0) to ON (1) and before the Start input turns ON (0).

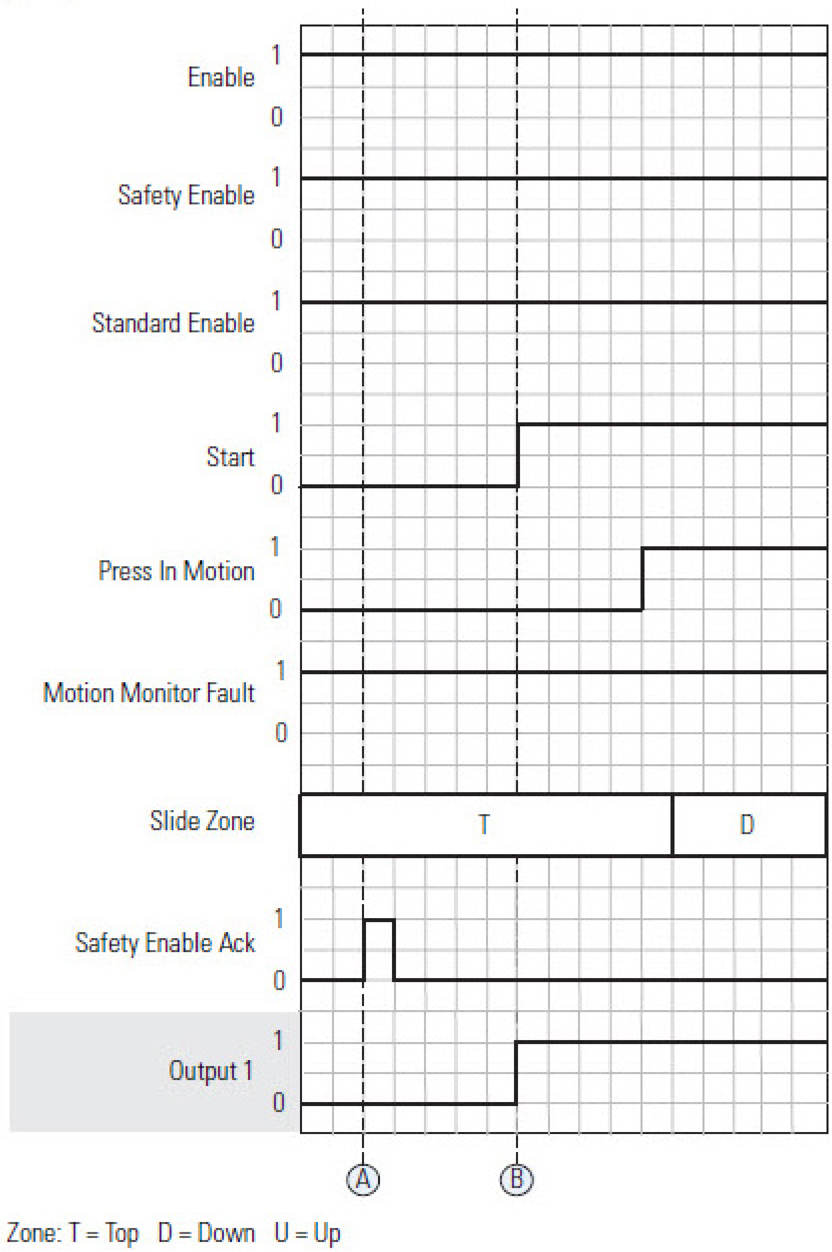
WARNING: When the configured Ack Type is Automatic, Output 1 is energized when the Safety Enable, Standard Enable, Press In Motion, and Motion Monitor Fault inputs return to the active or valid state at the same time the Start input transitions from OFF (0) to ON (1).

ATTENTION: Output 1 can be re-energized when the Slide Zone input is Down, providing that Output 1 had been initially energized when the Slide Zone input was Top, and Output 1 was de-energized because the Start input turned OFF (0). Any other reason for Output 1 being de-energized requires that the slide be inched back to the Top position.

ATTENTION: The cam switches that determine slide position are monitored by the CPM instruction. This instruction uses the Slide Zone output of the CPM instruction as a representation of the cam switches that determine slide position.

Energizing Output 1 Timing

This diagram demonstrates the acknowledgment of the Safety Enable input, at (A) and the energizing of Output 1 when the Start input transitions from OFF (0) to ON (1) at (B) and all input conditions have been met. The safety enable acknowledgment only needs to be made once while the Safety Enable input is ON (1) when the configured Ack Type is Manual.



De-energizing Output 1

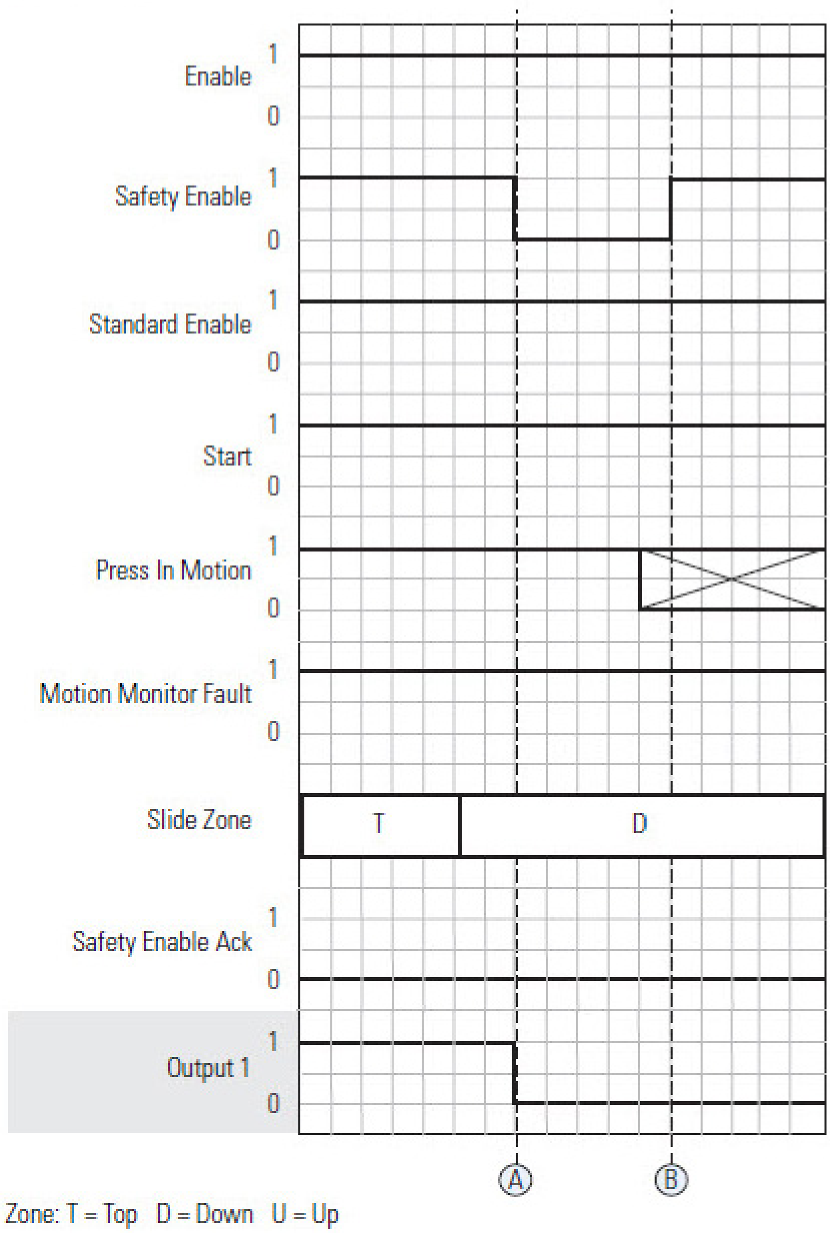
Once energized, Output 1 is de-energized when one or more of the following occurs:

- The Enable input transitions from ON (1) to OFF (0).
- The Start input transitions from ON (1) to OFF (0).
  When this transition occurs while the slide is in the Up zone and the Takeover Mode is Enabled, Output 1 is de-energized when the slide enters the Top zone. Otherwise, when the Takeover Mode is Disabled, Output 1 is de-energized immediately. Output 1 is also de-energized

immediately when this transition occurs while the slide is in the Top or Down zones.
- The Safety Enable input transitions from ON (1) to OFF (0). When this transition occurs while the slide is in the Up zone and Takeover Mode is enabled, Output 1 is de-energized when the slide enters the Top zone. Otherwise, when the Takeover Mode is disabled, Output 1 is de-energized immediately. Output 1 is also de-energized immediately when this transition occurs while the slide is in the Top or Down zones.
- The Standard Enable input transitions from ON (1) to OFF (0). When this transition occurs while the slide is in the Up zone, Output 1 is de-energized when the slide enters the Top zone. Otherwise, Output 1 is de-energized immediately.
- The Slide Zone input value becomes invalid.
- The slide transitions to the Top zone.
- The Monitor Motion Fault input transitions from ON (1) to OFF (0).
- The direction of the press appears to be running in reverse.
- The Press In Motion input is OFF (0) when the slide transitions from Top to Down.
- The Press in Motion input transitions from ON (1) to OFF (0).

This diagram shows the de-energizing of Output 1 when the Safety Enable input transitions from ON (1) to OFF (0) at (A). An acknowledgment of the

Safety Enable input is required when the Safety Enable input transitions from OFF (0) to ON (1) at (B) before Output 1 can be re-energized.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Diagnostic Codes and Corrective Actions

Diagnostics 2000H through 200AH are detected when attempting to start press movement by energizing Output 1. Diagnostics 2020H through 202D are used to diagnose the reason for stopping press movement by de-energizing Output 1.

The diagnostic codes are listed in hexadecimal format followed by decimal format.

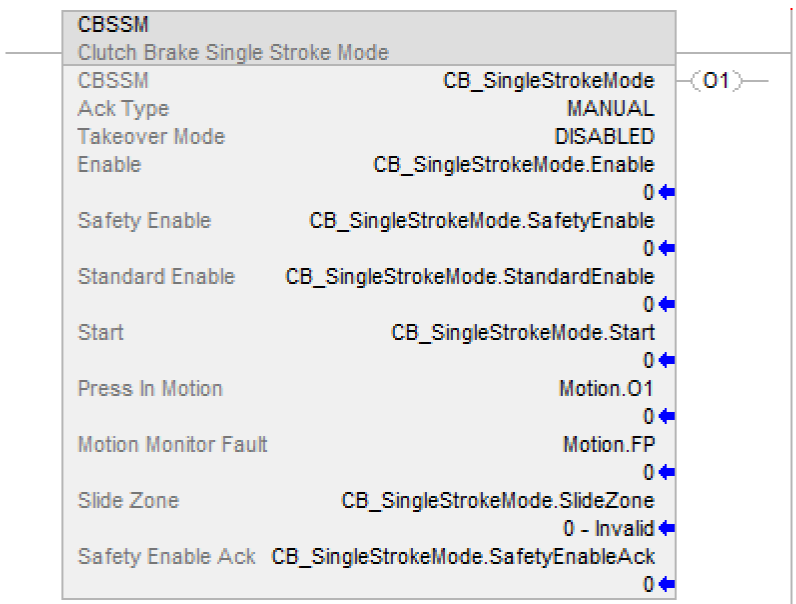
Diagnostic Code	Description	Corrective Action
0	No fault.	None.
16#2000 8192	Output 1 failed to energized when the Start input turned ON (1), due to an invalid Slide Zone input value.	Check the Crankshaft Position Monitor (CPM) instruction or the application logic used to source this input. This diagnostic is cleared when a valid Slide Zone is established.
16#2001 8193	Output 1 failed to energize when the Start input turned ON (1) due to the Press In Motion input being ON (1).	• Wait for the press to come to a complete stop before initiating press movement. • Verify that the device monitoring press movement is working correctly. • Verify that only one mode of operation is selected. This diagnostic is cleared when the Press In Motion input turns OFF (0).
16#2002 8914	Output 1 failed to energize when the Start input turned ON (1) prior to the acknowledgement of the Safety Enable input.	• Verify that the active opto-electronic protective devices (AOPDs) and electro-sensitive protective equipment (ESPEs) used to source the Safety Enable input are protecting their respective areas. • Then, to clear the diagnostic for manual Ack Types, acknowledge the Safety Enable input by turning the Safety Enable Ack input ON (1). • For automatic Ack Types, this diagnostic is cleared when the Safety Enable input turns ON (1).
16#2003 8915	Output 1 failed to energize when the Start input turned ON (1) due to the Standard Enable input being OFF (0).	Verify that the devices used to source the Standard Enable input are functioning properly. This diagnostic is cleared when the Standard Enable input is ON (1).
16#2008 8200	Output 1 failed to energize when the Start input turned ON (1) due to the Motion Monitor Fault input being OFF (0).	Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement. This diagnostic is cleared when the motion monitor functions are properly monitoring motion and the Motion Monitor Fault input is ON (1).
16#2009 8201	Manual Ack Type: Output 1 failed to energize when the Start input turned ON (1) due to the Safety Enable Ack input being ON (1). Automatic Ack Type: N/A	Turn the Safety Enable Ack input OFF (0). This diagnostic is cleared when the Safety Enable Ack input turns OFF (0).
16#200A 8202	Output 1 failed to energize when the Start input turned ON (1) due to the slide being in the Up or Down zone.	The slide must be in the Top zone to initiate press movement. This diagnostic is cleared when the slide is inched back to the Top zone.
16#2020 8224	Output 1 is de-energized due to the Slide Zone input value becoming invalid.	Check the Crankshaft Position Monitor (CPM) instruction or the application logic used to source this input. This diagnostic is cleared at the next attempt to begin press movement.

Diagnostic Code	Description	Corrective Action
16#2021 8225	Output 1 is de-energized due to the Motion Monitor Fault input turning OFF (0).	Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement. This diagnostic is cleared at the next attempt to begin press movement.
16#2022 8226	Output 1 is de-energized due to the detection of press movement in the reverse direction.	Verify the direction of the press. This diagnostic is cleared at the next attempt to begin press movement.
16#2023 8227	Output 1 is de-energized due to the Safety Enable input turning OFF (0) while the slide was in the Top or Down zone.	Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas. This diagnostic is cleared at the next attempt to begin press movement.
16#2024 8228	Output 1 is de-energized due to the Standard Enable input turning OFF (0) while the slide was in the Top or Down zone.	Verify that the devices and application logic used to source the Standard Enable input are functioning properly. This diagnostic is cleared at the next attempt to begin press movement.
16#2025 8229	Output 1 is de-energized due to the Start input turning OFF (0) while the slide was in the Top or Down zones.	Output 1 is always de-energized when the Start input turns OFF (0) while the slide is in the Top or Down zones. This diagnostic is cleared at the next attempt to begin press movement.
16#2026 8230	Not used by this instruction.	
16#2027 8231	Output 1 is de-energized immediately when the Safety Enable input turned OFF (0) while the slide was in the Up zone and the Takeover Mode is Disabled.	Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas. This diagnostic is cleared at the next attempt to begin press movement.
16#2028 8232	Output 1 is de-energized when the slide entered the Top zone due to the Standard Enable input turning OFF (0) while the slide was in the Up zone.	Verify that the devices and application logic used to source the Standard enable input are functioning properly. This diagnostic is cleared at the next attempt to begin press movement.
16#2029 8233	Output 1 is de-energized immediately when the Start input turned OFF (0) while the slide was in the Up zone and the Takeover Mode is Disabled.	This diagnostic is cleared at the next attempt to begin press movement.
16#202A 8234	Output 1 is de-energized due to the slide entering the Top zone.	Output 1 is always de-energized when the slide enters the Top zone. This diagnostic is cleared at the next attempt to begin press movement.
16#202B 8235	Output 1 is de-energized due to the Press In Motion input remaining OFF (0) when the slide entered the Down zone or the Press In Motion input transitioned from ON (1) to OFF (0.	Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement. This diagnostic is cleared at the next attempt to begin press movement.
16#202C 8236	Output 1 is de-energized when the slide entered the Top zone and the Safety Enable input turned OFF (0) while the slide was in the Up zone, when the Takeover Mode is Enabled.	Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas. This diagnostic is cleared at the next attempt to begin press movement.

Diagnostic Code	Description	Corrective Action
16#202D 8237	Output 1 is de-energized when the slide entered the Top zone and the Start input turned OFF (0) while the slide was in the Up zone when the Takeover Mode is Enabled.	This diagnostic is cleared at the next attempt to begin press movement.

Examples

Ladder Diagram



See also

Clutch Brake Wiring and Programming Example on page 313

Metal Form Instructions on page 239

Index Through Arrays on page 540

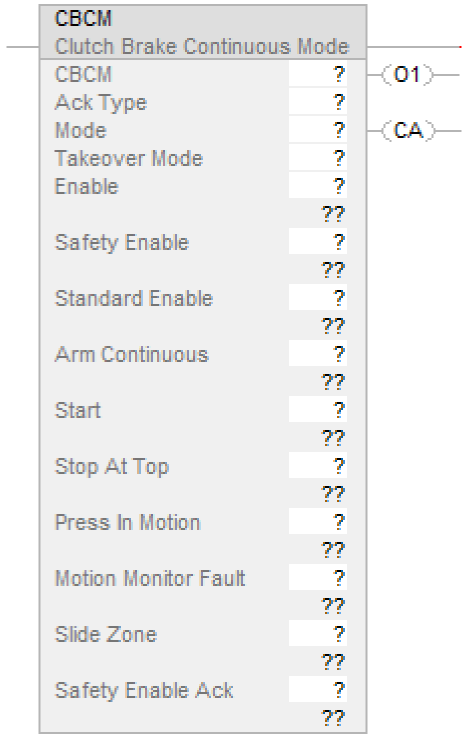
Clutch Brake Continuous Mode (CBCM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Clutch Brake Continuous Mode instruction is used in press applications where continuous operation is desired.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

WARNING: Do not use automatic acknowledgment when access within the danger zone can go undetected. This instruction, configured for automatic acknowledgment, must be used in combination with other instructions, at least one of which must fulfill the manual reset requirement.

Reset controls must be located within sight, but out of reach of the danger zone. See section 5.4.1.3 of EN692-2005 for details.

ATTENTION: This instruction is specified with the intent that the Slide Zone input is sourced only by the Slide Zone output of the Crankshaft Position Monitor (CPM) instruction or application logic that satisfies the Slide Zone requirements listed in the Clutch Brake Continuous Mode Instruction: Inputs table below.

This instruction is specified with the intent that the Enable input is sourced only by an Ox output[1] of the Eight Position Mode Selector (EPMS) instruction that is not already sourcing the Enable input of another Clutch Brake Inch Mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), or Clutch Brake Continuous Mode(CBCM) instruction.

[1] where x = 1 through 8

The Mode parameter specifies how continuous operation is attained. An arming sequence is required for these modes: Immediate with Arming, Half Stroke with Arming, or Stroke-and-a-Half with Arming. The arming sequence requires that the Start input transitions from OFF (0) to ON (1) within five seconds of the Arm Continuous input transitioning from OFF (0) to ON (1). When the arming sequence requirements have been satisfied and the Start input has remained ON (1) as specified by the configured Mode, the press begins to operate continuously.

An arming sequence is not required with Immediate mode configurations. In Immediate mode, the press begins to operate continuously when the Start input transitions from OFF (0) to ON (1).

Operands

IMPORTANT Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameters used to configure the instruction. These parameters cannot be changed at runtime.

Operand	Data Type	Format	Description	
CBCM	CB_CONTINUOUS_MODE	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.	
Ack Type	BOOL	name	Defines how instruction acknowledgment operates.	
			Automatic (1)	The acknowledgment is made automatically when the Safety Enable input transitions from OFF (0) to ON (1).
			Manual (0)	Acknowledgment is made when Safety Enable Ack transitions from OFF (0) to ON (1) and the Safety Enable input is ON (1).

Operand	Data Type	Format	Description	
Mode	DINT	name	This parameter configures the different continuous modes of operation.	
			Immediate (0)	The press begins to operate continuously when the Start input transitions from OFF (0) to ON (1).
			Immediate with Arming (3)	After completion of the arming sequence the continuous mode is entered immediately.
			Half Stroke with Arming (1)	After completion of the arming sequence the Start input signal must remain ON (1) until the first upstroke zone is reached.
			Stroke and a Half with Arming (2)	After completion of the arming sequence, the Start input signal must remain ON (1) until the slide completes a full rotation and the second upstroke zone is reached.
Takeover Mode	BOOL	name	This parameter determines when the stop occurs if the Safety Enable input transitions from ON (1) to OFF (0) while the slide is in the Up zone.	
			Enabled (1)	The press is stopped when the slide enters the Top zone.
			Disabled (0)	The press is stopped immediately.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Enable	BOOL	tag	This input is the signal to activate this instruction; for example, by an Eight Position Mode Selector (EPMS) Ox output, where x = 1 through 8. ON (1): The instruction is selected and operational. OFF (0): The instruction is not operating. All instruction outputs are de-energized.
Safety Enable	BOOL	tag	This input represents the status of safety-related permissive devices such as E-stops, light curtains, or safety gates. ON (1): Permissive devices are actively guarding the danger zone. Permits the energizing of O1 (Output 1). OFF (0): Permissive devices are in a state that doesn't allow Output 1 to be energized.
Standard Enable	BOOL	tag	Indicates the state of non safety-related permissive devices. ON (1): Permits the energizing of Output 1. OFF (0): Prevents the energizing of Output 1. This parameter is not safety-related.
Arm Continuous	BOOL	tag	Enables arming for the Immediate with Arming, Half Stroke with Arming, and Stroke-and-a-half with Arming modes only. ON (1): Enables arming. The arming sequence ends when the Start input transitions from OFF (0) to ON (1) within 5 seconds.

<table>
<tr><th>Operand</th><th>Data Type</th><th>Format</th><th>Description</th></tr>
<tr><td>Start</td><td>BOOL</td><td>tag</td><td>Input to start press movement.
ON (1): Energize Output 1 if all input conditions have been met.
OFF (0): Output 1 remains energized based on the configured continuous mode. Output 1 is de-energized if the continuous mode requirements are not met. See Mode parameter in the Clutch Brake Single Stroke Mode Instruction: Configuration Parameters table above for more information.</td></tr>
<tr><td>Stop At Top</td><td>BOOL</td><td>tag</td><td>This input is the request to stop press movement when the Top zone is reached.
OFF (0): Prevents the energizing of Output 1. De-energize Output 1 the next time the slide enters the Top zone.</td></tr>
<tr><td>Press In Motion</td><td>BOOL</td><td>tag</td><td>This input is typically sourced by Output 1 of the Camshaft Monitor (CSM) instruction or by user application logic. Feedback from the press safety valve needs to be included in the building of this signal.
ON (1): Indicates that the press is moving.
OFF (0): Indicates that the press is stopped.</td></tr>
<tr><td>Slide Zone</td><td>DINT</td><td>tag</td><td>This input represents the position of the slide and the position information status. It is sourced by the Crankshaft Position Monitor (CPM) instruction's Slide Zone output or user application logic that provides the following bit-mapped information.
Bit 0: Status
OFF (0) - The Slide Zone information is invalid. Prevents the energizing of Output 1 on an initial start or immediately stops the press.
ON (1) - Slide Zone information is valid.
Bits 1 and 2: Slide Zone
The following table lists how Bits 0 to 2 are used to represent the valid slide zones.
<table>
<tr><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th>Slide Zone</th><th>Decimal Value</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Down</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Up</td><td>3</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Top</td><td>5</td></tr>
</table>
Bits 3 to 31: Unused; Set to 0.</td></tr>
<tr><td>Motion Monitor Fault</td><td>BOOL</td><td>tag</td><td>Stops the press immediately when a press motion problem has been detected. This input is sourced by inverting the Fault Present output coming from the Camshaft Monitor (CSM) instruction or application logic that performs motion diagnostics.
ON (1): Indicates that press motion is valid. Permits Output 1 to be energized.
OFF (0): Indicates that a press motion problem exists. Prevents Output 1 from being energized or immediately de-energizes Output 1.</td></tr>
<tr><td>Safety Enable Ack</td><td>BOOL</td><td>tag</td><td>This input is required when the configured Ack Type is Manual.
OFF (0)->ON (1): Acknowledges that the Safety Enable input has transitioned from OFF (0) to ON (1).</td></tr>
</table>

The following table explains the instruction outputs.

Operand	Data Type	Description
Output 1 (O1)	BOOL	Output used to source the Actuate input of the Main Valve Control (MVC) instruction. ON (1): The output is energized. OFF (0): The output is de-energized. See CBCM - Energizing Output 1 and CBCM - De-energizing Output 1 below for details.
Continuous Armed (CA)	BOOL	This output is used when the instruction is configured for Immediate with Arming, Half Stroke with Arming and Stroke-and-a-half with Arming modes. ON (1): The arming sequence is in progress. OFF (0): Waiting to be armed. This parameter is not safety-related.
Diagnostic Code	DINT	See the CBCM - Diagnostic Codes below. This parameter is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Energizing Output 1

Output 1 is energized when the Start input transitions from OFF (0) to ON (1) and all of these conditions are met:

- The arming sequence, if configured, is complete.
- The Enable input is ON (1).
- The Safety Enable input has been acknowledged.
- The Standard Enable input is ON (1).
- The Slide Zone input represents the Top zone.
- The Motion Monitor Fault input is ON (1).
- The Press In Motion input is OFF (0).
- The Safety Enable Ack input is OFF (0).
- The Stop At Top input is ON (1).

IMPORTANT If the Ack Type is Manual, an acknowledgment of the Safety Enable input is required when the Enable input transitions from OFF (0) to ON (1) and before the Start or Arm Continuous input turns ON (0).

ATTENTION: When the configured Mode is Immediate and the Ack Type is Automatic, Output 1 energizes when the Safety Enable, Standard Enable, Slide Zone, Press In Motion, and Motion Monitor Fault inputs return to the active, or valid state at the same time the Start input transitions from OFF (0) to ON (1).

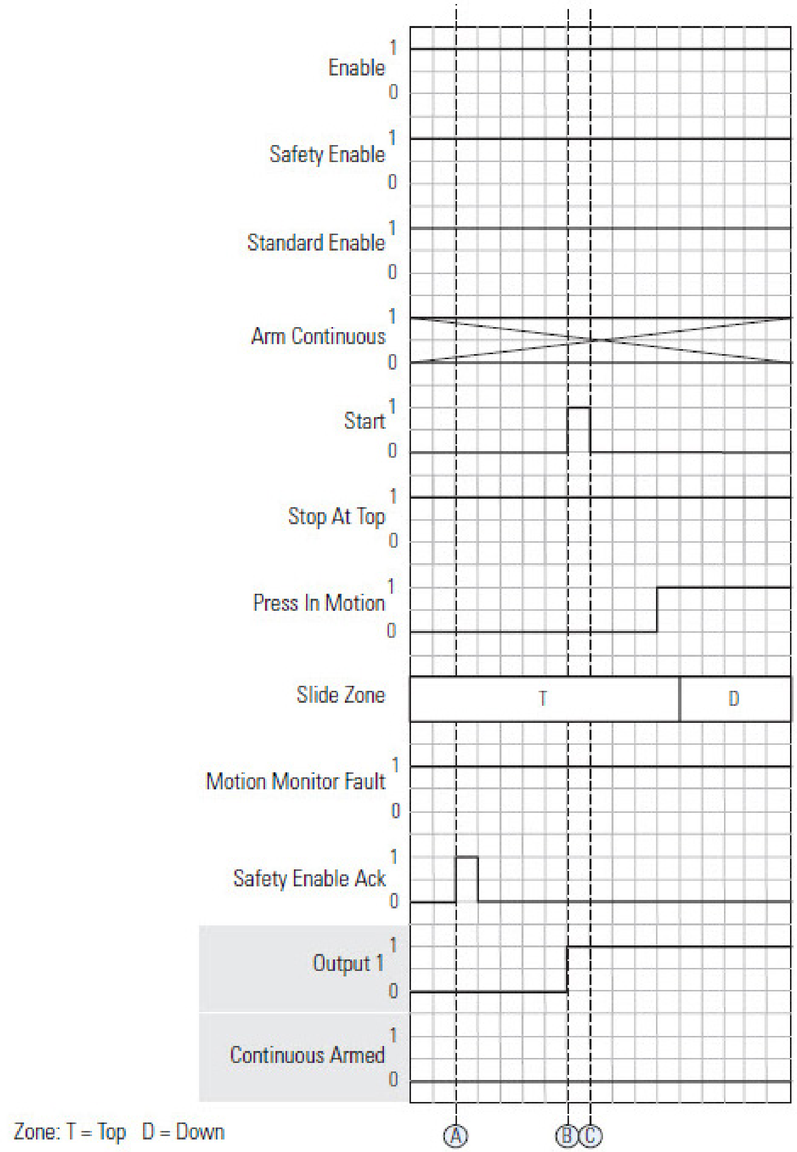
ATTENTION: When the configured Mode is Immediate with Arming, Half Stroke with Arming, or Stroke-and-a-half with Arming and the Ack Type is Automatic, the five-second arming time starts when the Safety Enable, Standard Enable, Slide Zone, Press In Motion, and Monitor Motion Fault inputs return to the ON (1), active, or valid state at the same time the Arm Continuous input transitions from OFF (0) to ON (1).

ATTENTION: The cam switches that determine slide position are monitored by the CPM instruction. This instruction uses the Slide Zone output of the CPM instruction as a representation of the cam switches that determine slide position.

Immediate Mode

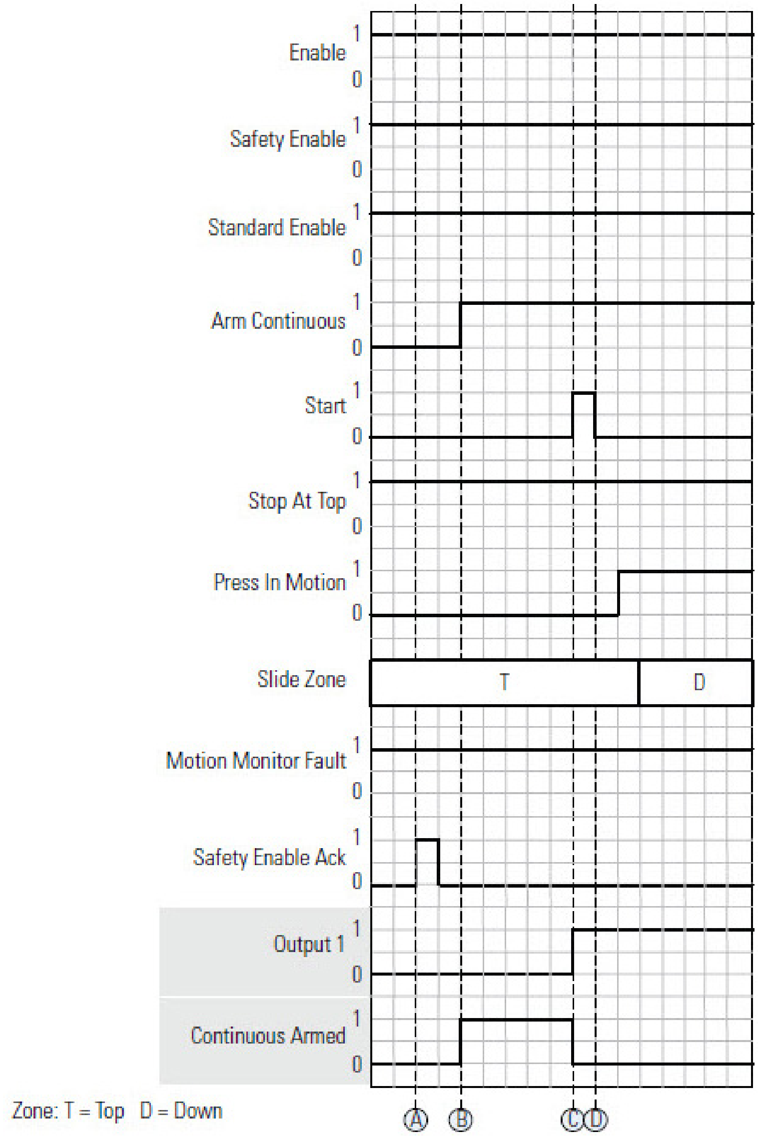
The timing diagram shows the acknowledgment of the Safety Enable input, at (A), and the energizing of Output 1 when the Mode is configured as Immediate. Output 1 is energized when the Start input transitions from OFF

(0) to ON (1) at (B) and all input conditions are being met. Output 1 remains energized when the Start input turns OFF (0) at (C).



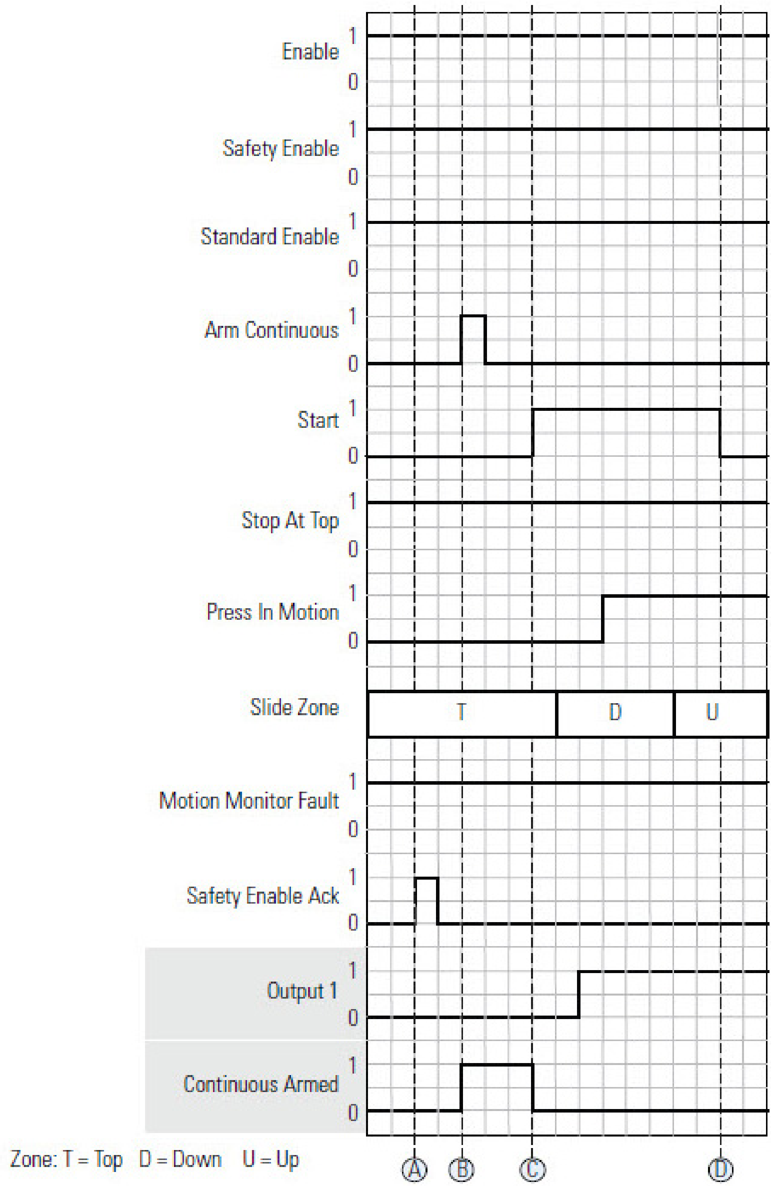
Immediate with Arming Mode

This diagram shows the acknowledgment of the Safety Enable input, at (A), and the energizing of Output 1 when the Mode is configured as Immediate with Arming. The five-second arming timer starts when the Arm Continuous input transitions from OFF (0) to ON (1) at (B) and all input conditions are being met. Within five seconds, Output 1 is energized when the Start input transitions from OFF (0) to ON (1) at (C) and all input conditions are being met. Output 1 remains energized when the Start input turns OFF (0) at (D).



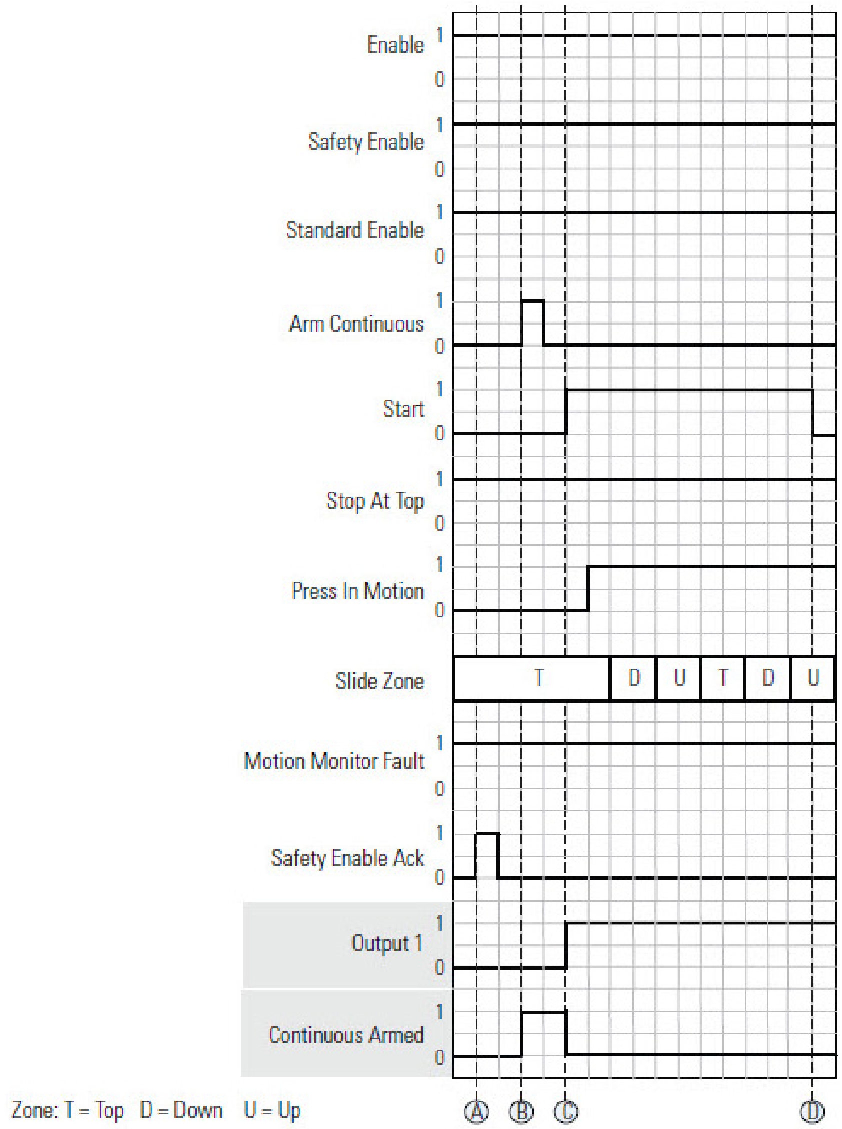
Half Stroke with Arming Mode

This diagram shows the acknowledgment of the Safety Enable input, at (A), and the energizing of Output 1 when the Mode is configured as Half Stroke with Arming. The five-second arming timer starts when the Arm Continuous input transitions from OFF (0) to ON (1) at (B) and all input conditions are being met. Within five seconds, Output 1 is energized when the Start input transitions from OFF (0) to ON (1) at (C) and all input conditions are being met. Output 1 remains energized when the Start input turns OFF (0) after the slide has transitioned a half-stroke at (D).



Stroke and a half with Arming Mode

This diagram shows the acknowledgment of the Safety Enable input, at (A), and the energizing of Output 1 when the Mode is configured as Stroke-and-a-half with Arming. The 5-second arming timer starts when the Arm Continuous input transitions from OFF (0) to ON (1) at (B) and all input conditions are being met. Within 5 seconds, Output 1 is energized when the Start input transitions from OFF (0) to ON (1) at (C) and all input conditions are being met. Output 1 remains energized when the Start input turns OFF (0) after the slide has transitioned a stroke-and-a-half at (D).



De-energizing Output 1

Once energized, Output 1 is de-energized when one or more of the following occurs:

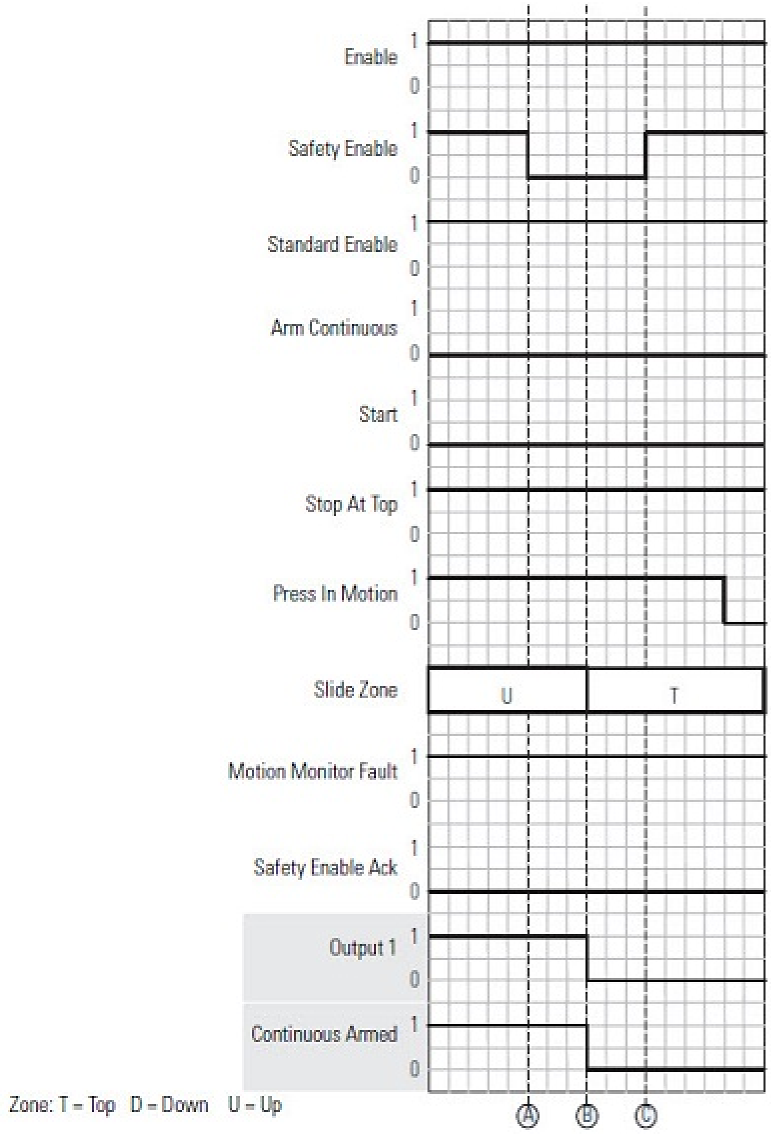
- The Enable input transitions from ON (1) to OFF (0).
- The Start input transitions from ON (1) to OFF (0) prior to entering the continuous operation.
  When this transition occurs while the slide is in the Up zone, Output 1 is de-energized when the slide enters the Top zone. Otherwise, Output 1 is de-energized immediately.
- The Safety Enable input transitions from ON (1) to OFF (0).
- When this transition occurs while the slide is in the Up zone and Takeover Mode is enabled, Output 1 is de-energized when the slide

enters the Top zone. Otherwise, when Takeover Mode is disabled, Output 1 is de-energized immediately. Output 1 is also de-energized immediately when this transition occurs while the slide is in the Top or Down zones.

- The Standard Enable input transitions from ON (1) to OFF (0). When this transition occurs while the slide is in the Up zone, Output 1 is de-energized when the slide enters the Top zone. Otherwise, Output 1 is de-energized immediately.
- The Slide Zone input value becomes invalid.
- The Monitor Motion Fault input transitions from ON (1) to OFF (0).
- The direction of the press appears to be running in reverse.
- The Press In Motion input is OFF (0) when the slide goes from Top to Down.
- The Stop At Top input transitions from ON (1) to OFF (0) and the slide enters the Top zone.
- The Press in Motion input transitions from ON (1) to OFF (0).

Safety Enable and Takeover Mode

This diagram shows Output 1 being de-energized when the slide enters the Top zone at (B). Output 1 is de-energized because the Safety Enable input has transitioned from ON (1) to OFF (0) during the Up zone, at (A), with Takeover Mode enabled. Before Output 1 can be re-energized, an acknowledgment of the Safety Enable input is required when the Safety Enable input transitions from OFF (0) to ON (1) at (C).



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Diagnostic Codes and Corrective Actions

Diagnostics 16#2000...16#200A are detected when attempting to start press movement by energizing Output 1.

Diagnostics 16#2020...16#202D are used to diagnose the reason for stopping press movement by de-energizing Output 1.

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description		Corrective Action
0	No fault.		None.
16#2000 8192	Immediate Mode	Output 1 failed to energized when the Start input turned ON (1), due to an invalid Slide Zone input value.	Check the Crankshaft Position Monitor (CPM) instruction or the application logic used to source this input. This diagnostic is cleared when a valid Slide Zone is established.
	Arming Modes	• The five-second arming timer failed to start when the Arm Continuous input turned ON (1) due to an invalid Slide Zone input value. • During the five-second arming period, the Slide Zone input value became invalid.	
16#2001 8193	Immediate Mode	Output 1 failed to energize when the Start input turned ON (1) due to the Press In Motion input being ON (1).	• Wait for the press to come to a complete stop before initiating press movement. • Verify that the device is monitoring press movement is working correctly. • Verify that only one mode of operation is selected.
	Arming Modes	• The five-second timer failed to start when the Arm Continuous input turned ON (1) due to the Press In Motion input being ON (1). • During the five-second arming period, the Press In Motion input turned ON (1).	
16#2002 8194	Immediate Mode	• When the configured Ack Type is Manual, Output 1 failed to energize when the Start input turned ON (1) prior to the acknowledgment of the Safety Enable input. • When the configured Ack Type is Automatic, Output 1 failed to energize when the Start input turned ON (1) and the Safety Enable input was OFF (0).	• Verify that the active opto-electronic protective devices (AOPDs) and electro-sensitive protective equipment (ESPEs) used to source the Safety Enable input are protecting their respective areas. • Then, to clear the diagnostic for manual Ack Types, acknowledge the Safety Enable input by

Diagnostic Code	Description		Corrective Action
	Arming Modes	• When the configured Ack Type is Manual, the five-second timer failed to start when the Arm Continuous input turned ON (1) prior to the acknowledgment of the Safety Enable input. • When the configured Ack Type is Automatic, the five-second arming timer failed to start when the Arm Continuous input and the Safety Enable inputs are OFF (0). • During the five-second arming period, the Safety Enable input turned OFF (0).	turning the Safety Enable Ack input ON (1). • For automatic Ack Types, this diagnostic is cleared when the Safety Enable input turns ON (1).
16#2003 8195	Immediate Mode	Output 1 failed to energize when the Start input turned ON (1) due to the Standard Enable input being OFF (0).	Verify that the devices used to source the Standard Enable input are functioning properly. This diagnostic is cleared when the Standard Enable input is ON (1).
	Arming Modes	• The five-second timer failed to start when the Arm Continuous input turned ON (1) due to the Standard Enable input being OFF (0). • During the five-second arming period, the Standard Enable input turned OFF (0).	
16#2004 8196	Immediate Mode	N/A	Turn the Start input OFF (0) and turn the Arm Continuous input ON (1) to clear this diagnostic.
	Arming Modes	The Start input was ON (1) when the Arm Continuous input turned ON (1).	
16#2005 8197	Immediate Mode	N/A	Turn the Arm Continuous input ON (1) to restart the arming timer and clear this diagnostic.
	Arming Modes	The Start input did not turn ON (1) within five seconds of the Arm Continuous input turning ON (1).	
16#2006 8198	Immediate Mode	N/A	The Arm Continuous input must turn ON (1) before the Start input does. Turn the Start input OFF (0) and turn the Arm Continuous input ON (1) to clear this diagnostic.
	Arming Modes	The Start input turned ON (1) before the Arm Continuous input turned ON (1).	
16#2007 8199	Immediate Mode	Output 1 failed to energize when the Start input turned ON (1) due to the Stop At Top input being OFF (0).	Turn the Stop At Top input OFF (0) and turn the Arm Continuous input ON (1) to clear this diagnostic.

Diagnostic Code	Description		Corrective Action
	Arming Modes	• The five-second timer failed to start when the Arm Continuous input turned ON (1) due to the Stop At Top input being OFF (0). • During the five-second arming period, the Stop At Top input turned OFF (0).	
16#2008 8200	Immediate Mode	Output 1 failed to energize when the Start input turned ON (1) due to the Motion Monitor Fault input being OFF (0).	Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement. This diagnostic is cleared when the motion monitor functions are properly monitoring motion and the Motion Monitor Fault input is ON (1).
	Arming Modes	• The five-second timer failed to start when the Arm Continuous input turned ON (1) due to the Motion Monitor Fault input being OFF (0). • During the five-second arming period, the Motion Monitor Fault input turned OFF (0).	
16#2009 8201	Immediate Mode	Output 1 failed to energize when the Start input turned ON (1) due to the Safety Enable Ack input being ON (1).	Turn the Safety Enable Ack input OFF (0). This diagnostic is cleared when the Safety Enable Ack input turns OFF (0).
	Arming Modes	• The five-second timer failed to start when the Arm Continuous input turned ON (1) due to the Safety Enable Ack input being OFF (0). • During the five-second arming period, the Safety Enable Ack input turned OFF (0).	
16#200A 8202	Immediate Mode	Output 1 failed to energize when the Start input turned ON (1) due to the slide being in the Down or Up zone.	The slide must be in the Top zone when press movement is initiated. This diagnostic is cleared when the slide is inched back to the Top zone.
	Arming Modes	• The five-second timer failed to start when the Arm Continuous input turned ON (1) due to the slide being in the Down or Up zone. • During the five-second arming period, the slide moved to the Down or Up zone.	

<table>
<tr><th>Diagnostic Code</th><th colspan="2">Description</th><th>Corrective Action</th></tr>
<tr><td>16#2020
8224</td><td colspan="2">Output 1 is de-energized due to the Slide Zone input value becoming invalid.</td><td>Check the Crankshaft Position Monitor (CPM) instruction or the application logic used to source this input.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
<tr><td>16#2021
8225</td><td colspan="2">Output 1 is de-energized due to the Motion Monitor Fault input turning OFF (0).</td><td>Check the Camshaft Monitor (CSM) instruction or the application logic used to monitor press movement.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
<tr><td>16#2022
8226</td><td colspan="2">Output 1 is de-energized due to the detection of press movement in the reverse direction.</td><td>Verify the direction of the press.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
<tr><td>16#2023
8227</td><td colspan="2">Output 1 is de-energized due to the Safety Enable input turning OFF (0) while the slide was in the Top or Down zone.</td><td>Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
<tr><td>16#2024
8228</td><td colspan="2">Output 1 is de-energized due to the Standard Enable input turning OFF (0) while the slide was in the Top or Down zone.</td><td>Verify that the devices and application logic used to source the Standard Enable input are functioning properly.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
<tr><td rowspan="4">16#2025
8229</td><td>Immediate</td><td rowspan="2">N/A</td><td rowspan="4">Output 1 is always de-energized when the Start input turns OFF (0) while the slide is in the Top or Down zones.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
<tr><td>Immediate with Arming</td></tr>
<tr><td>Half Stroke with Arming Mode</td><td rowspan="2">Output 1 is de-energized due to the Start input turning OFF (0) while the slide was in the Top or Down zones prior to entering continuous operation.</td></tr>
<tr><td>Stroke-and-a-half with Arming Mode</td></tr>
<tr><td>16#2026
8230</td><td colspan="3">Not used by this instruction.</td></tr>
<tr><td>16#2027
8231</td><td colspan="2">Output 1 is de-energized immediately when the Safety Enable input turned OFF (0) while the slide was in the Up zone and the Takeover Mode is Disabled.</td><td>Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas.
This diagnostic is cleared at the next attempt to begin press movement.</td></tr>
</table>

Diagnostic Code	Description	Corrective Action
16#2028 8232	Output 1 is de-energized when the slide entered the Top zone due to the Standard Enable input turning OFF (0) while the slide was in the Up zone.	Verify that the devices and application logic that is used to source the Standard Enable input are functioning properly. This diagnostic is cleared at the next attempt to begin press movement.
16#2029 8233	Output 1 is de-energized immediately when the Start input turned OFF (0) while the slide was Up zone before entering continuous operation, with a Takeover Mode of Disabled.	This diagnostic is cleared at the next attempt to begin press movement
16#202A 8234	Output 1 is de-energized because the slide entered the Top zone after a stop request has been made.	This diagnostic is cleared at the next attempt to begin press movement.
16#202B 8235	Output 1 is de-energized because the Press In Motion input remained OFF (0) when the slide entered the Down zone or the Press In Motion input is transitioned from ON (1) to OFF (0)	Check the Camshaft Monitor (CSM) instruction or he application logic that is used to monitor press movement. This diagnostic is cleared at the next attempt to begin press movement.
16#202C 8236	Output 1 is de-energized when the slide entered the Top zone and the Safety Enable input turned OFF (0) while the slide was in the Up zone, with Takeover Mode enabled.	Verify that the AOPDs and ESPEs used to source the Safety Enable input are protecting their respective areas. This diagnostic is cleared at the next attempt to begin press movement.
16#202D 8237	Output 1 de-energized when the slide entered the Top zone and the Start input turned OFF (0) while the slide was in the Up zone prior to entering continuous operation, with Takeover Mode enabled.	This diagnostic is cleared at the next attempt to begin press movement.

Affects Math Status Flags

No

Major/Minor Faults

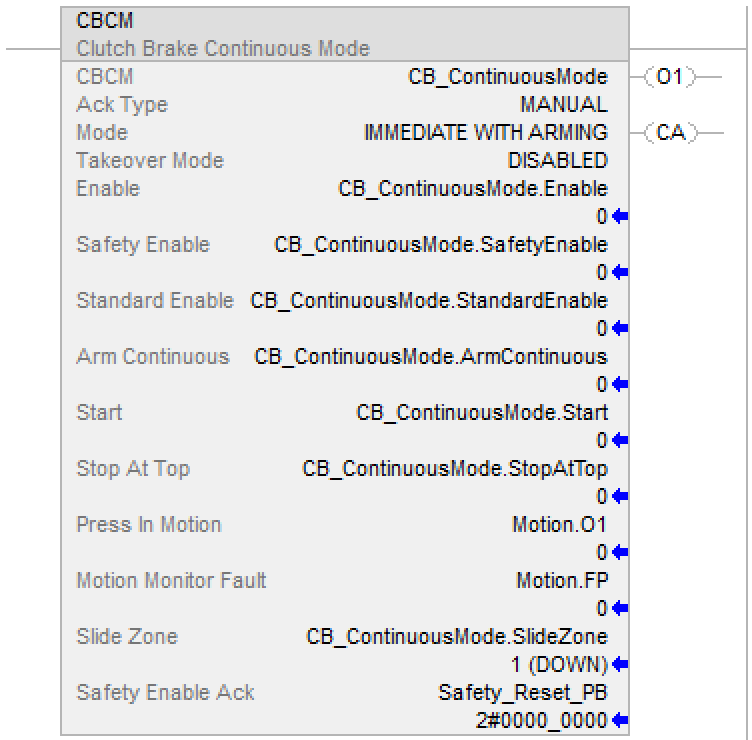
None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false

Condition/State	Action Taken
Rung-condition-in is false	The .01 and .CA are cleared to false. The Diagnostic Code output is set to 0.
Rung-condition-in is true	The instruction executes as described in the Normal operation section.
Postscan	Same as Rung-condition-in is false

Example



See also

Clutch Brake Wiring and Programming Example on page 313

Index Through Arrays on page 540

Metal Form Instructions on page 239

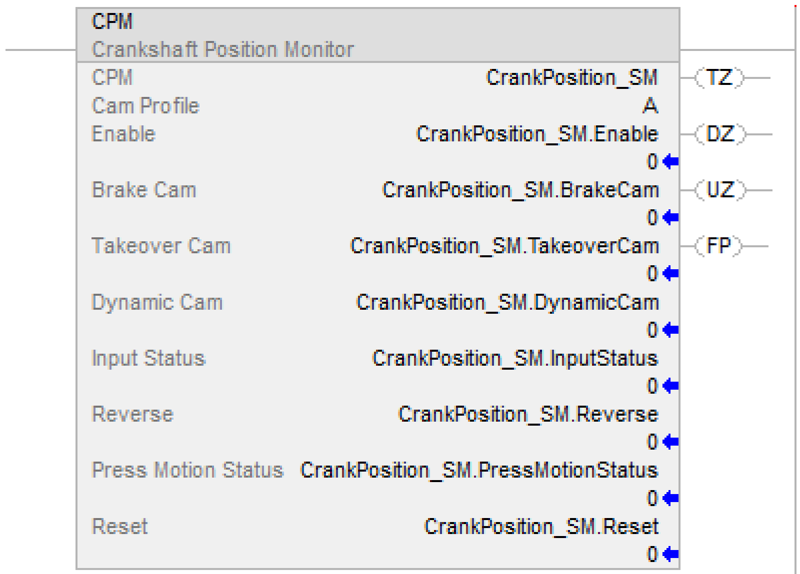
Crankshaft Position Monitor (CPM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Crankshaft Position Monitor instruction is used to determine the slide position of the press by monitoring the Brake (BCAM), Dynamic (DCAM), and Takeover (TCAM) cams and representing the position as Top, Down, or Up by using the Slide Zone output. Also, the Top Zone, Down Zone, and Up Zone Boolean outputs are provided for monitoring and diagnostic purposes.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

WARNING: This instruction is specified with the intent that the Slide Zone output is used to source the Slide Zone input of the Clutch Brake Inch Mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), Clutch Brake Continuous Mode (CBCM), and Camshaft Monitor (CSM) instructions.

Normal stop operation of a press begins when the slide enters the Top zone. A successful stop occurs when the press stops in the Top zone. During normal stopping, the speed of the press may cause the press to stop in the Down zone. This is called an overrun. To minimize this, the DCAM can be enabled to generate an early Top zone, allowing the press to begin stopping early.

WARNING: When required, the DCAM should only be enabled for normal stopping, based on speed of the press. Do not adjust the DCAM to account for deteriorating brake performance.

> **WARNING:** Reversing the press should only be performed during set up mode by using the Clutch Brake Inch Mode (CBIM) instruction. Reversing the press is only permitted for moving the slide from the Down zone to the Top zone where the CBIM instruction automatically stops the press at Top. A fault occurs when reverse movement continues into the Up zone.

Operands

> **IMPORTANT** Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

> **ATTENTION:** If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the parameters used to configure the instruction. These parameters cannot be changed at runtime.

Operand	Data Type	Description
CPM	CRANKSHAFT_POSITION_MONITOR	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.
Cam Profile	BOOL	This parameter determines the cam profile used to generate the Slide Zone values. A (0) - See CPM – Cam Profiles and CPM – Normal Operation with Cam Profile A below. B (1) - See CPM – Cam Profiles and CPM – Normal Operation with Cam Profile B below.

The following table explains the instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Description	
Enable	BOOL	This signal is used to enable the Crankshaft Position Monitor (CPM) instruction. ON (1): The instruction outputs are enabled. OFF (0): The instruction outputs are disabled.	
Brake Cam (BCAM)	BOOL	This input is sourced by the cam monitoring device (hard cam) or application logic (soft cam).	
		Cam Profile A	This input specifies the overrun point and the Top zone when dynamic stopping is disabled. OFF (0) -> ON (1): While the press is running and dynamic stopping is disabled, this transition signals the end of the Up zone and the start of the Top zone. ON (1) -> OFF (0): While the press is stopping, this transition causes the Camshaft Monitor instruction to generate a brake fault.

<table>
<tr><th>Operand</th><th>Data Type</th><th colspan="2">Description</th></tr>
<tr><td></td><td></td><td>Cam Profile B</td><td>This input specifies the overrun point and the zone where immediate braking of the press is allowed.
OFF (0) - No effect.
OFF (0) -> ON (1): When detected while the press is stopping, this transition causes the Camshaft Monitor (CSM) instruction to generate a brake fault. While the press is running, this transition signals the end of the Top zone and start of the Down zone.
ON (1) -> OFF (0): While the press is running, this transition must occur after the OFF (0) to ON (1) transition of the Takeover cam (TCAM).</td></tr>
<tr><td rowspan="3">Takeover Cam (TCAM)</td><td rowspan="3">BOOL</td><td colspan="2">This input is sourced by the cam monitoring device (hard cam) or application logic (soft cam).</td></tr>
<tr><td>Cam Profile A</td><td>This input is used to indicate the start of the Up zone.
OFF (0) -> ON (1): This transition signals the start of the end of the Down zone and the start of the Up zone.
ON (1) -> OFF (0: When dynamic stopping is enabled, this transition has no effect unless the dynamic stop signal has yet to occur. When this happens, this transition signals the end of the Up zone and start of the Top zone.</td></tr>
<tr><td>Cam Profile B</td><td>This input is used to indicate the start of the Up zone.
OFF (0): The press is considered to be in the Down zone when the Brake cam (BCAM) is ON (1).
OFF (0) -> ON (1): This transition signals the start of the Up zone and the end of the Down zone and must occur before the ON (1) to OFF (0) transition of the BCAM.
ON (1) -> OFF (0): When dynamic stopping is not enabled, this transition signals the end of the upstroke and the start of the Top zone. When dynamic stopping is enabled, this transition has no effect unless the dynamic stop signal has yet to occur. In this case, the dynamic stopping enable behavior is performed.</td></tr>
<tr><td>Dynamic Cam (DCAM)</td><td>BOOL</td><td colspan="2">This input is used to generate an early top signal for fast-running presses. This input is sourced by a cam monitoring device (hard cam) or application logic (soft cam).
This parameter is not safety-related.</td></tr>
</table>

Operand	Data Type	Description	
		Cam Profile A	When dynamic stopping is not required, this input should be sourced by the inverse of the Brake Cam (BCAM). OFF (0) -> ON (1): Dynamic stopping is enabled when this transition occurs at or after the ON (1) to OFF (0) transition of the BCAM. ON (1) -> OFF (0): This transition signals the end of upstroke and the start of the Top zone when it occurs before the OFF (0) to ON (1) transition of the Takeover cam (TCAM).
		Cam Profile B	When dynamic stopping is not required, this input should be sourced by the Takeover Cam (TCAM). OFF (0) -> ON (1): Dynamic stopping is enabled when this transition occurs at or after the OFF (0) to ON (1) transition of the TCAM. ON (1) -> OFF (0): This transition signals the end of Up zone and the start of the Top zone when it occurs at or before the ON (1) to OFF (0) transition of the TCAM.
Input Status	BOOL	This input represents the combined status of the cam monitoring functions in addition to the I/O module status. ON: Inputs are valid. The Slide Zone status bit is set to 1. OFF: Inputs are invalid. All outputs are set to their de-energized or OFF (0) state. The Slide Zone status bit is set to 0.	
Reverse	BOOL	Reversing the press should only be performed during set up mode by using the Clutch Brake Inch Mode (CBIM) instruction. Reversing the press is only permitted to move the slide from the Down zone to the Top zone where the Clutch Brake Inch Mode (CBIM) instruction automatically stops the press. A fault is generated when reverse movement is continued into the Up zone. OFF (0): Reverse operation is disabled. ON (1): When the slide is in the Down zone, this instruction lets the press move toward the Top zone. A fault is generated if this input is ON (1) when the slide is in the Up zone.	
Press Motion Status	BOOL	This input represents the motion status of the press and is sourced by Output 1 of the Main Valve Control (MVC) instruction or other valve control application logic. OFF (0): The press has stopped or a stop request has been issued. ON (1): The press is running or a start request has been issued. **Important:** When the press has been requested to stop at Top, overrun monitoring is enabled when the slide transitions from the Up to the Top zone. An overrun fault occurs when the slide continues to move into the Down zone.	
Reset[1]	BOOL	This input clears the instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset.	

(1) ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the “Reset_Signal” tag in this example to your

reset signal tagname. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains the instruction outputs. The outputs may be field device signals or derived from user logic.

<table>
<tr><th>Operand</th><th>Data Type</th><th>Description</th></tr>
<tr><td>Slide Zone</td><td>DINT</td><td>This output represents the position of the slide and the position information status. This output is used to source the Slide Zone input of the Clutch Brake Inch Mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), Clutch Brake Continuous Mode (CBCM), and Camshaft Monitor (CSM) instructions.
This is a bit-mapped value where:
Bit 0: Status
OFF (0) - The Slide Zone information is invalid. Prevents the energizing of Output 1 on an initial start or immediately de-energized Output 1.
ON (1) - Slide Zone information is valid.
Bits 1 and 2: Slide Zone
The following table lists how Bits 0 through 2 are used to represent the valid slide zones.
<table>
<tr><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th>Slide Zone</th><th>Decimal Value</th></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Down</td><td>1</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Up</td><td>3</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Top</td><td>5</td></tr>
</table>
Bits 3 through 31: Unused; Set to 0.</td></tr>
<tr><td>Top Zone (TZ)</td><td>BOOL</td><td>This information bit indicates when the slide is in the Top zone.</td></tr>
<tr><td>Down Zone (DZ)</td><td>BOOL</td><td>This information bit indicates when the slide is in the Down zone.</td></tr>
<tr><td>Up Zone (UZ)</td><td>BOOL</td><td>This information bit indicates when the slide is in the Up zone.</td></tr>
<tr><td>Diagnostic Code</td><td>DINT</td><td>This output indicates the diagnostic status of the instruction. See the CPM – Diagnostic Codes below for a list of diagnostic codes.
This parameter is not safety-related.</td></tr>
<tr><td>Fault Code</td><td>DINT</td><td>This output indicates the type of fault that occurred. See the CPM – Fault Codes below for a list of fault codes.
This parameter is not safety-related.</td></tr>
<tr><td>Fault Present (FP)</td><td>BOOL</td><td>ON (1): A fault is present in the instruction.
OFF (0): The instruction is operating normally.</td></tr>
</table>

IMPORTANT Do not write to any instruction output tag under any circumstances.

Cam Profiles

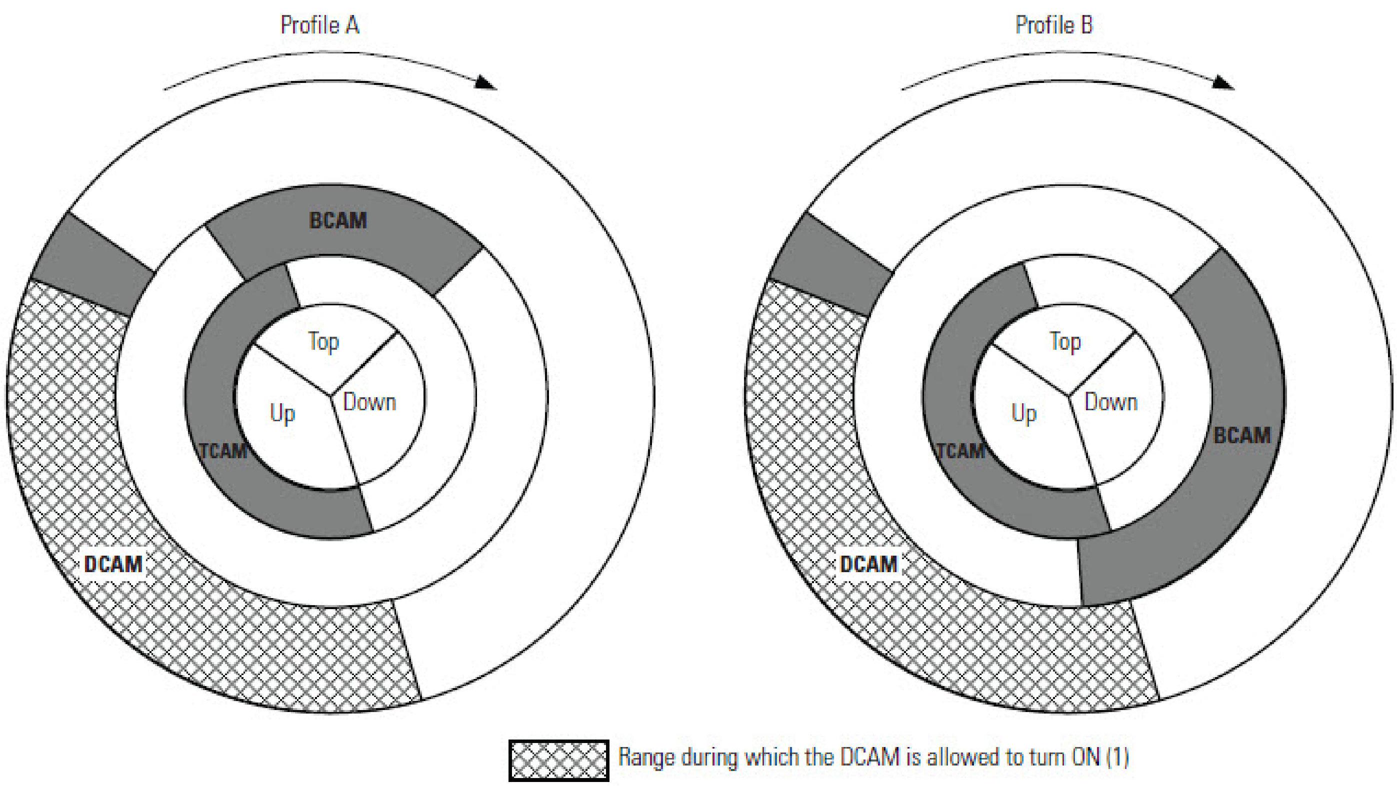
This instruction supports two cam profiles, A or B, selected by using the Cam Profile configurable parameter. The main difference between Cam Profiles A and B is the configuration of the Brake Cam (BCAM). In profile A, the BCAM is configured to represent the Top zone and in profile B, it is configured to represent the Down zone. The Takeover Cam (TCAM) in both profiles is configured to represent the Up zone.

These profile diagrams illustrate the relationships of the cams when the Dynamic Cam (DCAM) is enabled.

When enabled, the DCAM is configured the same way, with the ON (1) to OFF (0) transition during the Up zone generating the early Top zone. Depending upon the speed of the press, this transition can be configured to occur anytime during the Up zone. However, when the DCAM is disabled, it must be configured as follows:

- Profile A – The DCAM must be sourced by the inverse of the BCAM input source.
- Profile B – The DCAM must be sourced by the TCAM input source.

Cam Profiles



WARNING: Cam angles are not shown in these cam profiles. The cam angles should be selected by qualified personnel.

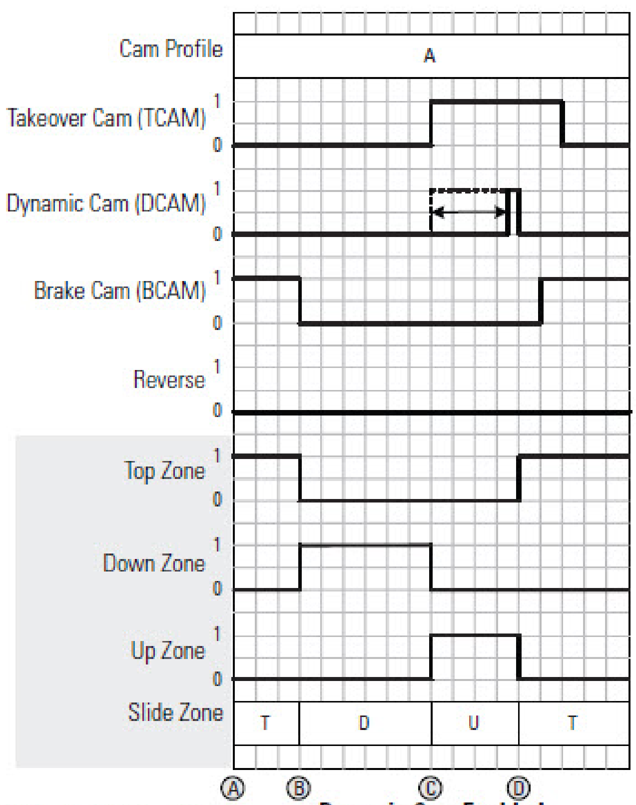
WARNING: When the Cam Profile is configured for A and dynamic stopping is disabled, the Dynamic Cam (DCAM) input must be sourced inverse of the Brake Cam (BCAM) input source.

WARNING: When the Cam Profile is configured for B and dynamic stopping is disabled, the Dynamic Cam (DCAM) input must be sourced by the Takeover Cam (TCAM) input source.

Normal Operation with Cam Profile A

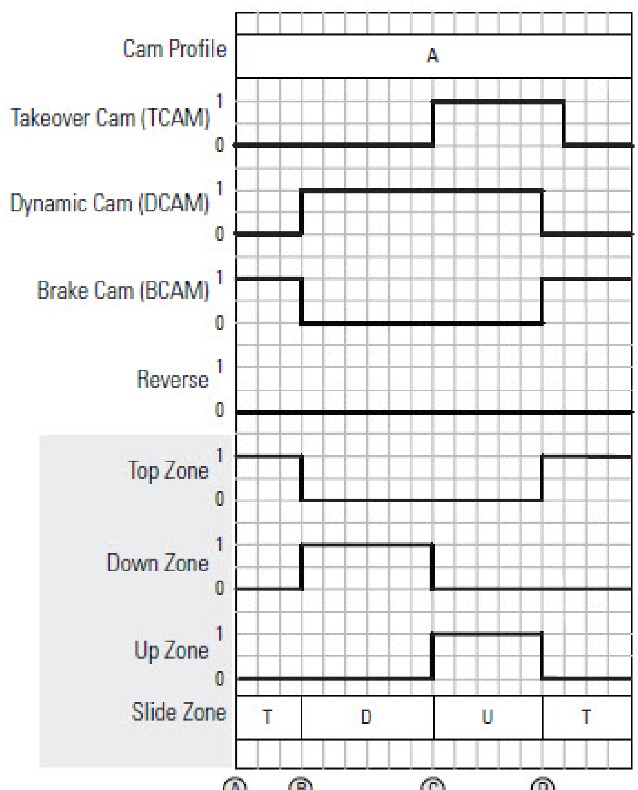
The following example describes normal operation when Cam Profile A is selected and the press is moving in the forward direction. The press starts with the slide at Top with the Takeover cam input (TCAM) OFF (0) and the Brake cam input (BCAM) ON (1) at (A) The Slide Zone is set to Top. As the press moves, the BCAM input transitions from ON (1) to OFF (0) at (B) and the Slide Zone changes from Top to Down. As the press continues moving, the TCAM input transitions from OFF (0) to ON (1) at (C) and the Slide Zone changes from Down to Up. Further press movement causes the Slide Zone output to change from Up to Top at different points depending on the Dynamic cam input (DCAM) configuration.

When the DCAM is enabled, the Slide Zone changes from Up to Top when the DCAM input transitions from ON (1) to OFF (0) while the TCAM input is ON (1) at (D). When the DCAM is disabled, the Slide Zone changes from Up to Top when the BCAM input transitions from OFF (0) to ON (1) at (D).



Zone: T = Top D = Down U = Up

Dynamic Cam Enabled

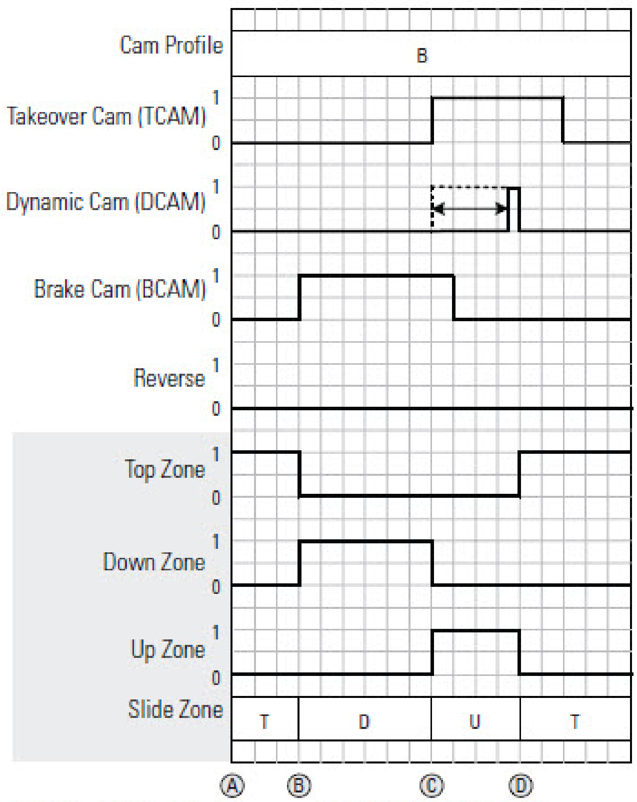


Dynamic Cam Disabled

Normal Operation with Cam Profile B

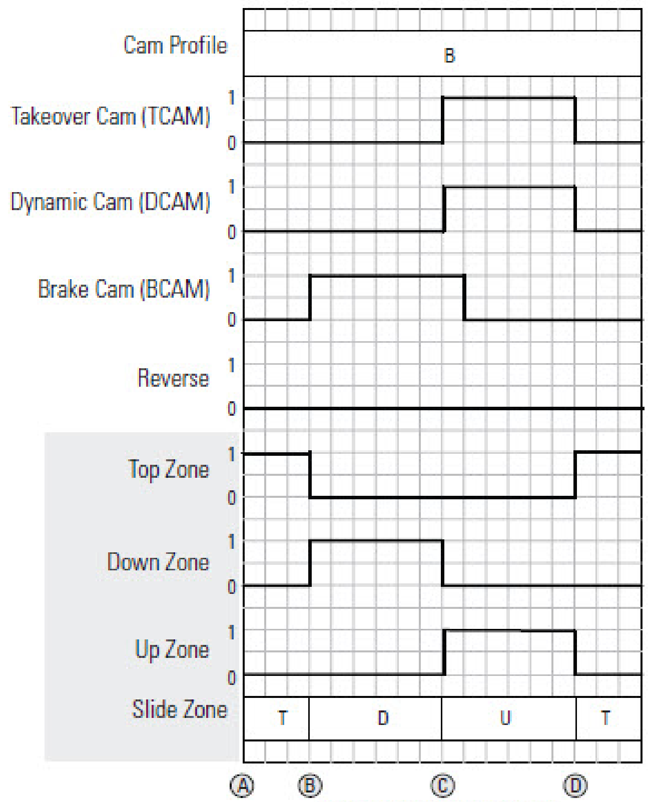
The following example describes normal operation when Cam Profile B is selected and the press is moving in the forward direction. The press starts with slide at Top with Takeover cam input (TCAM) and Brake cam input (BCAM) OFF (0) at (A) and Slide Zone set to Top. As the press moves, the BCAM input transitions from OFF (0) to ON (1) at (B) and the Slide Zone changes from Top to Down. As the press continues moving, the TCAM input transitions from OFF (0) to ON (1) at (C) and Slide Zone changes from Down to Up. Further press movement causes the Slide Zone output to change from Up to Top at different points depending on the Dynamic cam input (DCAM) configuration.

When the DCAM is enabled, the Slide Zone output changes from Up to Top when the DCAM input transitions from ON (1) to OFF (0) while the TCAM input is ON (1) and the BCAM input is OFF (0) at (D). When the DCAM is disabled, the Slide Zone output changes from Up to Top when the TCAM input transitions ON (1) to OFF (0) at (D).



Zone: T = Top D = Down U = Up

Dynamic Cam Enabled



Dynamic Cam Disabled

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

<table>
<tr><th>Fault Code</th><th colspan="2">Description</th><th>Corrective Action</th></tr>
<tr><td>00</td><td colspan="2">No fault.</td><td>None.</td></tr>
<tr><td>16#20
32</td><td colspan="2">The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.</td><td>• Check the I/O module connection or the internal logic used to source input status.
• Reset the fault.</td></tr>
<tr><td>16#1000
4096</td><td colspan="2">While the press was moving forward, slide movement from the Top zone to the Up zone was detected.</td><td rowspan="6">• Check the cams or the scan rate.
• Reset the fault.</td></tr>
<tr><td>16#1001
4097</td><td colspan="2">While the press was moving forward, slide movement from the Down zone to the Top zone was detected.</td></tr>
<tr><td>16#1002
4098</td><td colspan="2">While the press was moving forward, slide movement from the Up zone to the Down zone was detected.</td></tr>
<tr><td>16#1003
4099</td><td colspan="2">While the press was moving forward, slide movement from the Up zone to the Down zone was detected.</td></tr>
<tr><td>16#1004
4100</td><td colspan="2">Slide movement from the Top zone to the Down zone was detected while the press was reversing. Reverse movement is only permitted toward the Top zone.</td></tr>
<tr><td>16#1005
4101</td><td colspan="2">Slide movement from the Down zone to the Up zone was detected while the press was reversing. Forward movement of the press is not permitted when Reverse is enabled.</td></tr>
<tr><td>16#1006
4102</td><td colspan="2">The Dynamic cam (DCAM) is stuck OFF (0).</td><td rowspan="4">• Check the DCAM.
• Reset the fault.</td></tr>
<tr><td>16#1007
4103</td><td colspan="2">The Dynamic cam (DCAM) is stuck ON (1).</td></tr>
<tr><td rowspan="2">16#1008
4104</td><td>Cam Profile A</td><td>The DCAM turned OFF (0) while the slide was in the Down zone.</td></tr>
<tr><td>Cam Profile B</td><td>N/A</td></tr>
<tr><td rowspan="2">16#1009
4105</td><td>Cam Profile A</td><td>The Takeover cam (TCAM) is stuck ON (0).</td><td rowspan="2">• Check the TCAM.
• Reset the fault.</td></tr>
<tr><td>Cam Profile B</td><td>N/A</td></tr>
<tr><td rowspan="2">16#100A
4106</td><td>Cam Profile A</td><td>N/A</td><td rowspan="2">• Check the BCAM.
• Reset the fault.</td></tr>
<tr><td>Cam Profile B</td><td>The Brake cam (BCAM) is stuck ON (0).</td></tr>
<tr><td>16#1020
4128</td><td colspan="2">A request to reverse the press was made while the slide was in the Up zone.</td><td>• Set the Reverse input to OFF (0).
• Reset the fault.</td></tr>
<tr><td>16#1040
4160</td><td colspan="2">A slide overrun fault occurred.</td><td>• Check the brake linings for wear.
• Check the cam settings for proper alignment.
• Reset the fault.</td></tr>
</table>

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format

Fault Code	Description	Corrective Action
00	No fault.	None.
16#20 32	The Input Status input was OFF (0) when the instruction started.	Check the I/O module connection or the Camshaft Monitor (CSM) instruction used to source input status. Set the Input Status input to ON (1), if the inputs are not being sourced by a safety I/O module.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .TZ, DZ, UZ, and FP is cleared to false. The Diagnostic Code, Fault Code, and Slide Code are set to 0.
Rung-condition-in is true	The instruction executes as described in the Normal operation section.
Postscan	Same as Rung-condition-in is false.

See also

Clutch Brake Wiring and Programming Example on page 313

Index Through Arrays on page 540

Metal Form Instructions on page 239

CamShaft Monitor (CSM)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

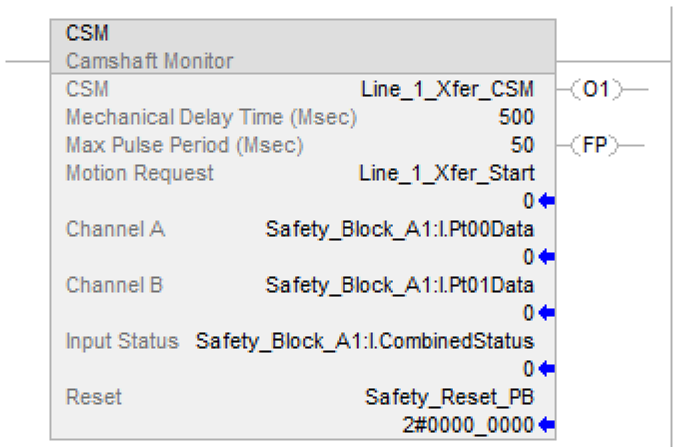
This instruction monitors the start, stop, and run operations of a camshaft.

Possible sources for the Channel A and Channel B inputs to the instruction could include proximity switches, resolvers, gray code encoders, or any device that can produce a series of pulses when the camshaft is moving.

Start and stop operation diagnostics are based on the configurable Mechanical Delay Time parameter. A fault is generated whenever the Mechanical Delay Time is exceeded during a start or stop operation.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT	Do not use the same tag name for more than one instruction in the same program. Do not write to any instruction output tag under any circumstances.

ATTENTION: If you change instruction parameters while in Run mode, you must accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operand used to configure the instruction. This operand cannot be changed at runtime.

Operand	Data Type	Formats	Description
CSM	CAMSHAFT_MONITOR	tag	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.

The following table explains the instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operands	Data Type	Formats	Description
Mechanical Delay Time	DINT	tag immediate	In a starting operation, this parameter determines the amount of time the instruction waits for the Channel A and Channel B inputs to indicate motion after the Motion Request input has transitioned from OFF (0) to ON (1) before generating a Start Time Exceeded fault. In a stopping operation, this parameter determines the amount of time the instruction waits for the Channel A or Channel B input to indicate a loss of motion after the Motion Request input has transitioned from ON (1) to OFF (0) before generating a Stop Time Exceeded fault. The valid range is 300 to 2000 ms.
Max Pulse Period	DINT	tag immediate	This parameter defines the maximum time allowed between the rising and falling edges in the input pulse train before motion is considered to be stopped. The valid range is 50 to 2000 ms.
Motion Request	BOOL	tag	This input indicates if motion is being requested. It is sourced by Output 1 of the Clutch Brake Inch Mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), or Clutch Brake Continuous Mode (CBCM) instruction. ON (1): The camshaft is being commanded to move and motion is expected. OFF (0): Camshaft motion is not requested.
Channel A[1]	BOOL	tag	A pulse train at this input indicates that the camshaft is moving.
Channel B[1]	BOOL	tag	A pulse train at this input indicates that the camshaft is moving.

Operands	Data Type	Formats	Description
Input Status	BOOL	tag immediate	If instruction inputs are from a safety I/O module, this is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Reset[2]	BOOL	tag	This input clears the instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset.

1If this input is from a Guard I/O input module, make sure the input is configured as single, not equivalent or complimentary.

2 ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the 'Reset_Signal' tag in the example shown below to your reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains the instruction outputs. The outputs may be field device signals or derived from user logic.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output indicates the status of camshaft motion at all times, even when the Fault Present (FP) output is ON. The only exception is when the Input Status input indicates that inputs to this instruction are invalid. In that case, this output (O1) is OFF. This output is used to source the Press in Motion input of the Clutch Brake Inch mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), and/or Clutch Brake Continuous Mode (CBCM) instructions. ON (1): The camshaft is moving. OFF (0): The camshaft is stopped.
Fault Present (FP)	BOOL	This output indicates the fault status of the instruction. This output is used to source the Motion Monitor Fault input of the Clutch Brake Inch Mode (CBIM), Clutch Brake Single Stroke Mode (CBSSM), and/or Clutch Brake Continuous Mode (CBCM) instruction. ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the CSM – Fault Codes below for the list of possible fault codes. This parameter is not safety-related.

Operand	Data Type	Description
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the CSM – Diagnostic Codes below for a list of possible diagnostic codes. This parameter is not safety-related.
Measured Start Time	DINT	The time, in milliseconds, that it took the camshaft to start moving. This is the difference in time from when the Motion Request input turns ON (1) to the time at which both Channel A and Channel B inputs indicate motion. This parameter is not safety-related.
Measured Stop Time	DINT	The time, in milliseconds, that it took the camshaft to stop moving. This is the difference in time from when the Motion Request input turns OFF (0) to the time at which either the Channel A or Channel B input stopped indicating motion. This parameter is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

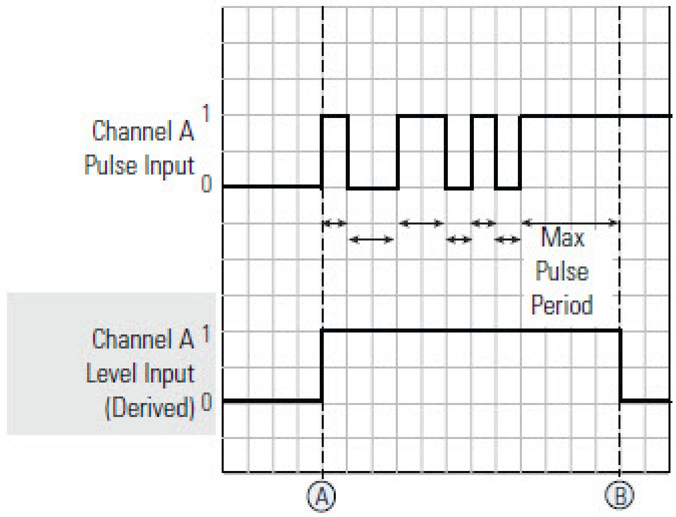
Input Pulse Conversion

The Channel A and Channel B input signals are a pulse train from an encoder, resolver, or proximity switch. When pulses are detected within the configured Max Pulse Period, motion is indicated.

The pulse trains are conditioned to provide level input signals to the instruction logic to derive a signal that is ON (1) when there is motion and OFF (0) when there is no motion. The conversion of each channel is independent of the other.

Shown here for Channel A, the signal turns ON (1) at the first pulse edge seen at the Channel A input at (A). The derived signal remains ON (1) as long as the elapsed time between pulses does not exceed the configured Max Pulse

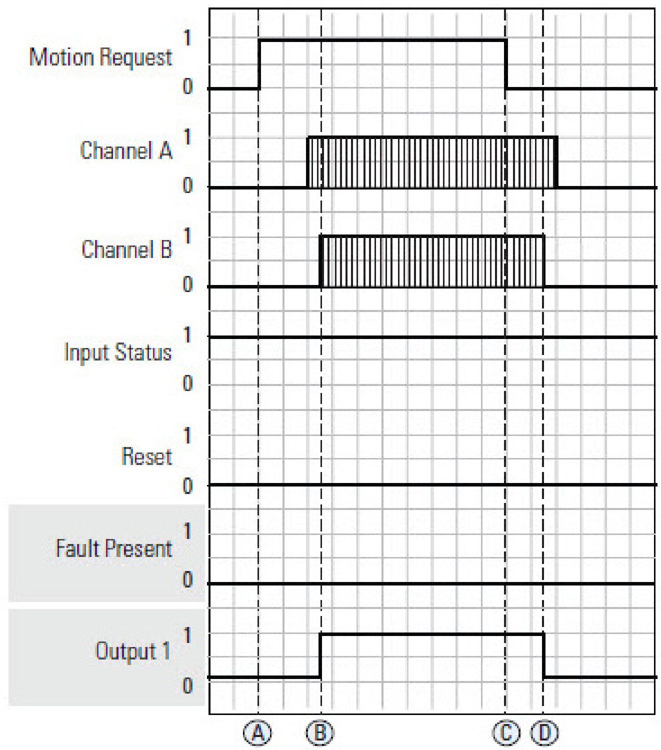
Period. If no edges are detected for more than the Max Pulse Period, the derived level signal turns OFF (0) at (B).



Normal Operation

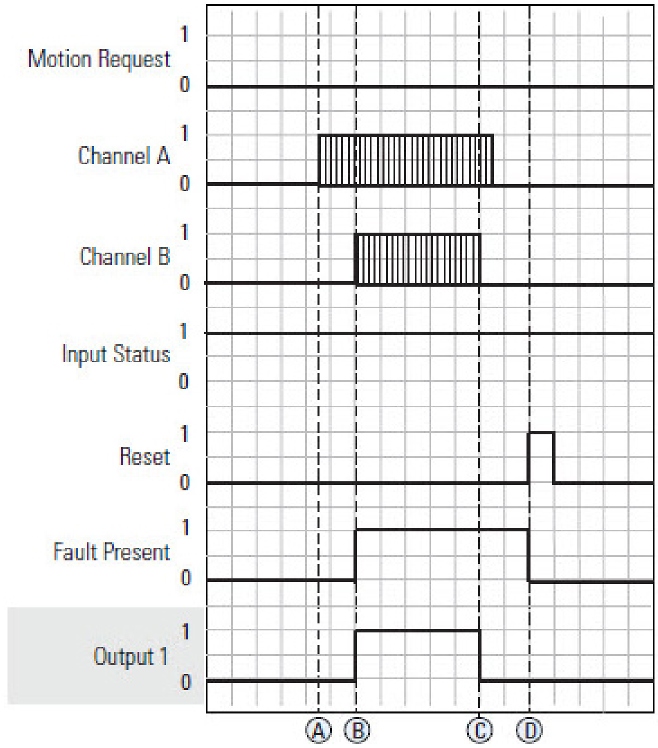
The Motion Request input transitions from OFF (0) to ON (1) at (A), indicating that the camshaft is being commanded to move. Output 1 turns ON (1) at (B), when pulses are detected on both Channel A and Channel B within the configured Mechanical Delay Time. After the Motion Request input turns OFF (0) at (C), indicating that the camshaft is being commanded to stop, Output 1 turns OFF (0) at (D) since pulses are no longer present on both channels.

Pulses must stop on either Channel A or Channel B within the configured Mechanical Delay Time to prevent a Stop Time Exceeded fault.



Uncommanded Motion Fault

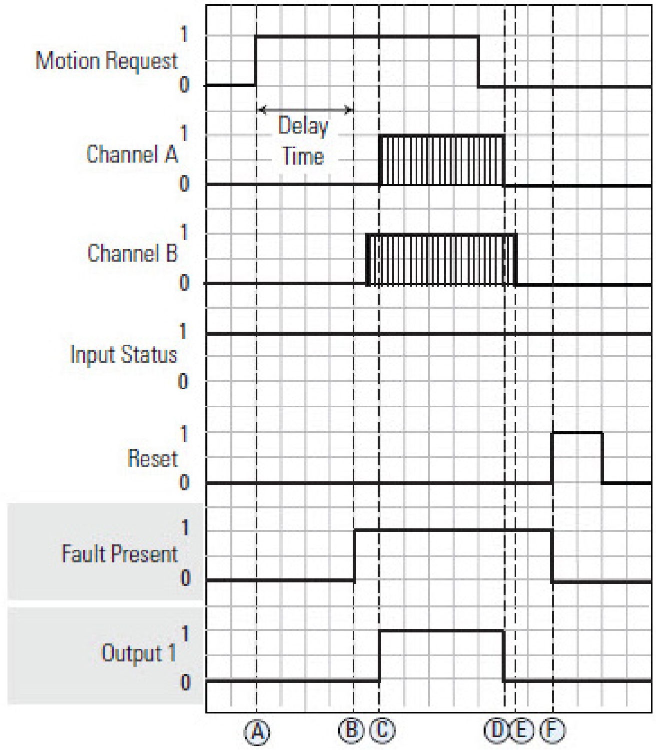
An Uncommanded Motion Fault occurs when the Motion Request input is OFF (0) but pulses on the Channel A and Channel B inputs indicate motion. The Motion Request input is OFF (0), indicating that motion is not being commanded. When pulses are detected on only one channel at (A), no fault occurs. When pulses are detected on both Channel A and Channel B at (B), a fault is generated indicating Uncommanded Motion. Output 1 tracks the presence of pulses on both Channel A and Channel B turning ON (1) at (B) and OFF (0) at (C). When no pulses are detected on either channel and the Motion Request input is OFF (0), indicating that motion is no longer requested, the fault is cleared on the next OFF (0) to ON (1) transition of the Reset input at (D).



Start Time Exceeded Fault

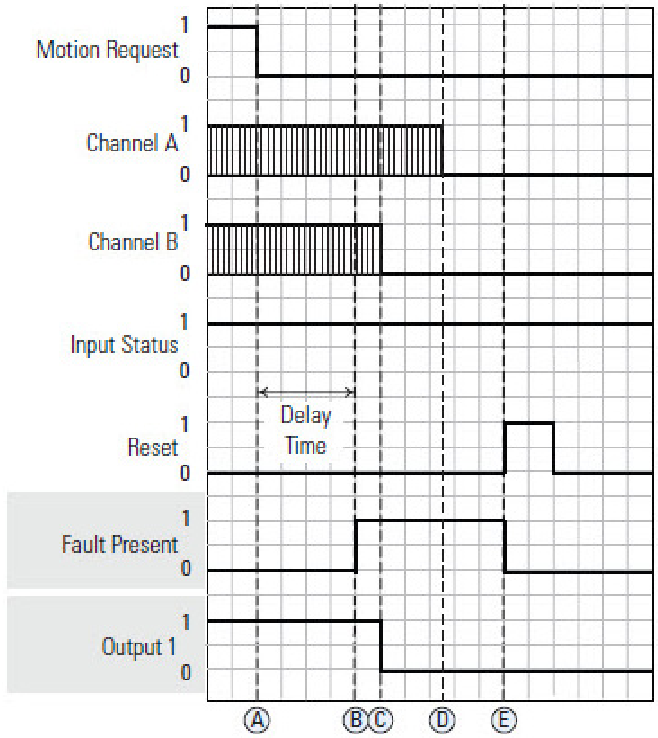
At (A), the Motion Request input turns ON (1), which indicates that motion is being requested. The Fault Present output turns ON (1) when the configured Mechanical Delay Time expires at (B), before pulses are detected on both Channel A and Channel B. When pulses are present on both inputs at (C), Output 1 turns ON (1) even though the fault condition is present. When either Channel A or Channel B are no longer indicating motion at (D), Output 1 turns OFF (0). When both channels are not indicating motion (no pulses) and the

Motion Request input is also OFF (0) at (E), a subsequent OFF (0) to ON (1) transition of the Reset input resets the fault condition at (F).



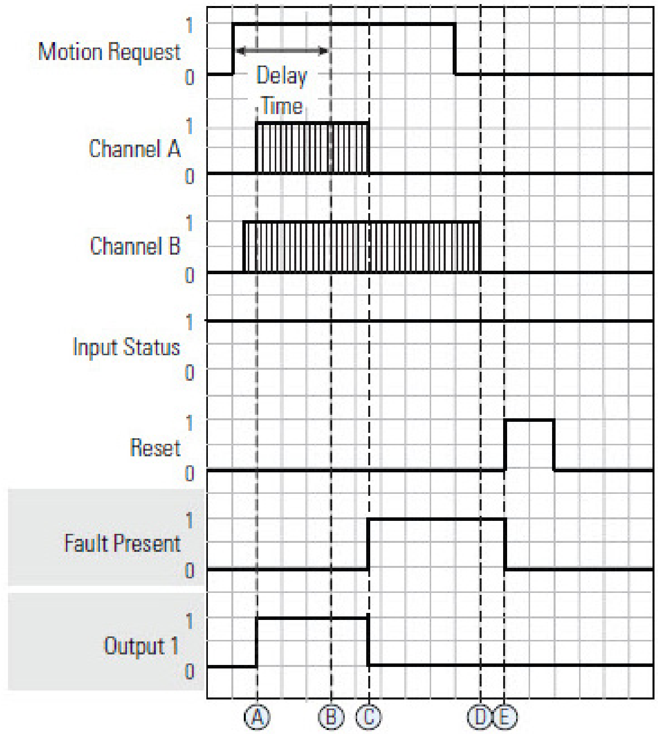
Stop Time Exceeded Fault

At (A), the Motion Request input turns OFF (0), indicating that motion is being commanded to stop. At (B), the Fault Present output turns ON (1) when the configured Mechanical Delay Time expires before pulses stop on either Channel A or Channel B. Output 1 transitions from ON (1) to OFF (0) when pulses stop occurring on either Channel A or Channel B at (C). When both Channel A and Channel B stop indicating motion and the Motion Request input is also OFF (0) at (D), a subsequent OFF (0) to ON (1) transition of the Reset input resets the fault condition at (E).



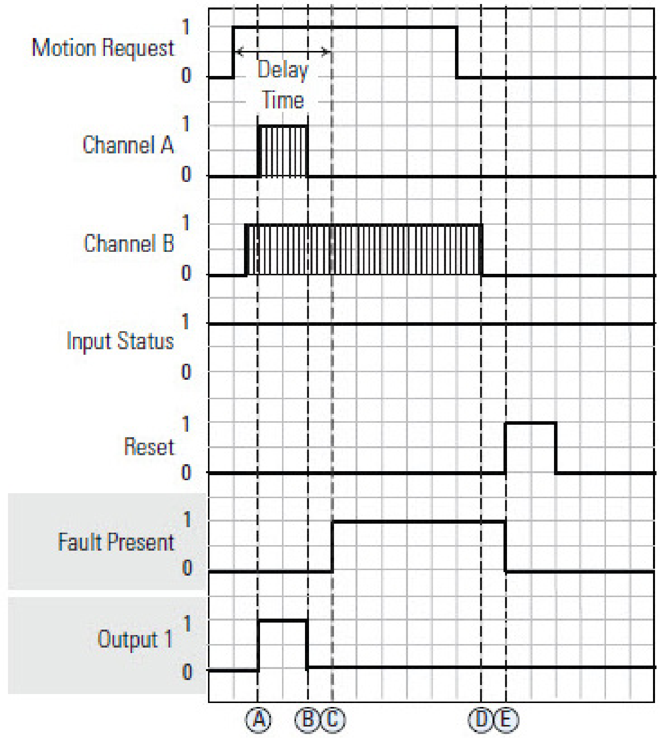
Loss of Motion Fault (Case 1)

The Motion Request input turns ON (1), and at (A) the Channel A and Channel B inputs both indicate motion within the configured Mechanical Delay Time. Once the Mechanical Delay Time has expired at (B), a subsequent loss of pulses on either Channel A or Channel B results in the Fault Present output turning ON (1), indicating a Loss of Motion fault at (C). Output 1 also turns OFF (0) at (C). When both Channel A and Channel B are no longer indicating motion at (D) and the Motion Request input is also OFF (0), a subsequent OFF (0) to ON (1) transition of the Reset input resets the fault condition, at (E).



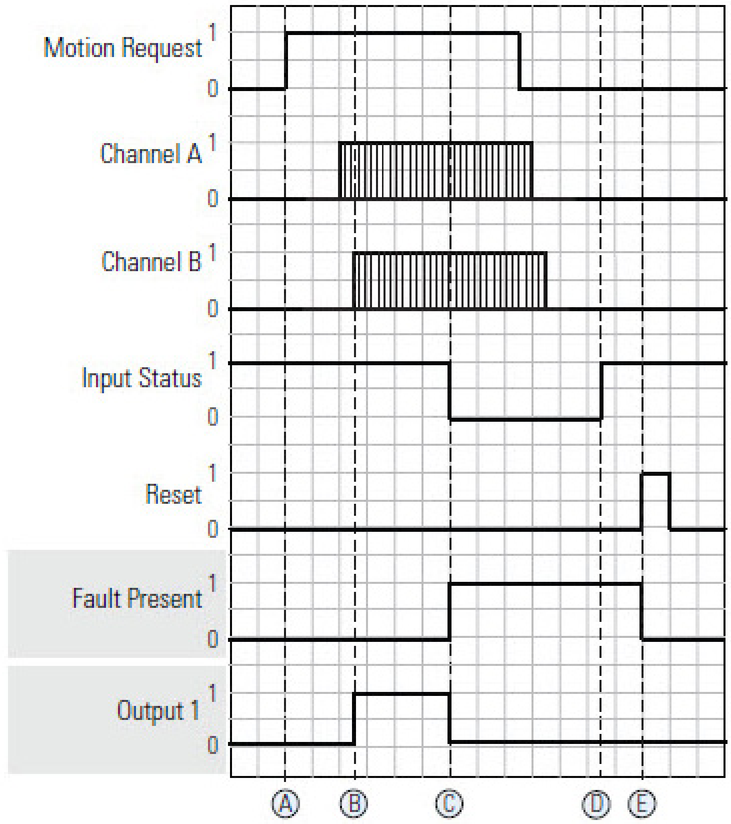
Loss of Motion Fault (Case 2)

The Motion Request input turns ON (1), and at (A) the Channel A and Channel B inputs both indicate motion within the configured Mechanical Delay Time. A loss of pulses on either Channel A or Channel B, at (B), before the Mechanical Delay Time expires, results in Output 1 turning OFF (0). When the Mechanical Delay Time expires at (C), the Fault Present output turns ON (1), indicating a Loss of Motion fault. When both Channel A and Channel B are no longer indicating motion at (D) and the Motion Request input is also OFF (0), a subsequent OFF (0) to ON (1) transition of the Reset input resets the fault condition, at (E).



Input Status Fault

At (A), the Motion Request input turns ON (1), indicating that motion is being commanded. Both Channel A and Channel B inputs indicate motion by detecting pulses within the configured Mechanical Delay Time. Output 1 turns ON (1) at (B). When the Input Status input turns OFF (0) at (C), an Input Status Fault occurs and the Fault Present output turns ON (1). Output 1 also turns OFF (0) at (C). Output 1 is always OFF (0) when the Input Status input is OFF (0). When both Channel A and Channel B no longer indicate motion at (D), the Motion Request input is also OFF (0), and the Input Status input has returned to ON (1), a subsequent OFF (0) to ON (1) transition of the Reset input resets the fault condition, at (E).



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
00	No fault.	None.
16#20 32	An input status error occurred. The Input Status input transitioned from ON (1) to OFF (0).	• Check the I/O module connection. • Reset the fault.
16#6000 24576	Uncommanded Motion occurred. The Motion Request input is OFF (0) but both input channels indicate the camshaft is moving.	• Check the devices driving the Channel A and Channel B inputs and the associated wiring. • Make sure the camshaft is stopped by inspecting it visually. • Reset the fault.

Fault Code	Description	Corrective Action
16#6001 24577	Start time was exceeded. The measured time to start the camshaft exceeded the configured Mechanical Delay Time.	• Re-evaluate the Mechanical Delay Time value. • Make sure camshaft mechanical linkages, brakes, and motion sensors are functioning. • Visually check that motion has stopped. • Reset the fault.
16#6002 24578	Stop time was exceeded. The measured time to stop the camshaft exceeded the configured Mechanical Delay Time.	• Re-evaluate the Mechanical Delay Time value. • Make sure mechanical linkages, brakes, and motion sensors are functioning. • Visually check that motion has stopped. • Reset the fault.
16#6003 24579	Loss of Motion occurred at Channel A. The Motion Request input is ON (1), but the Channel A input stopped indicating motion.	• Check the device driving the Channel A input and the associated wiring. • Make sure the camshaft is stopped by inspecting it visually. • Reset the fault.
16#6004 24580	Loss of Motion occurred at Channel B. The Motion Request input is ON (1), but the Channel B input stopped indicating motion.	• Check the device driving the Channel B input and the associated wiring. • Make sure the camshaft is stopped by inspecting it visually. • Reset the fault.
16#6005 24581	The Motion Request input turned ON (1) before all inputs were in their safe state, OFF (0).	• Check the I/O module connection. • Make sure the camshaft is stopped by inspecting it visually. • Make sure all motion sensors are operating properly. • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format

Diagnostic Code	Description	Corrective Action
00	None	None.
16#20 32	The Input Status input is OFF (0) when the instruction first executed.	Check the I/O module connection.
16#6000 24576	The Channel A and Channel B inputs are both indicating motion (pulses present) when the instruction first executed.	• Check the devices driving the Channel A and Channel B inputs and the associated wiring. • Visually check that motion has stopped.
16#6001 24577	The Channel A input is indicating motion (pulses present), when the instruction first executed.	• Check the device driving the Channel A input and the associated wiring. • Visually check that motion has stopped.
16#6002 24578	The Channel B input is indicating motion (pulses present), when the instruction first executed.	• Check the device driving the Channel B input and the associated wiring. • Visually check that motion has stopped.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01 and .FP are cleared to false. The Diagnostic Code and Fault Code outputs are set to 0.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung-condition-in is false.

See also

Clutch Brake Wiring and Programming Example on page 313

Index Through Arrays on page 540

Metal Form Instructions on page 239

Eight Position Mode Selector (EPMS)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Eight Position Mode Selector (EPMS) instruction's main function is to energize one of its eight outputs when the associated input goes active. Only one output may be energized at a time.

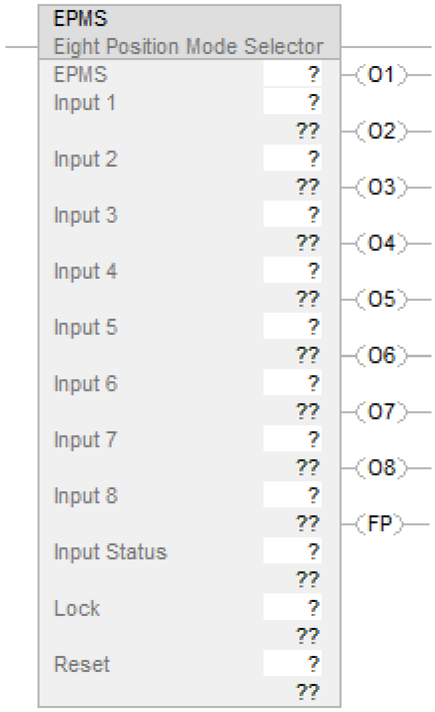
A fault is generated when a no input active condition exists for more than 250 ms, or a multiple input active condition exists. The fault is cleared by applying an OFF (0) to ON (1) transition on the Reset input, but only after the fault condition is corrected.

This instruction supports a Lock input. Updating the outputs is prohibited when the Lock input is set to ON (1). Attempting to update the outputs while the Lock input is ON (1) results in the generation of a diagnostic code and outputs are de-energized (no mode).

ATTENTION: This instruction is specified to operate with Break before Make types of inputs.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
EPMS	EIGHT_POS_MODE_SELECTOR	tag	EPMS structure

The following table explains instruction inputs. The inputs can be field device signals from input devices or be derived from user logic.

Name	Data Type	Format	Description
Input 1	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 2	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 3	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 4	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 5	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 6	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 7	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input 8	BOOL	immediate tag	ON (1): Input ON (1) OFF (0): Input OFF (0)
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid. ON (1) -> OFF (0): Generates a fault.
Lock	BOOL	immediate tag	ON (1): The instruction is locked. Any changes in the input states result in all outputs being de-energized and a fault or diagnostic is generated. OFF (0): The instruction is unlocked. Valid input changes are accepted.
Reset[1]	BOOL	tag	This input clears instruction faults provided the fault condition is not present. OFF (0) -> ON (1): The Fault Present and Fault Code outputs are reset.

(1) ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the “Reset_Signal” tag in this example to the

reset signal tagname. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains instruction outputs. The outputs are typically used to select different modes of application operation by enabling other instructions (Output 1 for mode 1, and so on).

Name	Data Type	Description
Output 1 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 2 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 3 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 4 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 5 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 6 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 7 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Output 8 (01)	BOOL	ON (1): Input ON (1) OFF (0): Input OFF (0)
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): This instruction is operating normally.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. This operand is not safety-related. See Diagnostic Codes.
Fault Code	DINT	This output indicates the type of fault that occurred. This operand is not safety-related. See Fault Codes.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

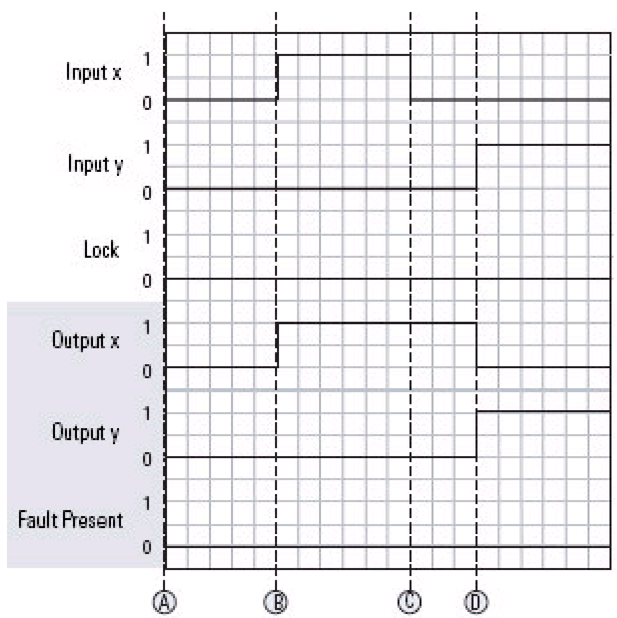
Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01, .02, .03, .04, .05, .06, .07, .08, and .FP are cleared to false.
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in is false.

Operation

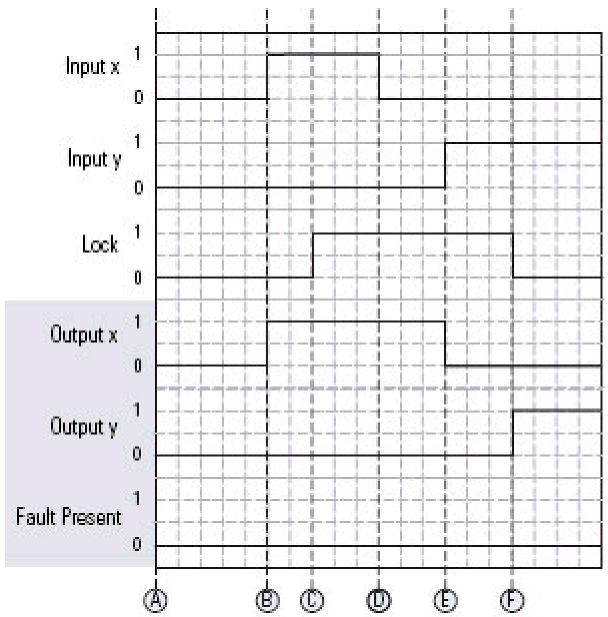
Lock Input OFF (0)

The timing diagram illustrates the Lock input OFF (0). At (A), a no inputs condition exists. At (B), a single input, Input x, transitions from OFF (0) to ON (1) within 250 ms and the corresponding output, Output x, turns ON (1). At (C), a no inputs condition is created when the single input, Input x, transitions from ON (1) to OFF (0). At (D), a single input, Input y, then transitions to ON (1) within 250 ms and the corresponding output, Output y, turns ON (1).



Lock Input ON (1)

The timing diagram illustrates the Lock input ON (1). At (A), a no inputs condition exists. At (B), a single input, Input x, transitions from OFF (0) to ON (1) within 250 ms and the corresponding output, Output x, turns ON (1). At (C), the instruction becomes locked when the Lock input transitions from OFF (0) to ON (1). At (D), an attempt is made to change the mode when the single input, Input x, transitions from ON (1) to OFF (0), creating a no inputs condition. At (E), a single input, Input y, transitions from OFF (0) to ON (1) within 250 ms, generating a diagnostic code indicating that an attempt was made to change the mode while locked. The output, Output x, transitions from ON (1) to OFF (0). At (F), the Lock input transitions from ON (1) to OFF (0) while the single input, Input y, is ON (1), the corresponding output, Output y, is turned ON (1) and the diagnostic code is cleared.



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No fault.	None.

Fault Code	Description	Corrective Action
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the Safety I/O module connections or the internal logic used to source input status. • Reset the fault.
16#3000 12288	A multiple selection input was detected.	• Check the mode selection inputs. • Reset the fault.
16#3001 12289	A no selection input condition existed for more than 250 ms.	• Check the timing of the mode selection inputs to see if they are within 250 ms. • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status was OFF(0) when the instruction started.	• Check the Safety I/O module connections or the internal logic used to source the input status. • Set the I/O status to 1 (if the inputs are not being sourced by the Safety I/O).
16#3000 12288	Input data changed while the Lock input was ON (1).	Only update the inputs when the Lock input is OFF (0).

See also

Eight Position Mode Selector (EPMS) wiring and programming example on page 308

Index Through Arrays on page 540

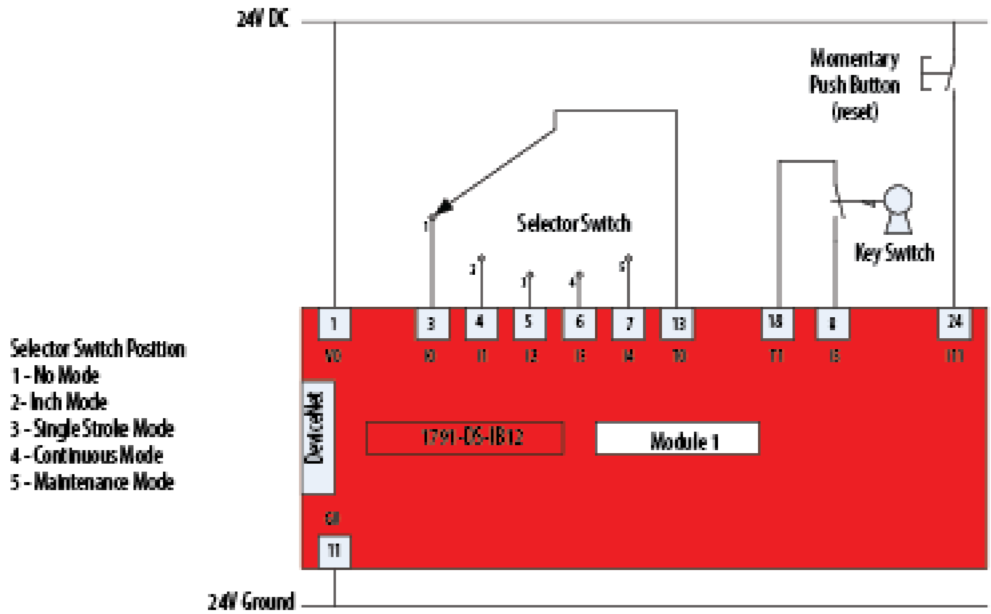
Metal Form Instructions on page 239

Eight Position Mode Selector (EPMS) wiring and programming example

This topic demonstrates how to wire the Guard I/O module and the instruction in the safety control portion of an application.

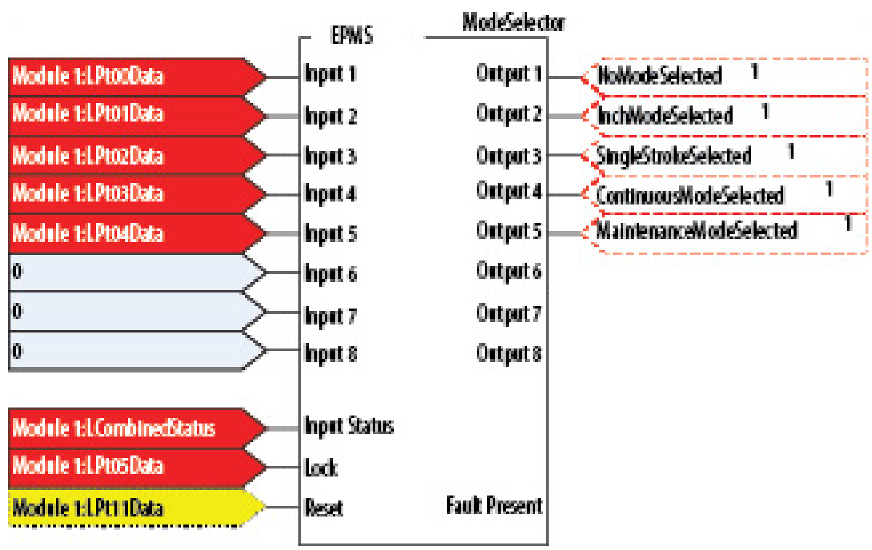
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram



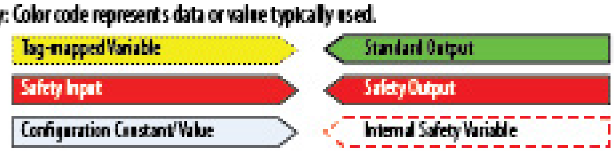
Programming Diagram

This programming diagram shows the instruction with inputs and outputs.

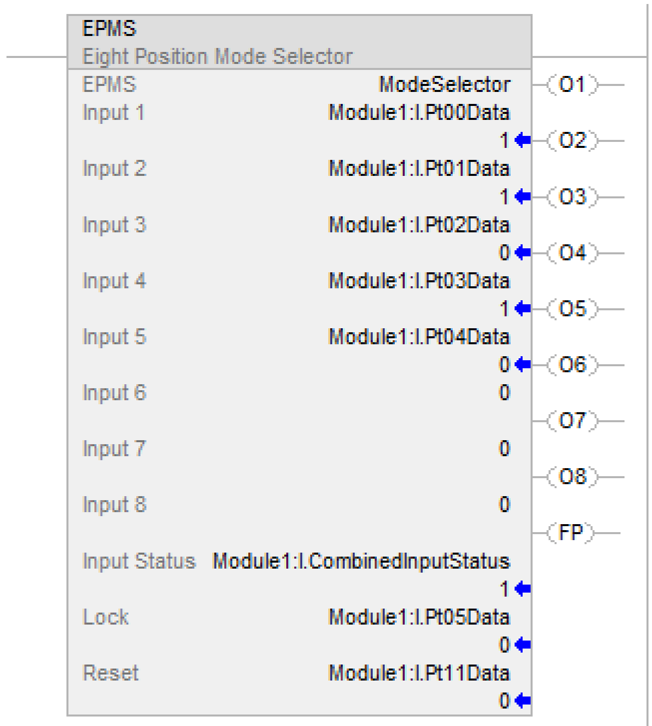


Note 1: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.

Key: Color code represents data or value typically used.

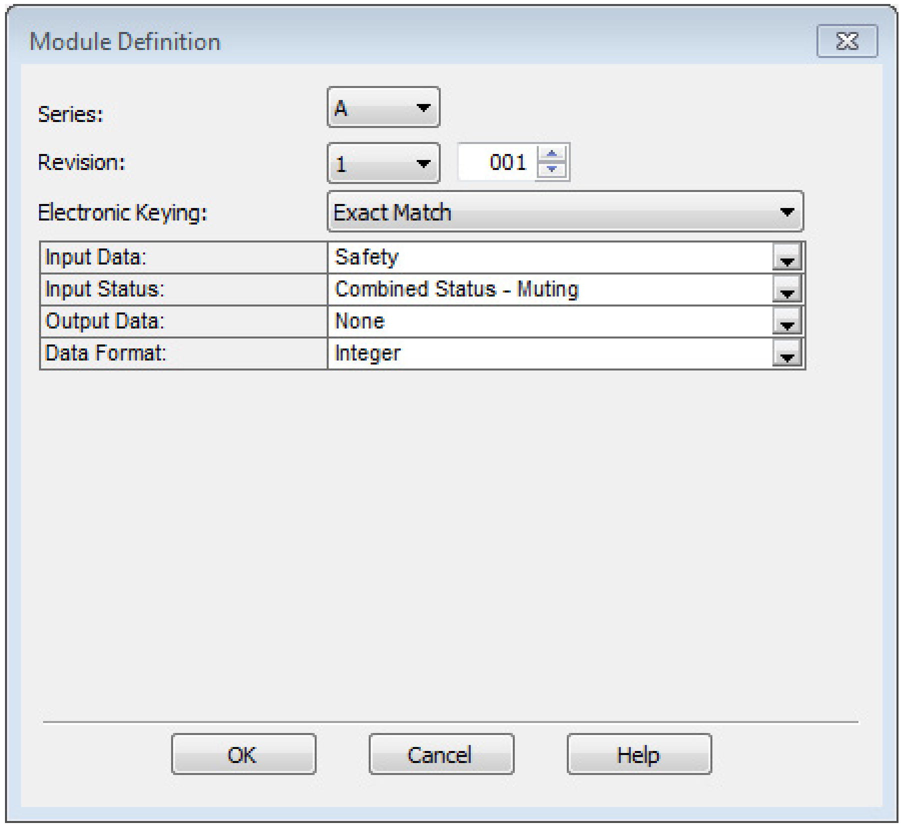


Ladder Diagram



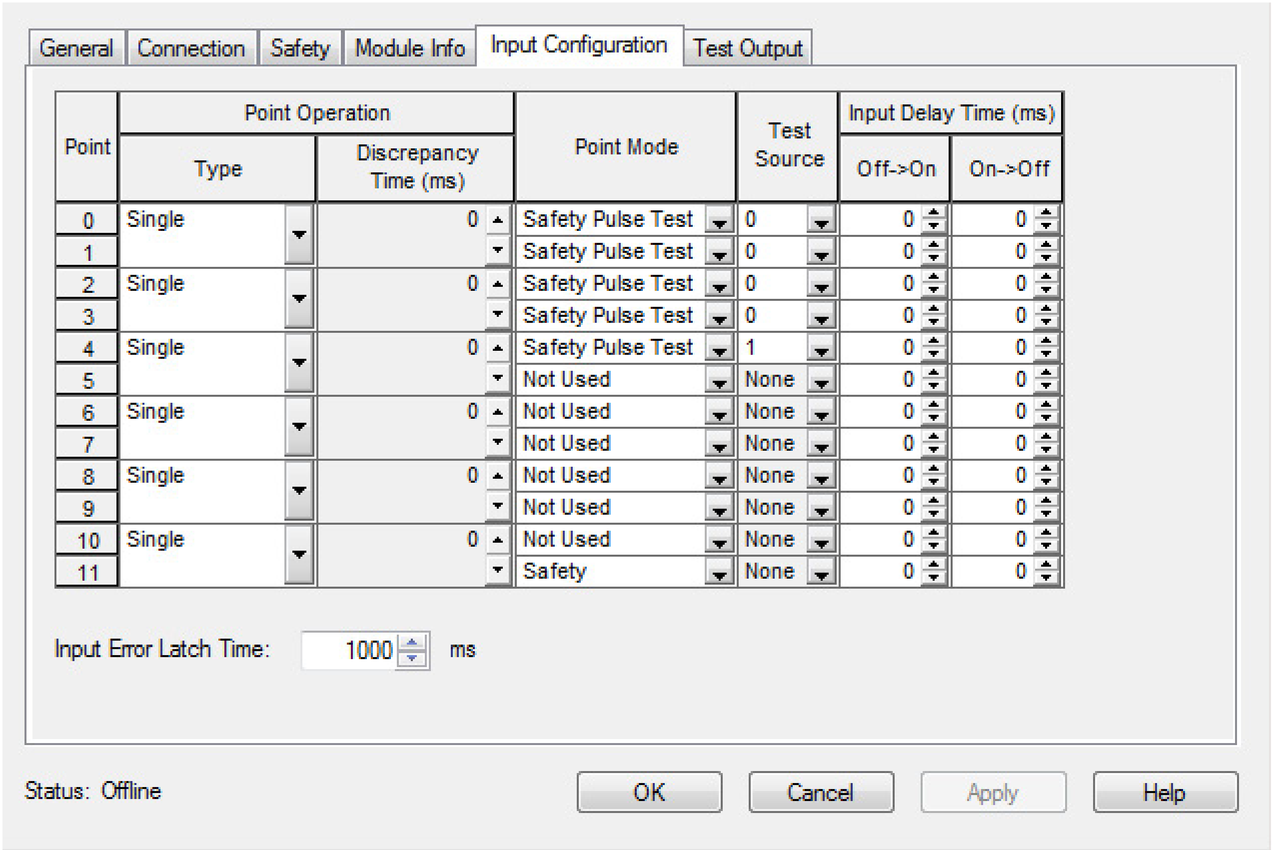
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands

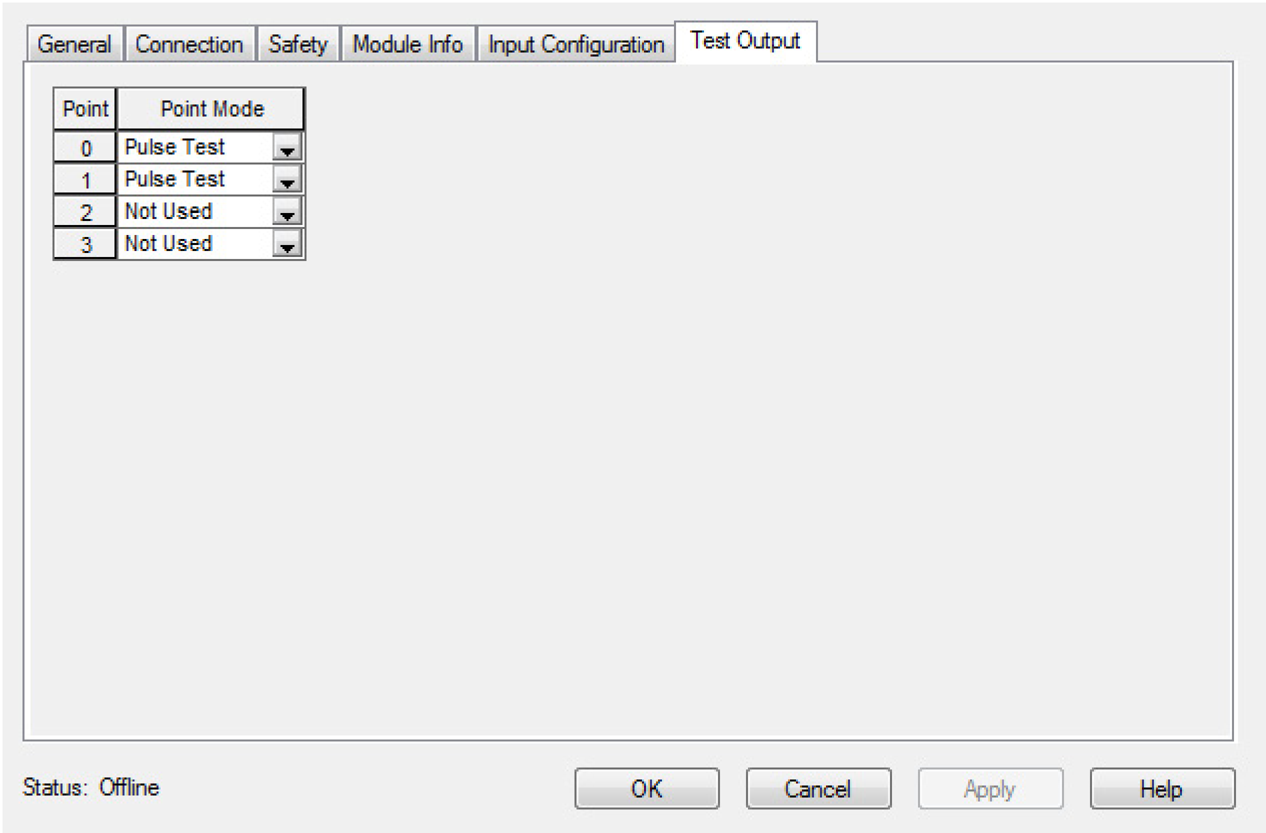


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

Module Input Configuration



Module Output Configuration



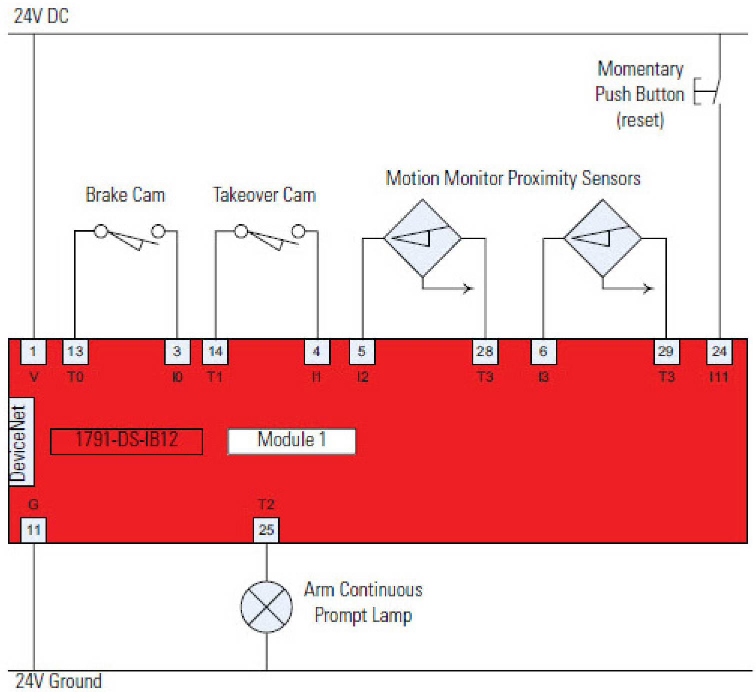
See also

Eight-position Mode Selector (EPMS) on page 302

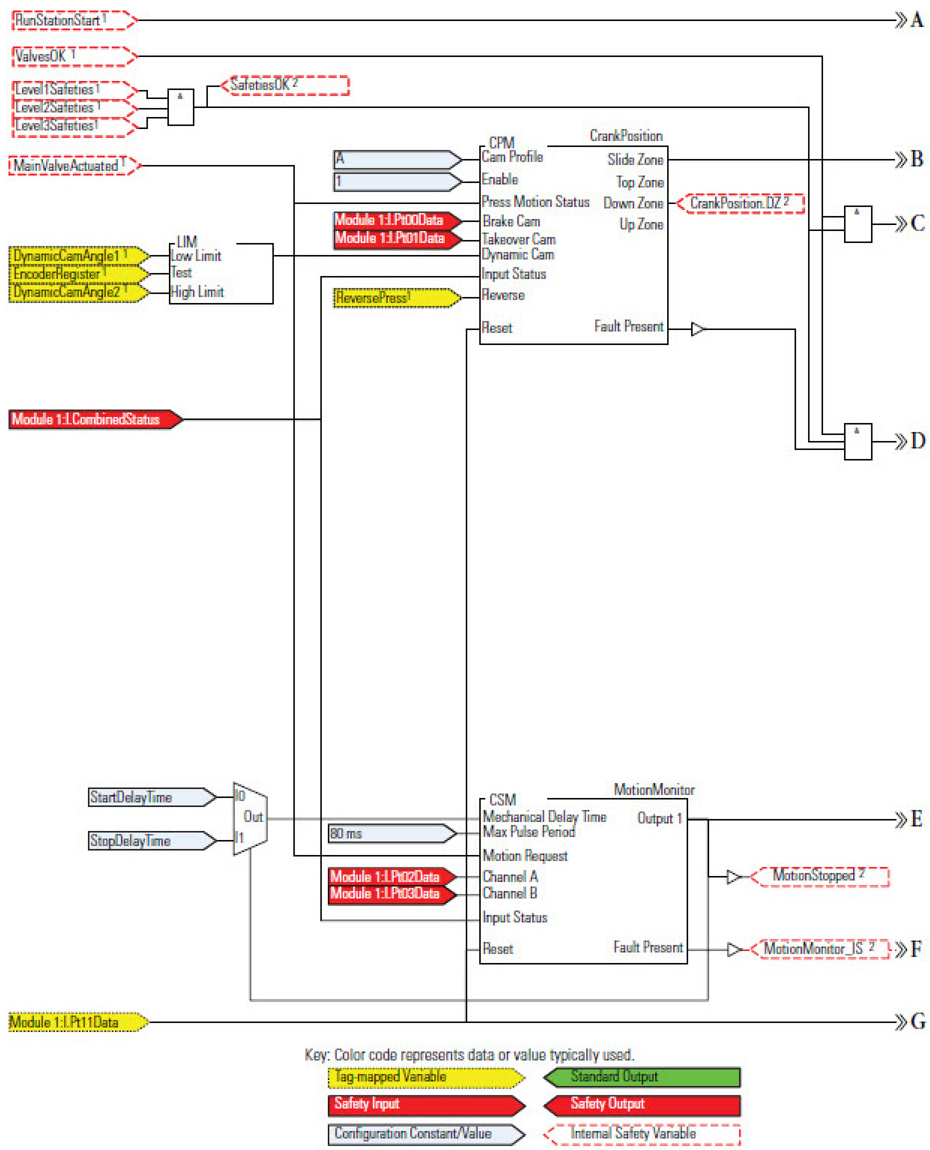
Clutch Brake Wiring and Programming Example

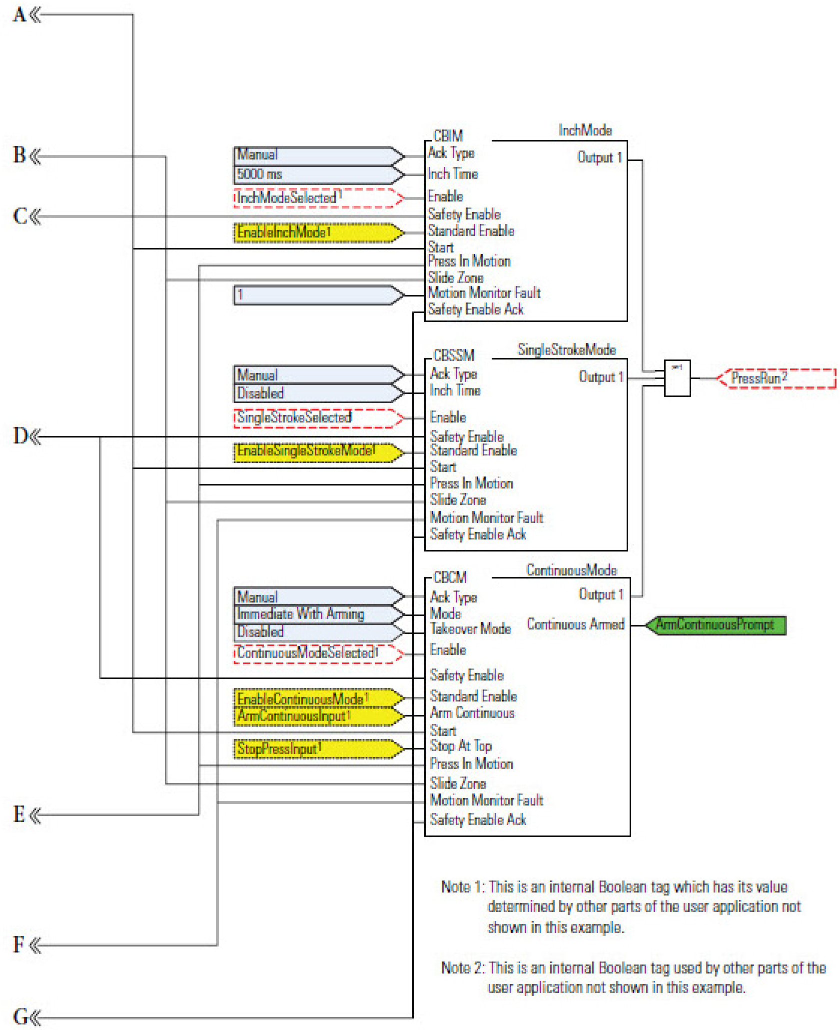
The following examples illustrate the use of some of the Metal Form instructions in a press safety application, including the three Clutch Brake instructions (CBIM, CBSSM, and CBCM), the Camshaft Motion Monitor (CSM), and the Crankshaft Position Monitor (CPM).

Wiring Diagram



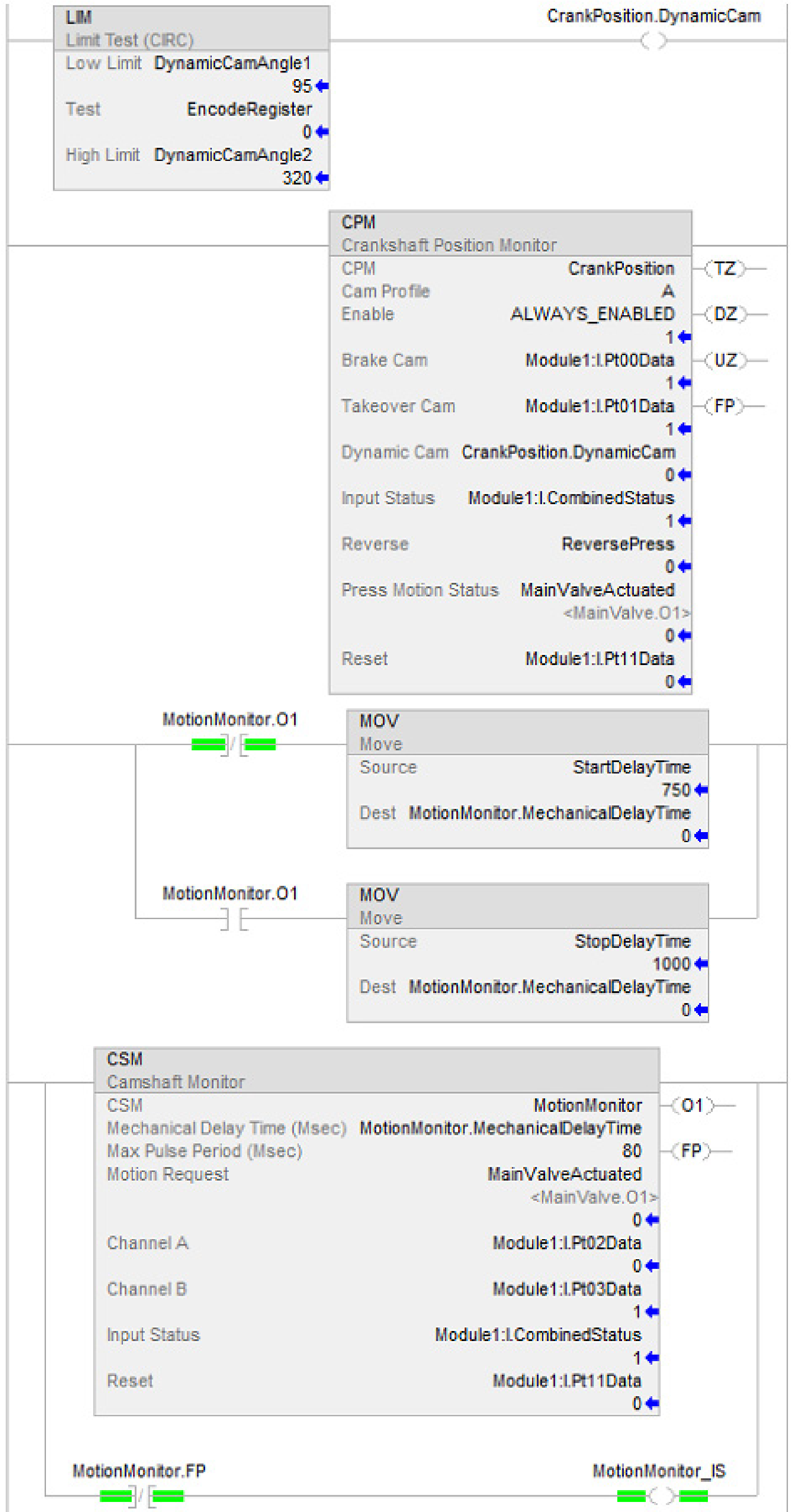
Programming Diagram

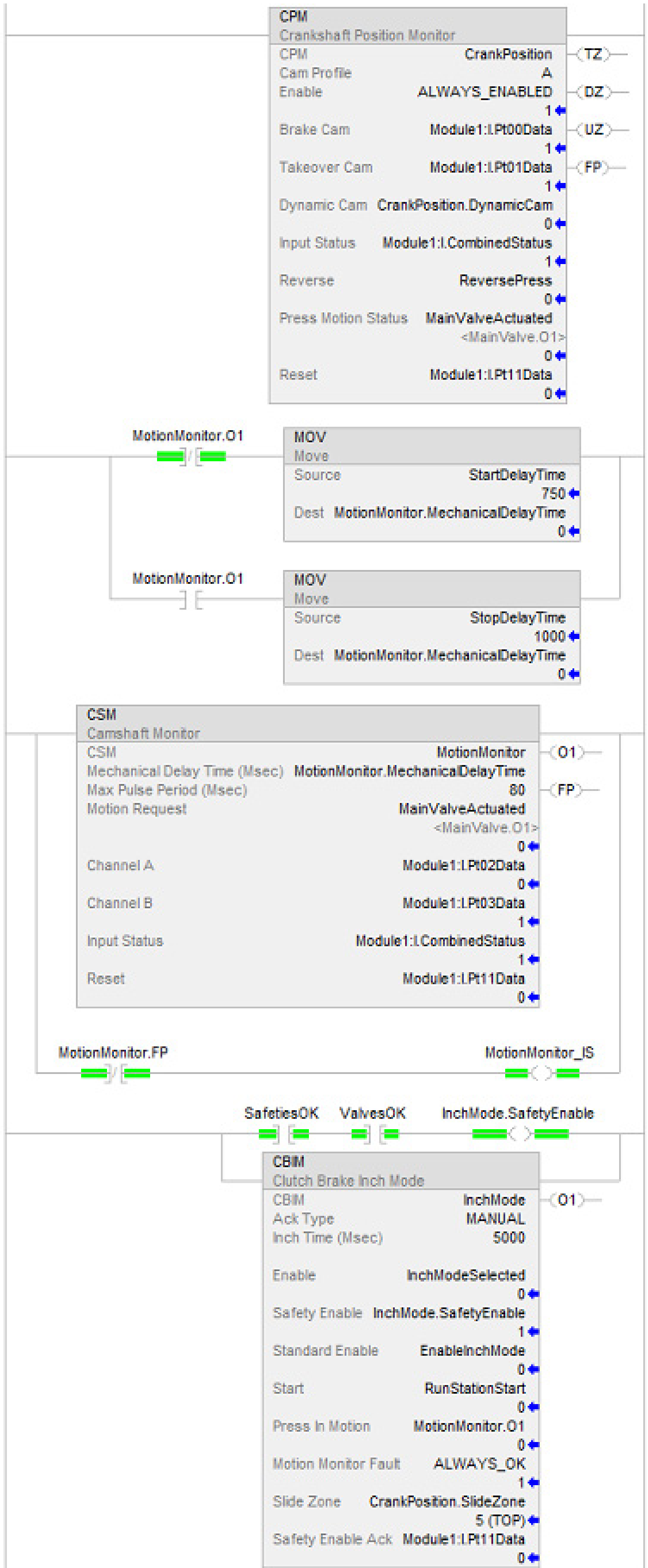


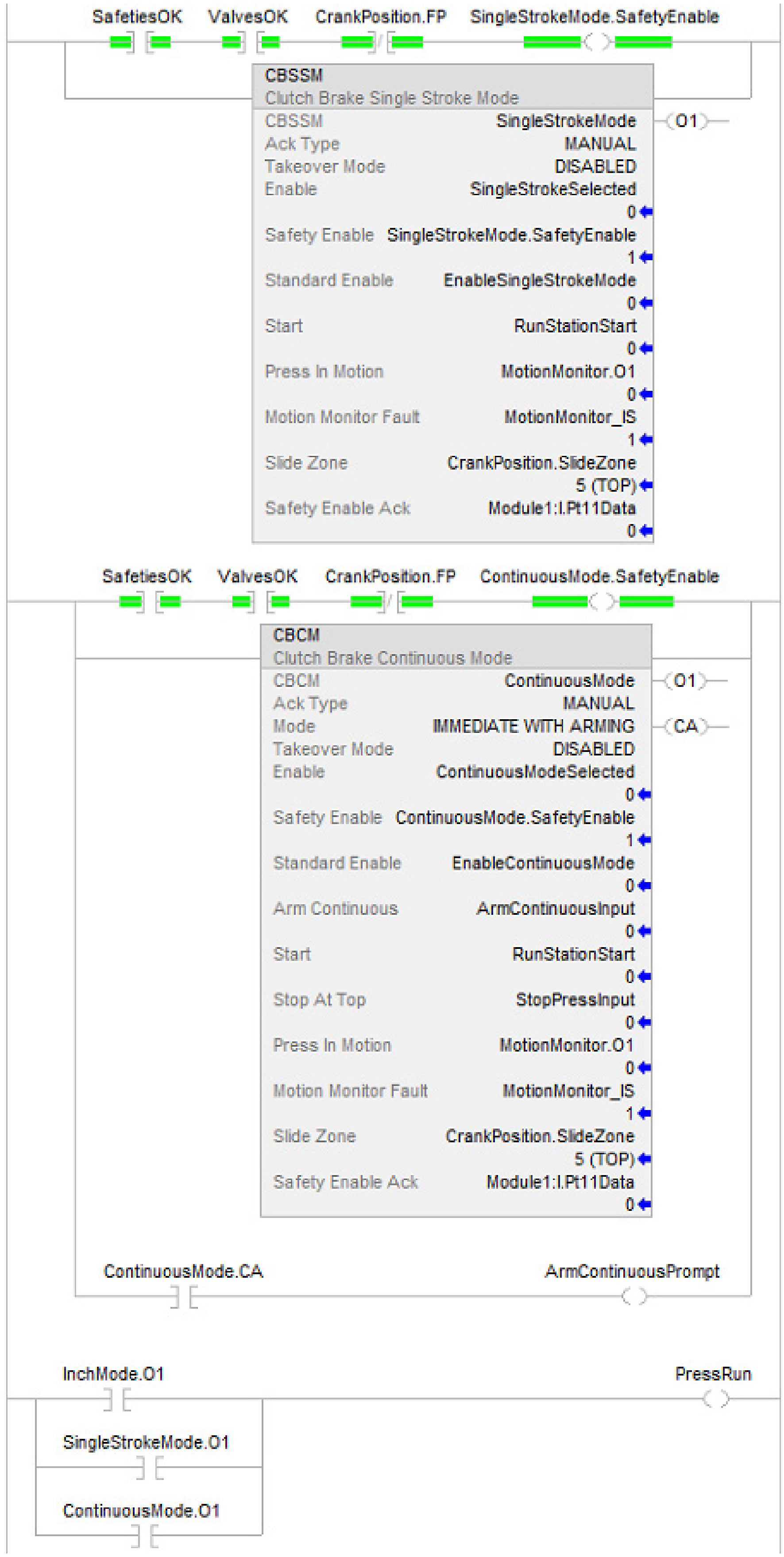


A
B
C
D
E
F
G
CBIM
InchMode
Manual
5000 ms
InchModeSelected1
EnableInchMode1
1
Ack Type
Inch Time
Enable
Safety Enable
Standard Enable
Start
Press In Motion
Slide Zone
Motion Monitor Fault
Safety Enable Ack
Output 1
CBSSM
SingleStrokeMode
Manual
Disabled
SingleStrokeSelected
EnableSingleStrokeMode1
Ack Type
Inch Time
Enable
Safety Enable
Standard Enable
Start
Press In Motion
Slide Zone
Motion Monitor Fault
Safety Enable Ack
Output 1
PressRun2
CBCM
ContinuousMode
Manual
Immediate With Arming
Disabled
ContinuousModeSelected1
EnableContinuousMode1
ArmContinuousInput1
StopPressInput1
Ack Type
Mode
Takeover Mode
Enable
Safety Enable
Standard Enable
Arm Continuous
Start
Stop At Top
Press In Motion
Slide Zone
Motion Monitor Fault
Safety Enable Ack
Output 1
Continuous Armed
ArmContinuousPrompt
Note 1: This is an internal Boolean tag which has its value determined by other parts of the user application not shown in this example.
Note 2: This is an internal Boolean tag used by other parts of the user application not shown in this example.

Ladder Diagram

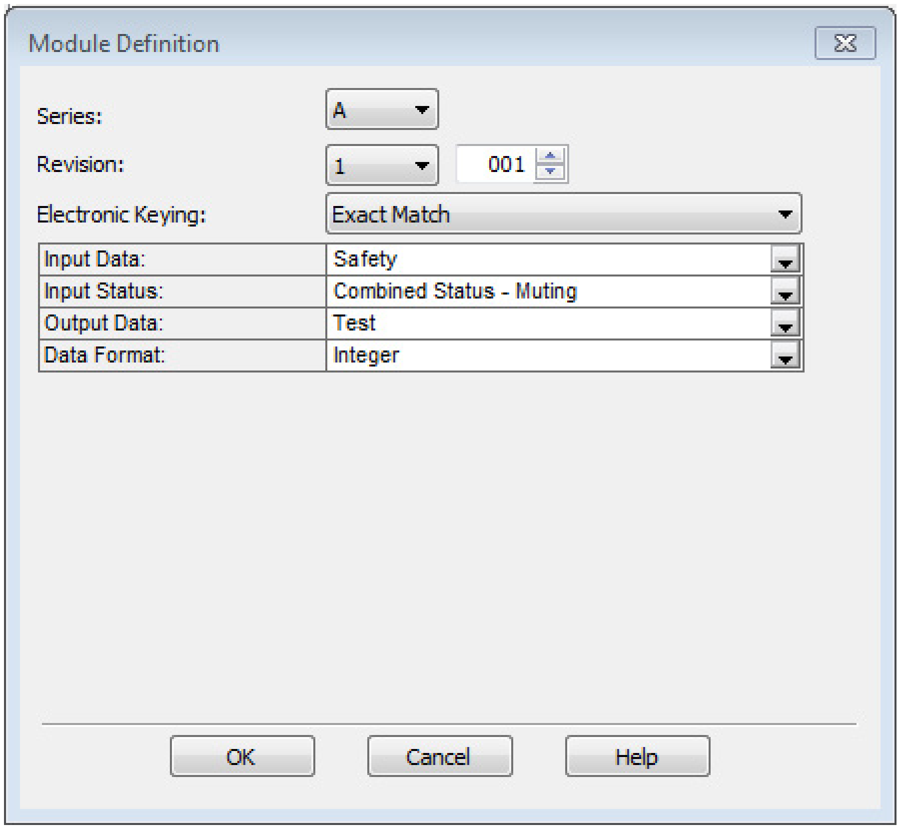



CPM
Crankshaft Position Monitor
CPM CrankPosition
Cam Profile A
Enable ALWAYS_ENABLED
1
Brake Cam Module1:I.Pt00Data
1
Takeover Cam Module1:I.Pt01Data
1
Dynamic Cam CrankPosition.DynamicCam
0
Input Status Module1:I.CombinedStatus
1
Reverse ReversePress
0
Press Motion Status MainValveActuated
<MainValve.O1>
0
Reset Module1:I.Pt11Data
0
TZ
DZ
UZ
FP
MotionMonitor.O1
MOV
Move
Source StartDelayTime
750
Dest MotionMonitor.MechanicalDelayTime
0
MotionMonitor.O1
MOV
Move
Source StopDelayTime
1000
Dest MotionMonitor.MechanicalDelayTime
0
CSM
Camshaft Monitor
CSM MotionMonitor
Mechanical Delay Time (Msec) MotionMonitor.MechanicalDelayTime
Max Pulse Period (Msec) 80
Motion Request MainValveActuated
<MainValve.O1>
0
Channel A Module1:I.Pt02Data
0
Channel B Module1:I.Pt03Data
1
Input Status Module1:I.CombinedStatus
1
Reset Module1:I.Pt11Data
0
O1
FP
MotionMonitor.FP
MotionMonitor_IS
SafetiesOK
ValvesOK
InchMode.SafetyEnable
CBIM
Clutch Brake Inch Mode
CBIM InchMode
Ack Type MANUAL
Inch Time (Msec) 5000
Enable InchModeSelected
0
Safety Enable InchMode.SafetyEnable
1
Standard Enable EnableInchMode
0
Start RunStationStart
0
Press In Motion MotionMonitor.O1
0
Motion Monitor Fault ALWAYS_OK
1
Slide Zone CrankPosition.SlideZone
5 (TOP)
Safety Enable Ack Module1:I.Pt11Data
0
O1



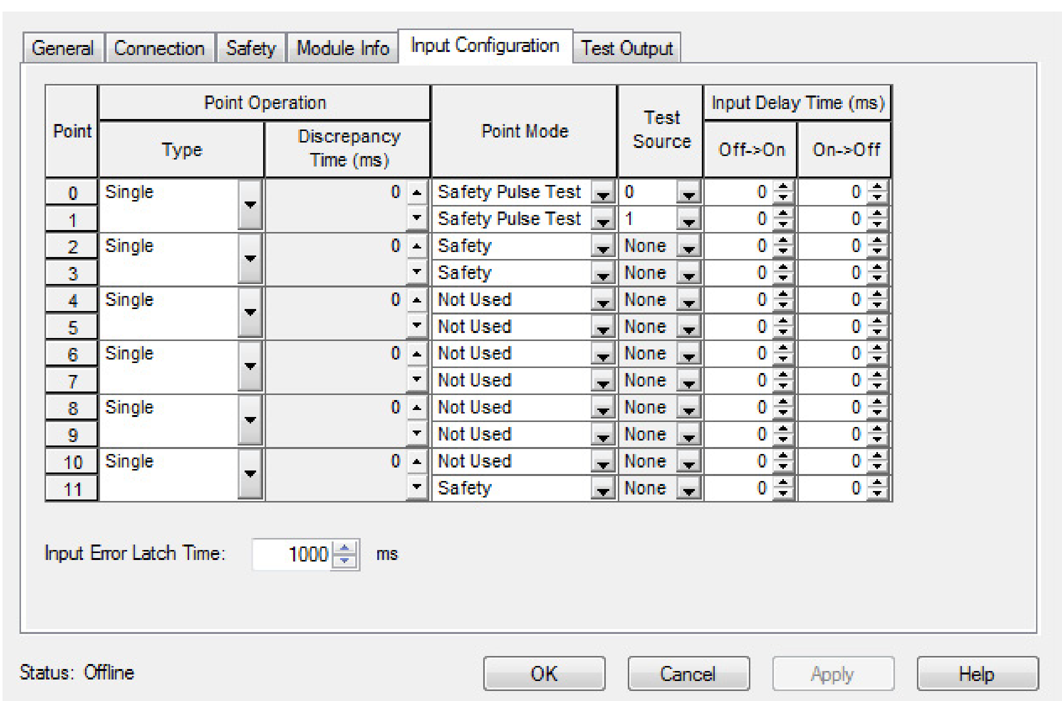
The programming software is used to configure the input and test output parameters of the Guard I/O module, as shown.

Module Definition

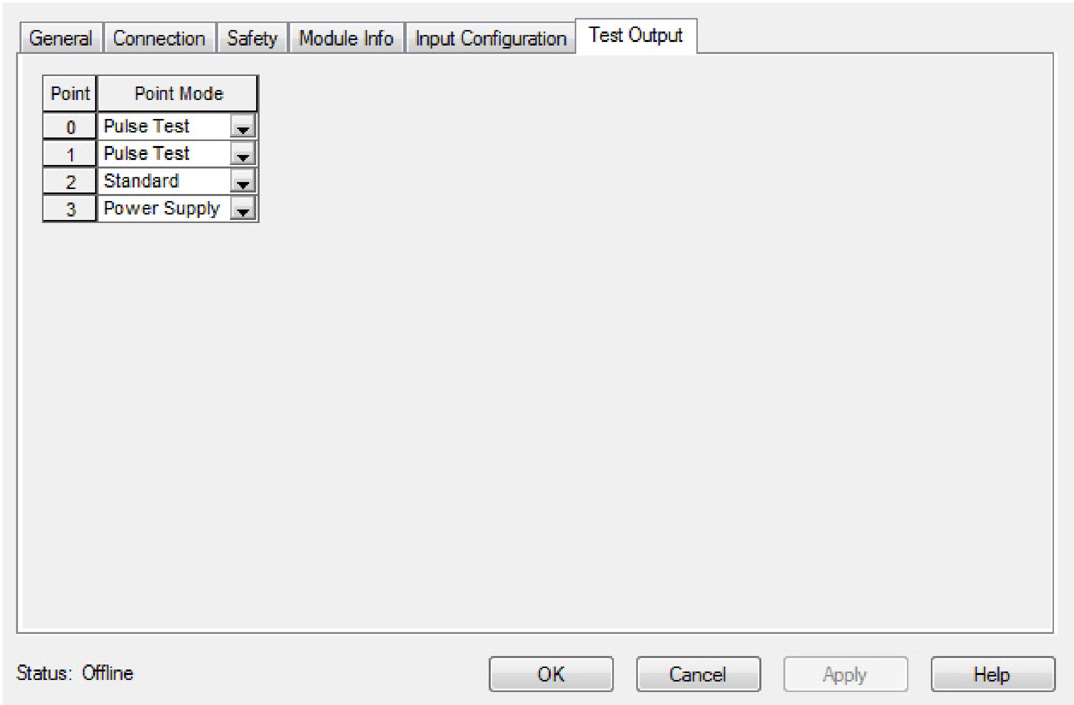


Rockwell Automation suggests selecting **Exact Match** from the **Electronic Keying** list. You can also select **Compatible Match**.

Module Input Configuration



Module Test Output Configuration



See also

CamShaft Monitor (CSM) on page 288

Auxiliary Valve Control (AVC)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

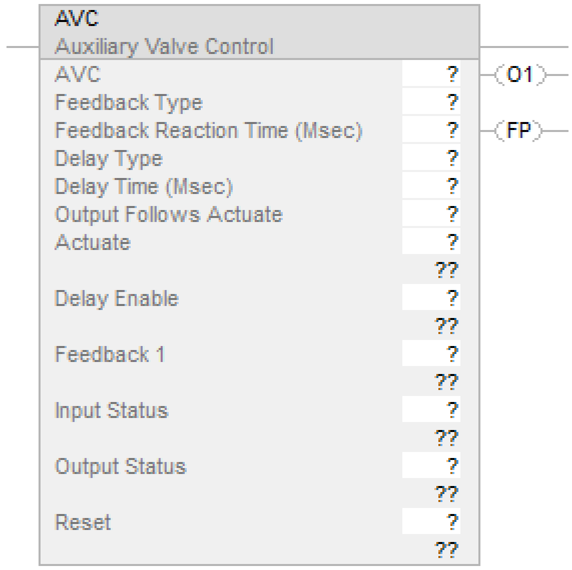
The Auxiliary Valve Control (AVC) instruction controls an auxiliary valve that is used with the main clutch or brake valves of a press. This instruction is used when a delay is desired between the enabling or disabling of the main clutch or brake valves and an auxiliary valve (for example, a soft clutch or brake application). The clutch or brake can then be engaged in a two-step sequence providing pressure relief for smoother starting or stopping of the press. One AVC instruction is required for each function that is to be implemented. For example, if a delay is needed when starting and stopping a press, one AVC instruction controls the start delay and another AVC instruction controls the stop delay.

The timing of the auxiliary valve reaction is configurable. Also, the instruction can be set up to handle different valve types and positive or negative feedback signals.

ATTENTION: It is not always desirable to allow the auxiliary valve reaction to be delayed. For example, in a press safety application, soft braking during the press downstroke is not allowed. For this reason, delays can be temporarily disabled by tuning the Delay Enable Input OFF (0).

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in Structured Text.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
AVC	AUX_VALVE_CONTROL	tag	AVC structure

Operand	Data Type	Format	Description
Feedback Type	BOOL	Drop Down	This operand defines feedback OFF and ON states for positive and negative feedback. Positive (1): OFF (0): Output 1 OFF, Feedback 1 OFF. ON (1): Output 1 ON, Feedback 1 ON. Negative (0): OFF (0): Output 1 OFF, Feedback 1 ON. ON (1): Output 1 ON, Feedback 1 OFF.
Feedback Reaction Time	DINT	immediate	This operand specifies the amount of time that the instruction waits for the Feedback 1 input to reflect the state of Output 1 as defined by the Feedback Type operand. The valid range is 5 to 1000 ms
Delay Type	BOOL	name	This operand specifies where the auxiliary valve delay is to occur. See the timing diagrams below for details. ON (1): The delay occurs when the Actuate input transitions from OFF (0) to ON (1). OFF (0): The delay occurs when the Actuate input transitions from ON (1) to OFF (0).
Delay Time	DINT	immediate	This operand defines the time delay. The valid range is 5 to 2000 ms.
Output Follows Actuate	BOOL	name	This operand specifies how the auxiliary valve reacts to the Actuate input. See the timing diagrams below for details. True: Output 1 changes state following the Actuate input. False: Output 1 changes state opposite to the Actuate input.

The following table explains the instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Actuate	BOOL	tag	This input is the signal to actuate the valve. A change in state on this input causes Output 1 (the auxiliary valve) to react depending on the how the instruction is configured. See the timing diagrams below for more information. ON (1): Output 1 energizes as specified by the Delay Type and Output Follows Actuate inputs. OFF (0): Output 1 de-energizes as specified by the Delay Type and Output Follows Actuate inputs.
Delay Enable	BOOL	tag	This input indicates whether auxiliary valve delays are currently enabled. It can be used to temporarily disable auxiliary valve delays. If a delay of the auxiliary valve is not desired during any part of press operation, this input can be set to OFF (0). ON (1): Delays are currently allowed. OFF (0): Delays are not currently allowed and the auxiliary valve reacts immediately.
Feedback 1	BOOL	tag	This input is constantly monitored to make sure that it reflects Output 1. When Output 1 transitions, this input must react within the configured Feedback Reaction Time.

Operand	Data Type	Format	Description
Input Status	BOOL	tag immediate	If instruction inputs are from a safety I/O module, this value is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Output Status	BOOL	tag immediate	This input indicates the output status of the I/O module connected to this instruction. ON (1): The output module is operating properly. OFF (0): The output module is faulted or offline. Instruction outputs are set their safe state.
Reset[1]	BOOL	tag immediate	This input clears instruction faults provided the fault condition is not present. ON (1): The Fault Present and Fault Code outputs are reset.

(1) ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction.

Rename the "Reset_Signal" tag in this example to the reset signal tagname. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains the instruction outputs. The outputs may be field device signals, or may be derived from user logic.

Name	Data Type	Description
Output 1 (01)	BOOL	This output is used to control an auxiliary valve. Output 1 is de-energized when: • A valve feedback fault occurs as described in the Auxiliary Valve Feedback Fault section below. • Input Status or Output Status inputs turn OFF (0). • The normal operation of the instruction causes Output 1 to be de-energized as described in the timing diagrams starting in the Normal Auxiliary Valve Reaction (Delay Type = On) section below.
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the AVC Fault Codes section below for a list of fault codes. This operand is not safety-related.

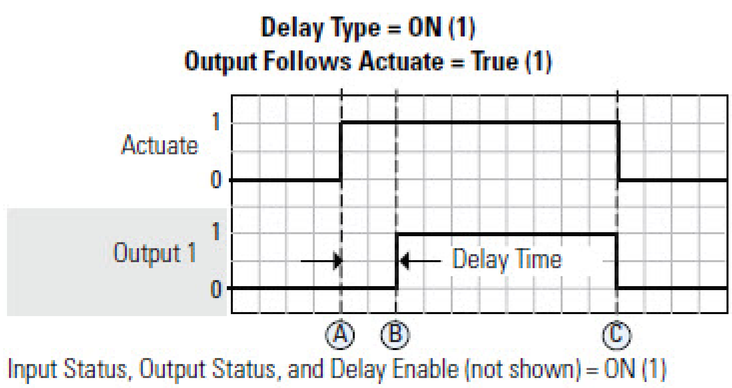
Name	Data Type	Description
Diagnostic Code	Integer	This output indicates the diagnostic status of the instruction. See the AVC – Diagnostic Codes below for a list of diagnostic codes. This operand is not safety-related.

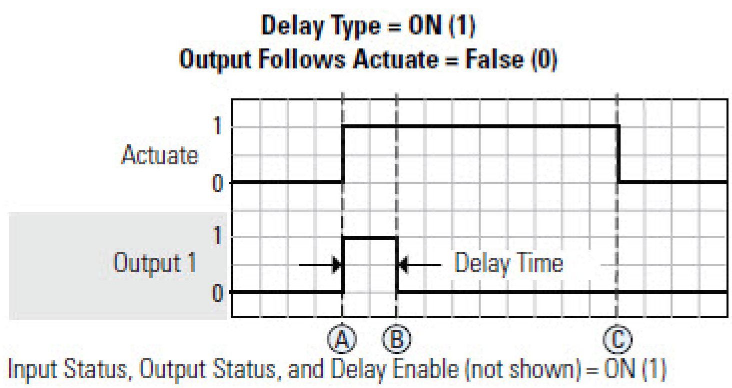
IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Auxiliary Valve Reaction (Delay Type = On)

The following diagram shows a typical soft clutch setup where the auxiliary valve instruction is configured for an On-delay. When Actuate transitions from OFF (0) to ON (1) at (A), the delay timer starts if the Delay Enable input is ON (1). If the Output Follows Actuate input is True, Output 1 energizes once the delay period is over at (B). If the Output Follows Actuate input is False, Output 1 is energized only during the delay period. When the Actuate input transitions from ON (1) to OFF (0), Output 1 follows it and is de-energized immediately if the Output Follows Actuate input is True.

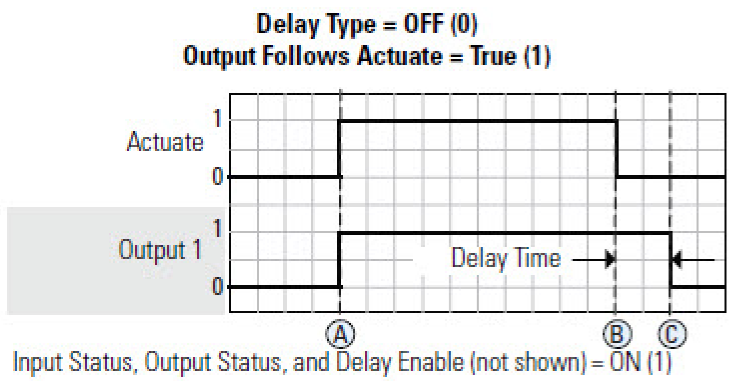


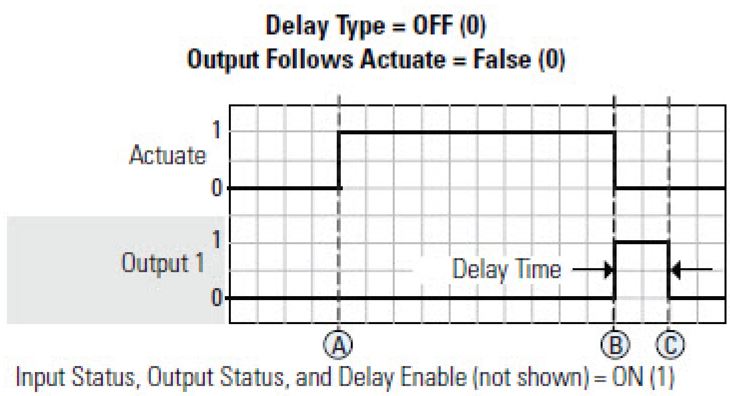


In a soft clutch application, the time period from (A) to (B) indicates the 'soft' part of the clutch engagement where there is pressure relief through the auxiliary valve. During this period, the main clutch valve is choked yielding a smoother clutch engagement.

Normal Auxiliary Valve Reaction (Delay Type = Off)

This example shows a typical brake setup where the auxiliary valve instruction is configured for an Off-delay. When the Acutate input transitions from OFF (0) to ON (1) at (A), Output 1 energizes immediately if the Output Follows Acutate input is True. When the Actuate input transitions from ON (1) to OFF (0) at (B), the delay timer starts if the Delay Enabled input is ON (1). If the Output Follows Actuate input is True, Output 1 remains energized until the delay period ends at (C). Output 1 is then de-energized. If the Output Follows Actuate input is False, Output 1 is energized only during the delay period.



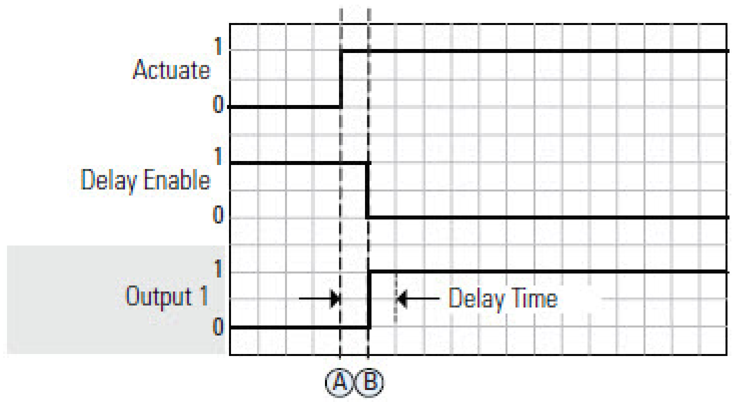


In a soft brake application, the time period from (B) to (C) indicates the 'soft' part of the brake engagement, where there is pressure relief from the auxiliary valve. During this period, the brake valve is choked, yielding a smoother brake engagement.

Immediate Auxiliary Valve Reaction (Delay Type = On)

This example shows the Delay Enable input changing from ON (1) to OFF (0) during the On-delay phase. When the Actuate input transitions from OFF (0) to ON (1) at (A), the delay timer starts. Then, the Delay Enable input transitions from ON (1) to OFF (0) before the delay timer expires and Output 1 is immediately energized at (B).

Delay Type = ON (1)
Output Follows Actuate (not shown) = True (1)

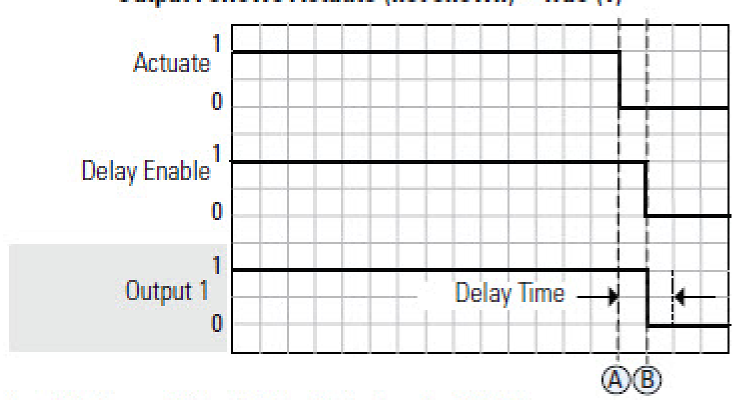


Input Status and Output Status (not shown) = ON (1)

Immediate Auxiliary Valve Reaction (Delay Type = Off)

This example shows the Delay Enable input changing from ON (1) to OFF (0) during the Off-delay phase. When the Actuate input transitions from ON (1) to OFF (0) at (A), the delay timer starts. Then, the Delay Enable input transitions from ON (1) to OFF (0) before the delay timer expires and Output 1 is immediately de-energized at (B).

Delay Type = OFF (0)
Output Follows Actuate (not shown) = True (1)

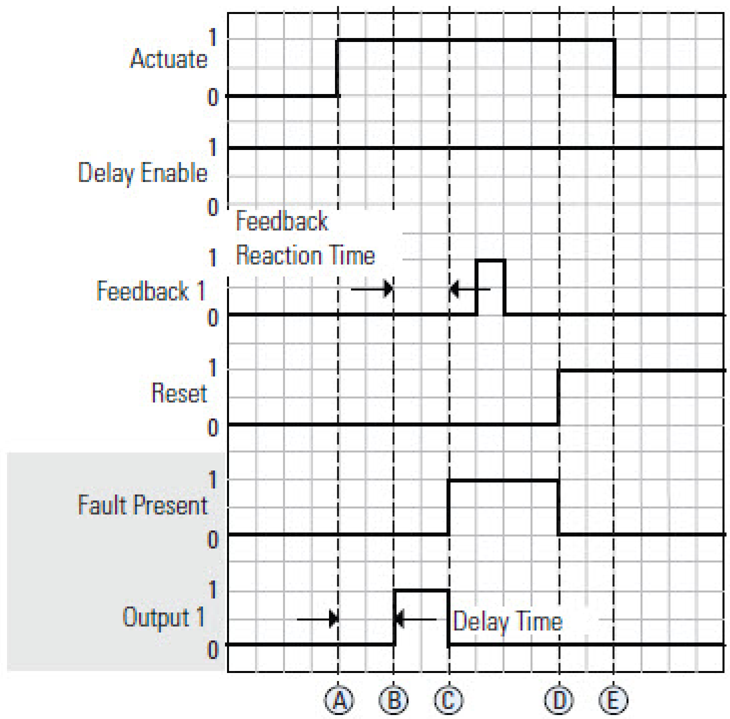


Input Status and Output Status (not shown) = ON (0)

Auxiliary Valve Feedback Fault

This timing diagram shows an example of a Feedback fault where the auxiliary valve did not react within the specified time with Delay Type = ON (1), Output Follows Acutate = True, and Feedback Type = Positive. When the Actuate input transitions from OFF (0) to ON (1) at (A), the delay timer begins. After the delay timer expires at (B), Output 1 is energized. At (C), the Feedback 1 input has not reacted within the specified Feedback Reaction Time, causing a fault. Output 1 is de-energized.

The Fault Present output is cleared at (D) because the Reset input has been asserted and the Feedback 1 input is in the correct state. However, Output 1 cannot be energized again until (E), when the Actuate input turns OFF (0).



Output Follows Actuate (not shown) = True
Delay Type = ON (1)
Feedback type = Positive
Input Status and Output Status (not shown) = ON (1)

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Alarms

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#5020 20512	Feedback is inconsistent with the valve output.	• Check the feedback signal. • Reset the fault.
16#5021 20513	Feedback did not turn ON (1) when Output 1 transitioned from OFF (0) to ON (1).	• Check the feedback signal. • Adjust the Feedback Reaction Time, if necessary. • Reset the fault.
16#5022 20514	Feedback did not turn OFF when Output 1 transitioned from ON (1) to OFF (0).	

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None.
16#20 32	The Input Status was OFF (0) when the instruction started.	Check the I/O module connection.
16#21 33	The Output Status input was OFF (0) when the instruction started.	Check the I/O module connection.
16#5000 20480	The Actuate input is held ON (1).	Set the Actuate input to OFF (0).

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .01, .02, and .FP outputs are cleared to false. The Diagnostic Code and Fault Code outputs are set to 0
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in is false.

See also

Auxiliary Valve Control (AVC) wiring and programming example on page 330

Metal Form Instructions on page 239

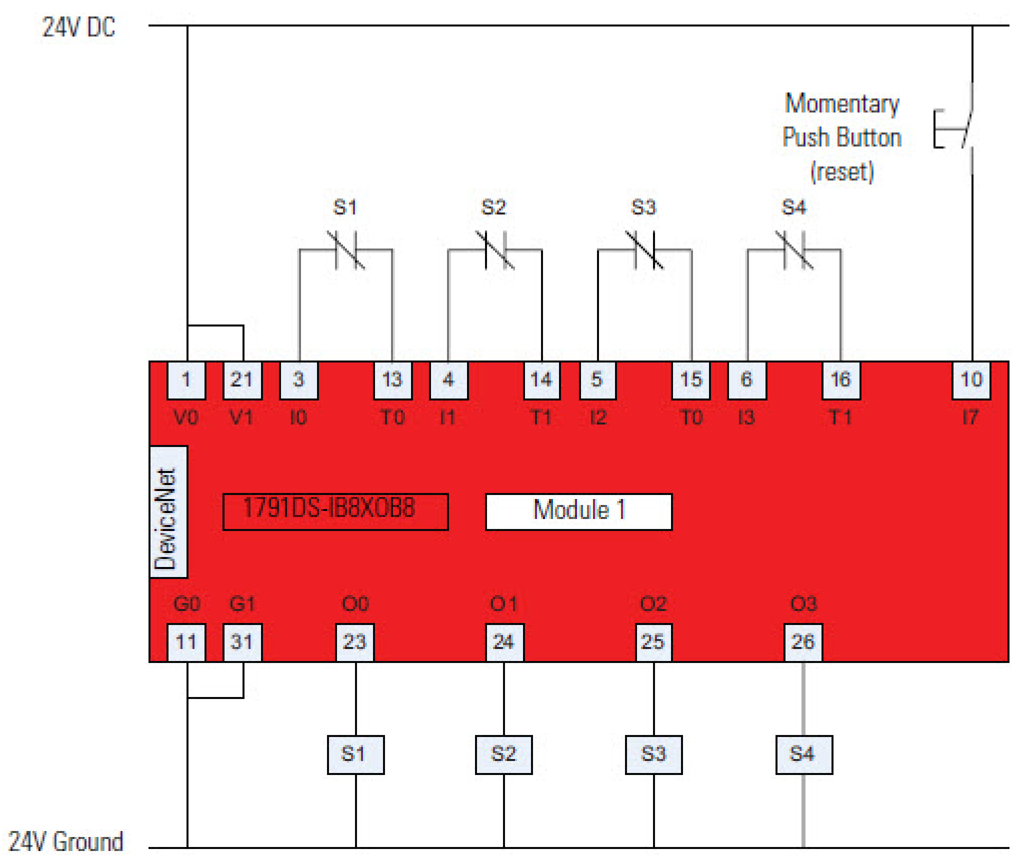
Index Through Arrays on page 540

Auxiliary Valve Control (AVC) wiring and programming example

This topic demonstrates how to program the instruction in the safety control portion of an application.

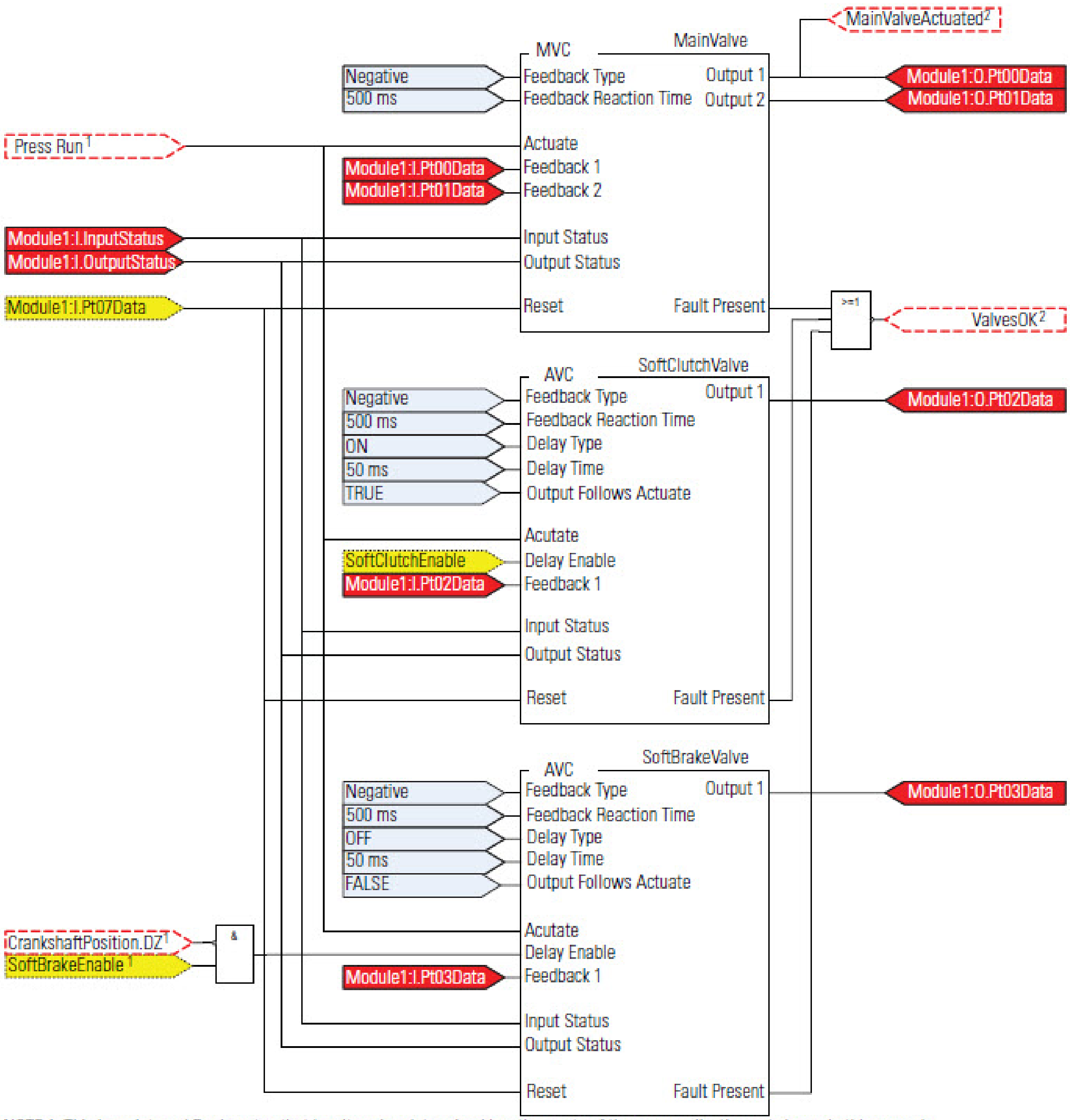
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram



Programming Diagram

This programming diagram shows the Auxiliary Valve Control (AVC) instruction used with a Main Valve Control (MVC) instruction.



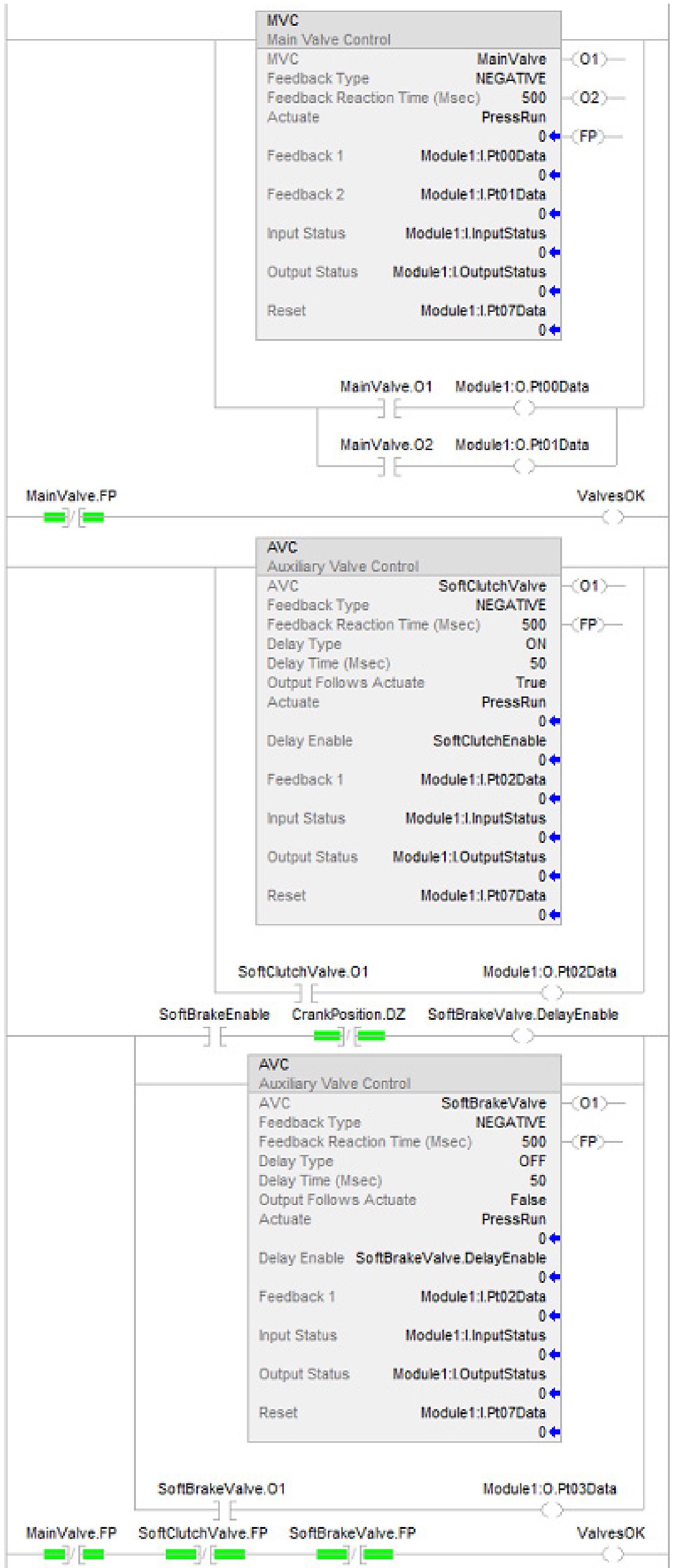
NOTE 1: This is an internal Boolean tag that has its value determined by other parts of the user application not shown in this example.

NOTE 2: This is an internal Boolean tag used by other parts of the user application and not shown in this example.

Key: Color code represents data or value typically used.

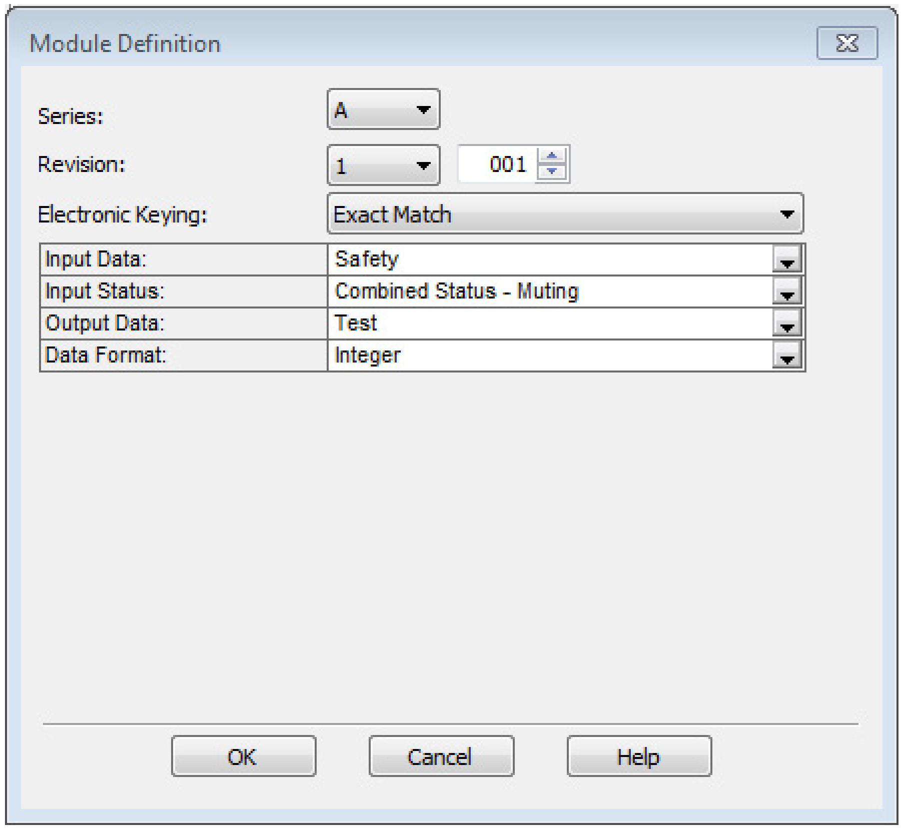
Tag-mapped Variable | Standard Output
Safety Input | Safety Output
Configuration Constant/Value | Internal Safety Variable

Ladder Diagram



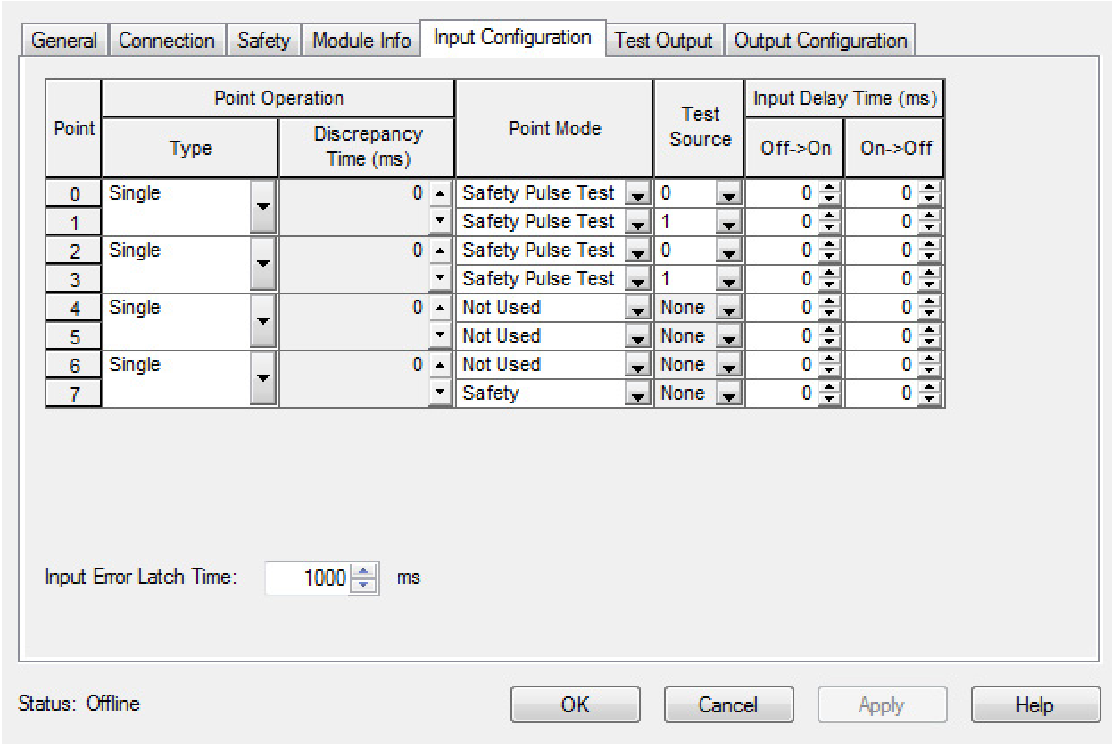
The Logix Designer application is used to configure the input and test output operands of the Guard I/O, as illustrated.

Module Definition

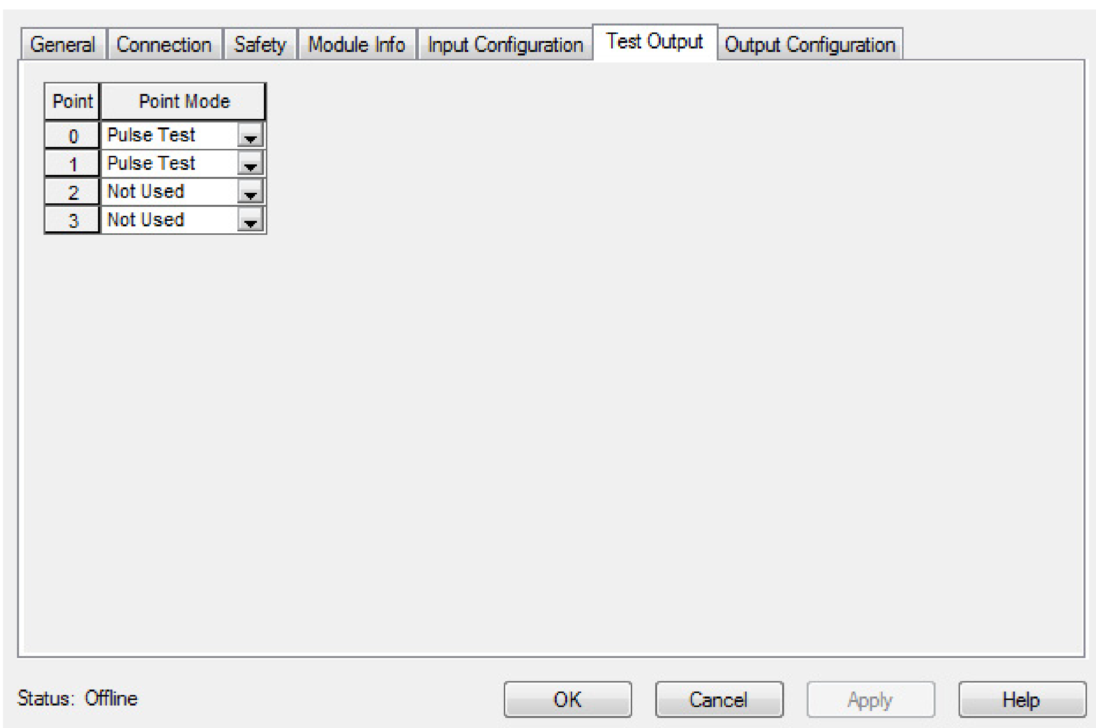


Rockwell Automation suggests using Exact Match, as shown. However, setting Electronic Keying to Compatible Match is allowed.

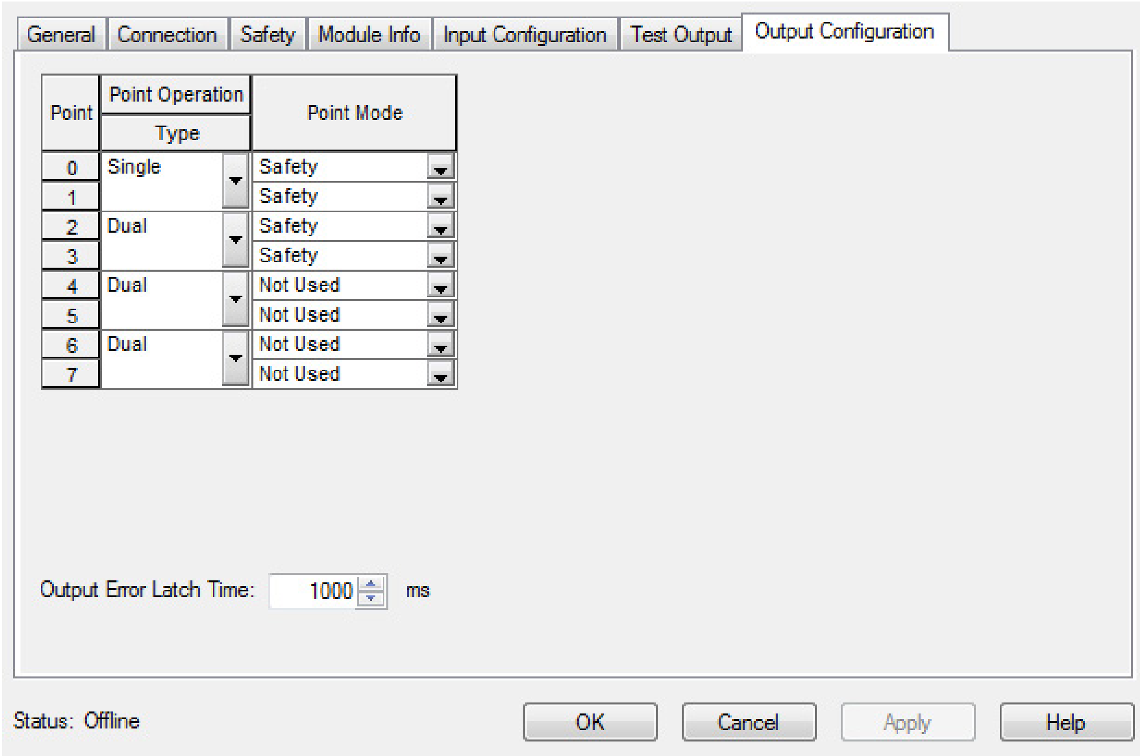
Module Input Configuration



Module Test Output Configuration



Module Output Configuration



See also

Auxiliary Valve Control (AVC) on page 321

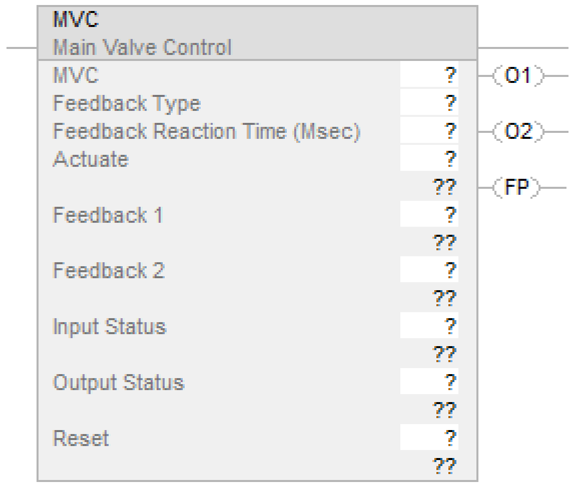
Main Valve Control (MVC)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Main Valve Control (MVC) instruction is used to control and monitor the main clutch or brake valve. This instruction supports valves with various reaction times and positive or negative feedback signals. Single-channel valves are supported by combining Output 1 and Output 2 to control the valve and combining Feedback 1 and Feedback 2 for monitoring.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operand used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
MVC	MAIN_VALVE_CONTROL	tag	MVC structure
Feedback Type	BOOL	list item	This operand defines the feedback OFF and ON states for positive and negative feedback signals.

Operand	Data Type	Format	Description	
			Positive (1)	OFF (0): Feedbacks OFF / Outputs OFF ON (1): Feedbacks ON / Outputs ON
			Negative (0)	OFF (0): Feedbacks ON / Outputs OFF ON (1): Feedbacks OFF / Outputs ON
Feedback Reaction Time	DINT	immediate	This operand specifies the amount of time that the instruction waits for Feedback 1 and Feedback 2 inputs to reflect the state of Output 1 and Output 2 as defined by the Feedback Type operand. The valid range is 5 to 1000 ms.	

The following table explains the instruction inputs. The inputs can be field device signals from input devices or be derived from the user logic.

Operand	Data Type	Format	Description
Actuate	BOOL	tag	This input energizes or de-energizes Output 1 and Output 2. OFF (0) - > ON (1): Output 1 and Output 2 are energized if no faults exist. ON (1) - > OFF (0) Output 1 and Output 2 are de-energized.
Feedback 1	BOOL	tag	These inputs are constantly monitored to make sure that they reflect the state of Output 1 and Output 2. When Output 1 and Output 2 transition, these inputs must react within the Feedback Reaction Time.
Feedback 2	BOOL	tag	
Input Status	BOOL	tag immediate	If instruction inputs are from a safety I/O module, this value is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Output Status	BOOL	tag immediate	This input indicates the output status of the I/O module or modules used by this instruction. ON (1): The output module is operating properly. OFF (0): The output module is faulted. Instruction outputs are set their de-energized (safe) state.
Reset[1]	BOOL	tag	This input clears the instruction faults provided the fault condition is not present. ON (1): The Fault Present and Fault Code outputs are reset.

[1] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the 'Reset_Signal' tag in the example shown below to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains the instruction outputs. The outputs can be field device signals or be derived from user logic.

Operand	Data Type	Description
Output 1 (O1)	BOOL	A redundant pair, these outputs are used to control a press clutch or brake valve. The outputs are de-energized when the following occurs: • A feedback fault occurs. • Input Status or Output Status inputs turn OFf • The normal operation of the instruction causes Output 1 and Output 2 to be de-energized as described in the timing diagram.
Output 2 (O2)	BOOL	
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the Fault Codes section below for the list of fault codes. This operand is not safety-related
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the Diagnostic Codes section below for a list of diagnostic codes. This operand is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

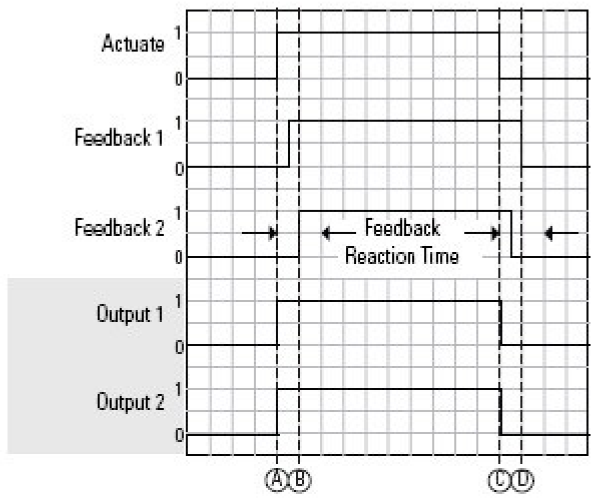
Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in is false.
Rung-condition-in is false	The .O1, .O2, and .FP outputs are cleared to false. The Diagnostic Code and Fault Code outputs are set to 0.
Rung-condition-in is true	The instruction executes.
Postscan	Same as Rung-condition-in is false.

Operation

Normal

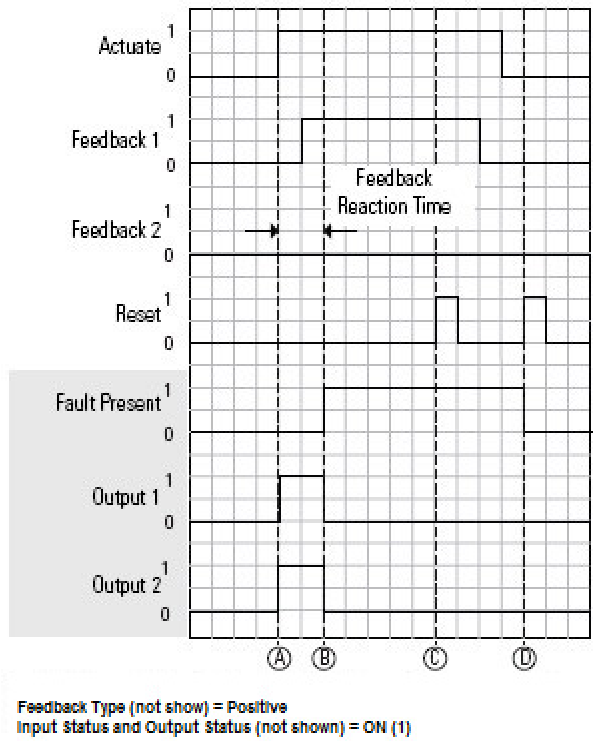
This timing diagram shows normal operation of this instruction to control a press clutch or brake valve with Feedback Type = Positive. Outputs 1 and 2 are energized when the Actuate input transitions from OFF (0) to ON (1) at (A). Both feedback inputs react before the Feedback Reaction Time expires, so the outputs remain energized in a steady state at (B). Outputs 1 and 2 are de-energized at (C) when the Actuate input transitions from ON (1) to OFF (0). Both of the feedback inputs react before the Feedback Reaction Time expires so the outputs remain de-energized in steady state at (D).



Feedback Type (not shown) = Positive
Input Status and Output Status (not shown) = ON(1)

Feedback Fault

The following diagram is an example of how a feedback fault can occur when either of the Feedback inputs fail to reflect the state of Outputs 1 and correctly with Feedback Type = Positive. Outputs 1 and 2 are energized at (A), but at (B), Feedback 2 has not transitioned from OFF (0) to ON (1) before the Feedback Reaction Time has expired, which generates a Feedback fault. The fault cannot be cleared at (C) because the Feedbacks 1 and 2 do not yet reflect the state of Outputs 1 and 2. The fault is cleared when an OFF (0) to ON (1) transition is detected on the Reset input and both Feedback inputs are OFF (0), correctly reflecting the state of Outputs 1 and 2 at (D).



False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No fault.	None
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#5000 20480	Feedback 1 and Feedback 2 turned OFF (0) unexpectedly.	• Check the feedback signal. • Reset the fault.
16#5001 20481	Feedback 1 turned OFF (0) unexpectedly.	• Check the feedback 1 signal. • Reset the fault.
16#5002 20482	Feedback 2 turned OFF (0) unexpectedly.	• Check the feedback 2 signal. • Reset the fault.
16#5003 20483	Feedback 1 and Feedback 2 turned ON (1) unexpectedly.	• Check the feedback signals. • Reset the fault.

Fault Code	Description	Corrective Action
16#5004 20484	Feedback 1 turned ON (1) unexpectedly.	• Check the feedback 1 signal. • Reset the fault.
16#5005 20485	Feedback 2 turned ON (1) unexpectedly.	• Check the feedback 2 signal. • Reset the fault.
16#5006 20486	Feedback 1 and Feedback 2 did not turn ON (1) within the configured Feedback Reaction Time.	• Check the feedback signal. • Adjust the Feedback Reaction Time, if necessary • Reset the fault.
16#5007 20487	Feedback 1 did not turn ON (1) within the configured Feedback Reaction Time.	• Check the feedback 1 signal. • Adjust the Feedback Reaction Time, if necessary • Reset the fault.
16#5008 20488	Feedback 2 did not turn ON (1) within the configured Feedback Reaction Time.	• Check the feedback 2 signal • Adjust the Feedback Reaction Time, if necessary • Reset the fault.
16#5009 20489	Feedback 1 and Feedback 2 did not turn OFF (0) within the configured Feedback Reaction Time.	• Check the feedback signal • Adjust the Feedback Reaction Time, if necessary • Reset the fault.
16#500A 20490	Feedback 1 did not turn OFF (0) within the configured Feedback Reaction Time.	• Check the feedback 1 signal • Adjust the Feedback Reaction Time, if necessary • Reset the fault.
16#500B 20491	Feedback 2 did not turn OFF (0) within the configured Feedback Reaction Time.	• Check the feedback 2 signal • Adjust the Feedback Reaction Time, if necessary • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No fault.	None
16#20 32	The Input Status was OFF (0) when the instruction started.	Check the I/O module connection.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	Check the I/O module connection.
16#5000 20480	The Actuate input is held ON (1).	Set the Actuate input to OFF (0).

See also

Maintenance Valve Control (MVC) wiring and programming example on page 342

Index Through Arrays on page 540

[Auxiliary Valve Control (AVC)](#) on [page 321](#)

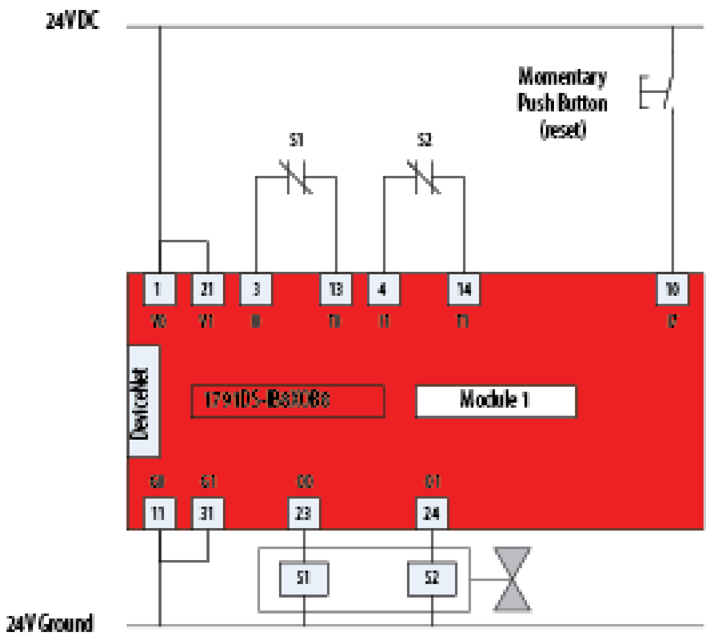
[Maintenance Manual Valve Control (MMVC)](#) on [page 346](#)

Maintenance Valve Control (MVC) wiring and programming example

This topic demonstrates how to wire the Guard I/O module and program the instruction in the safety control portion of an application.

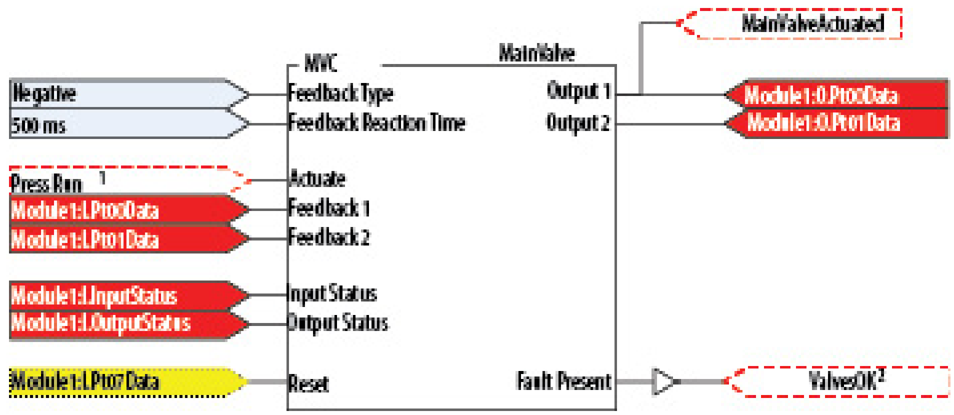
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram

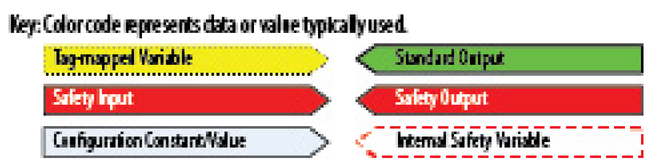


This programming diagram shows the Main Valve Control (MVC) instruction with inputs and outputs.

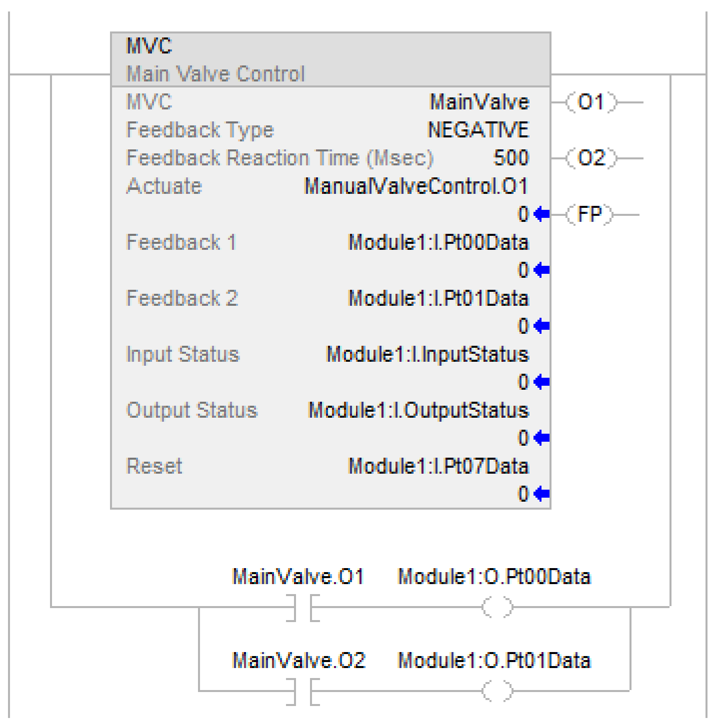
Programming Diagram



NOTE 1: This tag is an internal Boolean tag that has its value determined by other parts of the user application that are not shown in this example.
NOTE 2: This tag is an internal Boolean tag that is used by other parts of the user application that are not shown in this example.

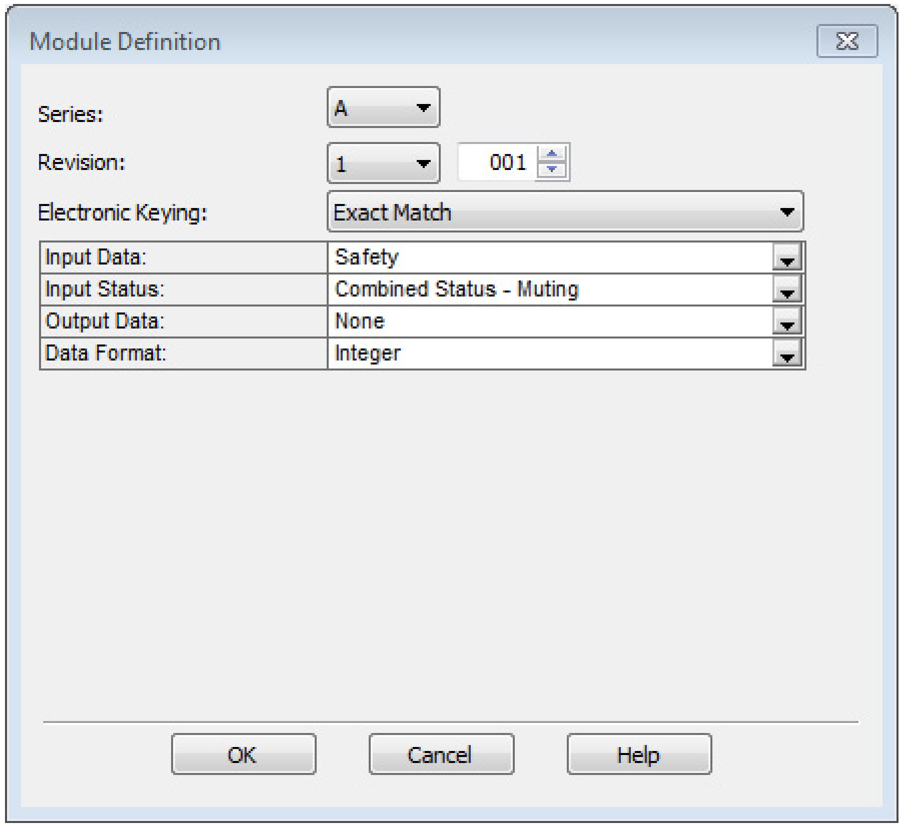


Ladder Diagram



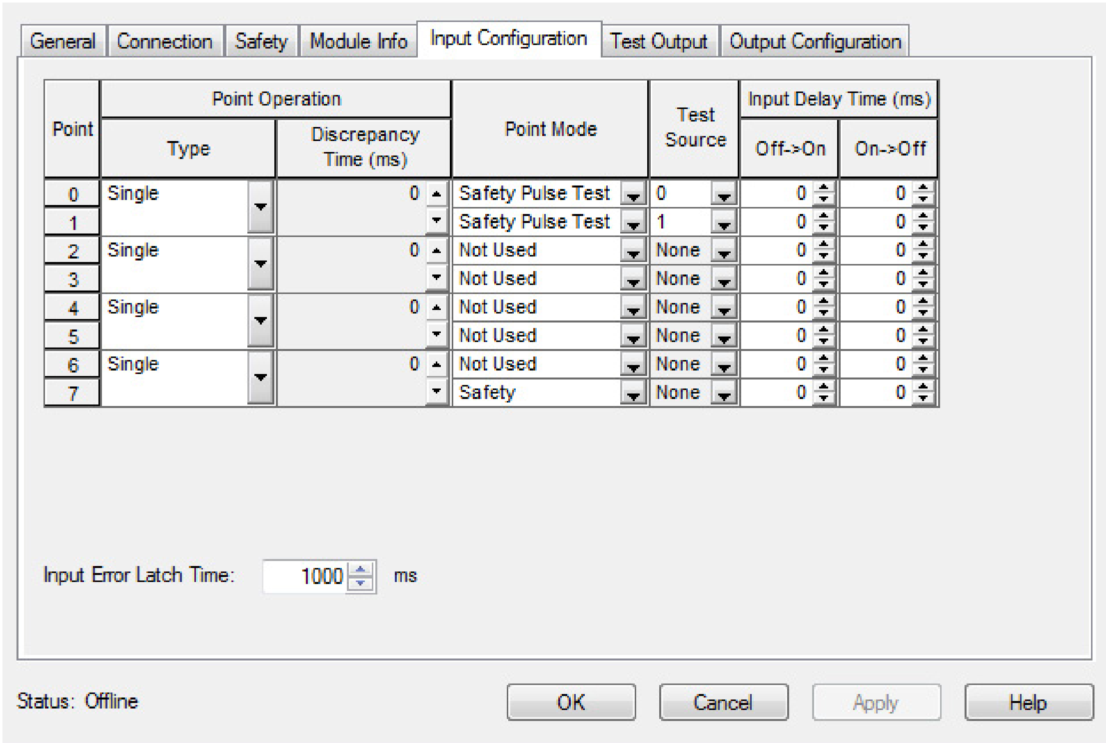
Module Definition

The following sections provide examples of how to use the programming software to set the Guard I/O module configuration operands.

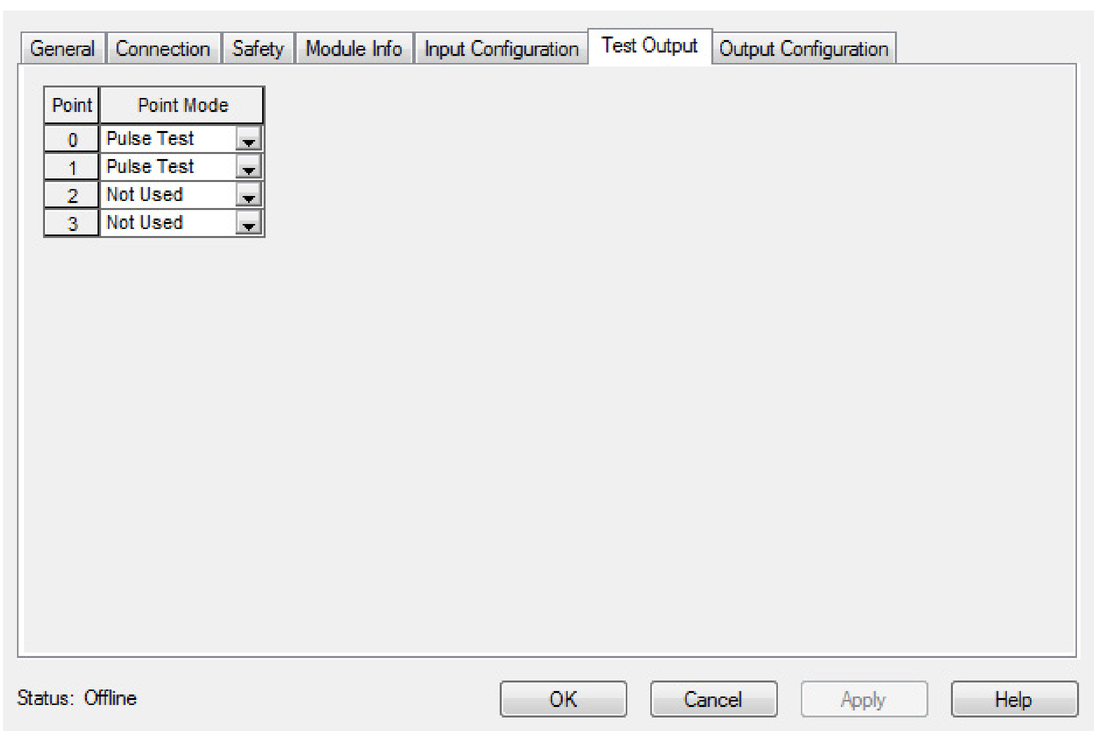


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. It also acceptable to select **Compatible Match**.

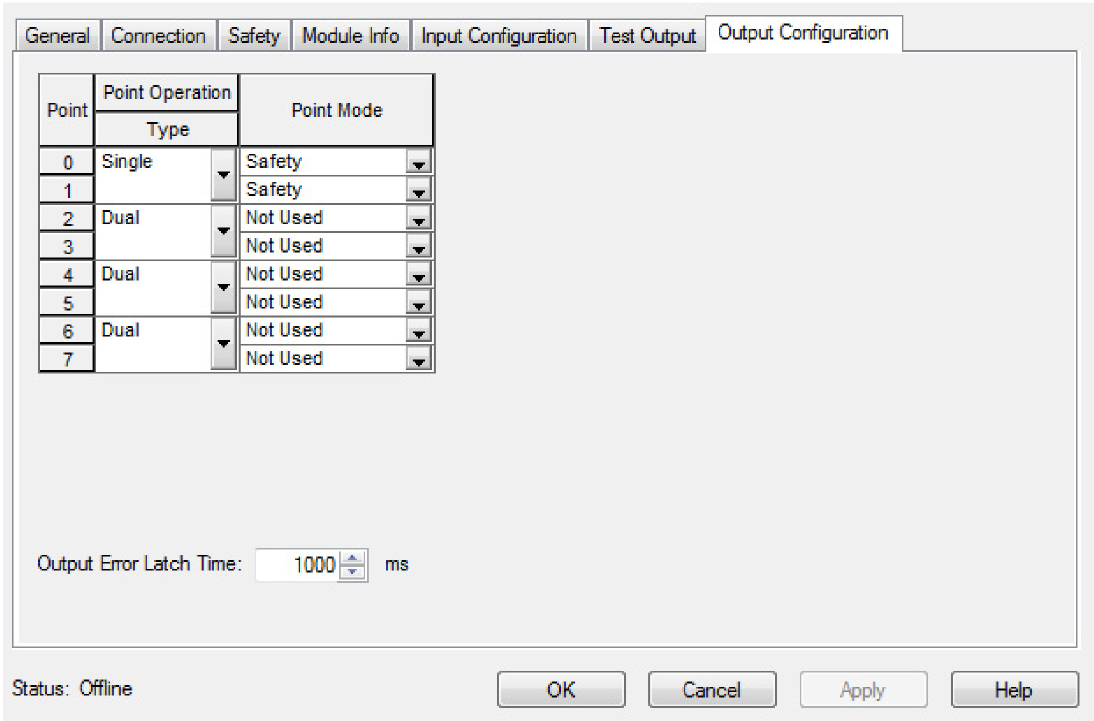
Module Input Configuration



Module Test Output Configuration



Module Output Configuration



See also

Main Valve Control (MVC) on page 335

Maintenance Manual Valve Control (MMVC)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The Maintenance Manual Valve Control (MMVC) instruction is intended to drive a press valve manually during a maintenance operation. Manual drive of the valve is permitted when the instruction is enabled and in the permissive state. The permissive state means all of these conditions have been met:

- A key switch is enabled.
- The flywheel is stopped.
- The slide is at bottom-dead-center (BDC).
- The Safety Enable input is ON (1).

One instruction is required for each valve that needs to be manually controlled.

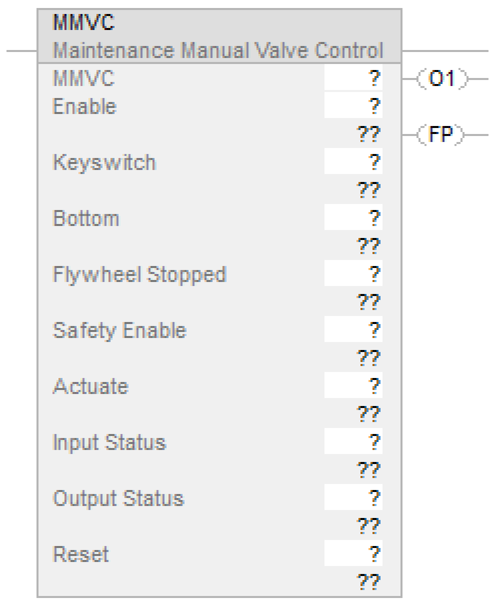
ATTENTION: This instruction should only be enabled during a maintenance operation and should never be used during press operation.

ATTENTION: Besides sourcing the Bottom and Flywheel Stopped inputs, perform a visual inspection to make sure that the press is at bottom-dead-center (BDC) and that the flywheel is not in motion before activating the keyswitch and enabling the valve.

ATTENTION: The Keyswitch Enable Input must only be activated with a supervised key switch.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT	Unexpected operation may occur if: • Output tag operands are overwritten. • Members of a structure operand are overwritten. • Structure operands are shared by multiple instructions.

ATTENTION: If changing instruction operands while in Run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used to configure the instruction. These operands cannot be changed at runtime.

Operand	Data Type	Format	Description
MMVC	MANUAL_VALVE_CONTROL	tag	MMVC structure

The following table explains the instruction inputs. The inputs may be field device signals from input devices or derived from user logic.

Operand	Data Type	Format	Description
Enable	BOOL	tag	This input is the instruction enable from mode switch. This instruction should be enabled in maintenance mode only. ON (1): The instruction is enabled. Output 1 can be energized after the Actuate input transitions from OFF (0) to ON (1) when the instruction is in the permissive state. OFF (0): The instruction is not enabled. Output 1 cannot be energized.
Keyswitch	BOOL	tag	This is the supervised keyswitch input for the instruction. ON: The instruction is activated. OFF: The instruction is not activated. Output 1 cannot be energized.
Bottom	BOOL	tag	This input indicates slide position. ON (1): The slide is at bottom-dead-center (BDC). OFF (0): The slide is not at BDC. Output 1 cannot be energized.
Flywheel Stopped	BOOL	tag	This input indicates whether or not the flywheel is stopped. This input must be ON (1) to allow manual valve control. ON (1): The flywheel is stopped. OFF (0): The flywheel is not stopped.

Operand	Data Type	Format	Description
Safety Enable	BOOL	tag	This input represents the status of safety-related permissive devices such as E-stops, light curtains or safety gates. This input is optional on this instruction for extra protection if required for a particular application. ON (1): Indicates that permissive devices are actively guarding the danger zone and permits the energizing of Output 1. OFF (0): Indicates that permissive devices are no longer protecting the danger zone and prevents the energizing of Output 1.
Actuate	BOOL	tag	This input is the signal to manually actuate the valve, energizing or de-energizing Output 1. OFF (0) -> ON (1): Output 1 is energized if the instruction is enabled, the Keyswitch input is activated, and no faults exist. ON (1) -> OFF (0): Output 1 is de-energized.
Input Status	BOOL	immediate tag	If instruction inputs are from a safety I/O module, this is the status from the I/O module or modules (Connection Status or Combined Status). If instruction inputs are derived from internal logic, it is the application programmer's responsibility to determine the conditions. ON (1): The inputs to this instruction are valid. OFF (0): The inputs to this instruction are invalid.
Output Status	BOOL	immediate tag	This input indicates the output status of the I/O module connected to this instruction. ON (1): The output module is operating properly. OFF (0): The output module is faulted or offline. Instruction outputs are set their safe state.
Reset[1]	BOOL	tag	This input clears the instruction faults provided the fault condition is not present. ON (1): The Fault Present and Fault Code outputs are reset.

[1] ISO 13849-1 stipulates instruction reset functions must occur on falling edge signals. To comply with ISO 13849-1 requirements, add this logic immediately before this instruction. Rename the 'Reset_Signal' tag in the example shown below to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

The following table explains the instruction outputs. The outputs may be field device signals or derived from user logic.

Operand	Data Type	Description
Output 1 (O1)	BOOL	This output manually controls a valve. The output is de-energized when: • The Enable input transitions from ON (1) to OFF (0). • The Keyswitch input transitions from ON (1) to OFF (0). • The Bottom input transitions from ON (1) to OFF (0), indicating the slide has left bottom-dead-center. • The Flywheel Stopped input transitions from ON (1) to OFF (0), indicating flywheel motion. • The Safety Enable input transitions from ON (1) to OFF (0). • The Input Status or Output Status inputs have turned OFF (0). • The Actuate input transitions from ON (1) to OFF (0).
Fault Present (FP)	BOOL	ON (1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Code	DINT	This output indicates the type of fault that occurred. See the MMVC Fault Codes section for a list of fault codes. This operand is not safety-related.
Diagnostic Code	DINT	This output indicates the diagnostic status of the instruction. See the MMVC Diagnostic Codes section below for a list of diagnostic codes. This operand is not safety-related.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

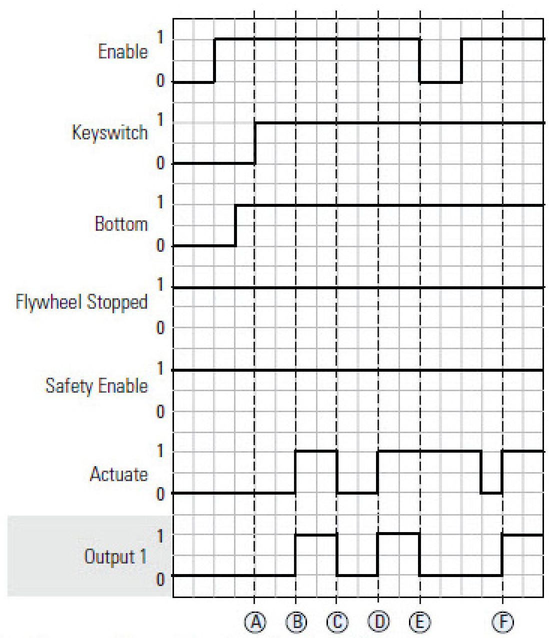
Execution

Condition/State	Action Taken
Prescan	Same as Rung-condition-in false.
Rung-condition-in is false	The .O1, and .FP are cleared to false. The Diagnostic Code and Fault Code outputs are set to 0.
Rung-condition-in is true	The instruction executes as described in the Operation section.
Postscan	Same as Rung-condition-in false.

Operation

Normal

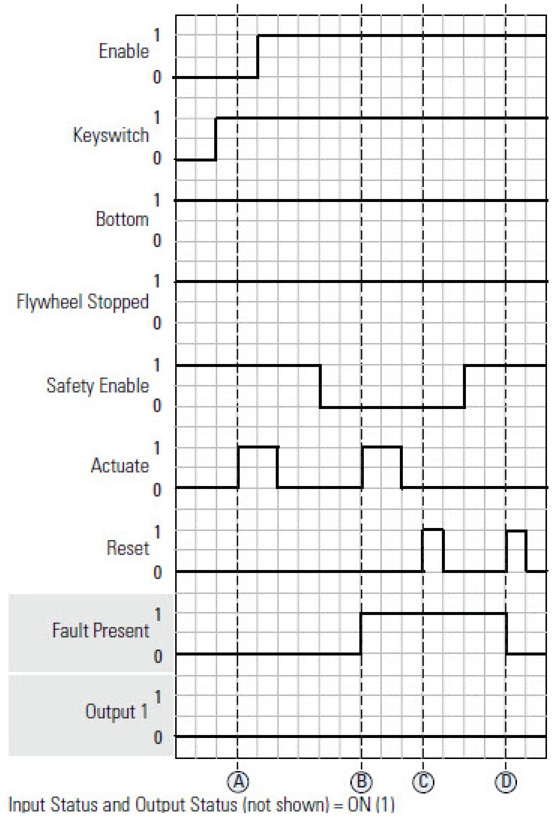
This timing diagram shows normal operation of this instruction to manually drive a valve. The instruction enters the permissive state at (A) because the instruction has been enabled, bottom-dead-center (BDC) has been achieved, the flywheel is stopped, and the Safety Enable input is ON (1). Output 1 is energized at (B) because a rising edge is detected on the Actuate input, manually energizing the valve. Output 1 is de-energized at (C) because the Actuate input is turned OFF (0). Output 1 is energized again when another rising edge is detected on the Actuate input at (D). Output 1 is de-energized at (E) because the Enable input turns OFF (0), resetting the instruction. Finally, Output 1 is energized at (F) once the instruction is back in a permissive state and a rising edge is detected on the Actuate input. None of the conditions in this example results in a fault.



Input Status and Output Status (not shown) = ON (1)

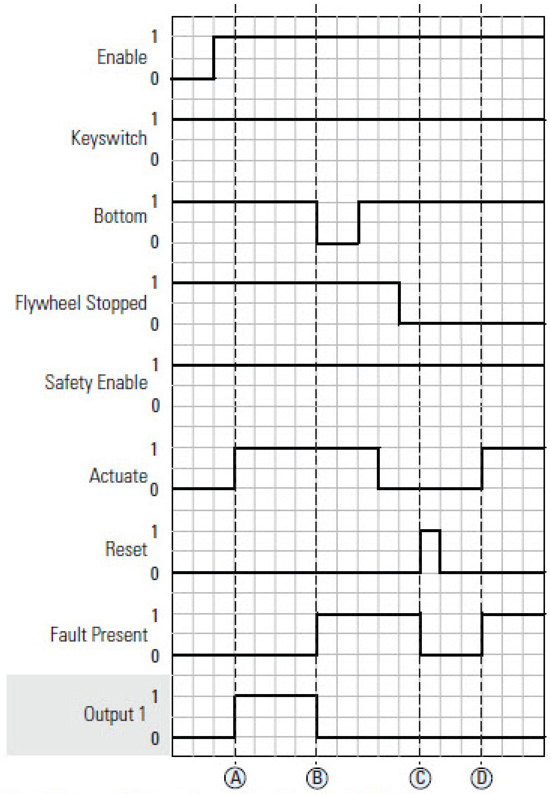
Actuate in Non-permissive State

This timing diagram shows conditions that do not allow Output 1 to be energized because the instruction is not in a permissive state when the Actuate input transitions from OFF (0) to ON (1). Output 1 is not energized at (A) because the instruction is not enabled when the Actuate input transitions from OFF (0) to ON (1). The instruction is enabled, but faults immediately when the Actuate input transitions from OFF to ON because the Safety Enable input is OFF (0) at (B). The fault cannot be cleared because the fault condition still exists at (C). Finally, the fault is cleared at (D) when the Reset input transitions from OFF (0) to ON (1) because the Safety Enable input is now ON (1). Output 1 can now be energized when the Actuate input transitions from OFF (0) to ON (1).



Fault After Output 1 Energized

Output 1 is energized at (A) after the Actuate input transitions from OFF (0) to ON (1) when the instruction is in the permissive state. The instruction faults at (B) because the slide is no longer at bottom-dead-center (BDC). The fault is cleared at (C) when the Reset input transitions from OFF (0) to ON (1) and the slide has returned to BDC. Another fault is generated at (D) when the Actuate input transitions from OFF (0) to ON (1) and the flywheel is not stopped.



Input Status and Output Status (not shown) = ON (1)

False Rung State Behavior

When the instruction is executed on a false rung, all instruction outputs are de-energized.

Fault Codes and Corrective Actions

The fault codes are listed in hexadecimal format followed by decimal format.

Fault Code	Description	Corrective Action
0	No Fault	None.
16#20 32	The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	• Check the I/O module connection. • Reset the fault.
16#5040 20544	The slide was not at bottom-dead-center (BDC) when the Actuate input transitioned from OFF (0) to ON (1).	• Visually check to make sure the slide is at bottom. • Check the Bottom input signal. • Reset the fault.

Fault Code	Description	Corrective Action
16#5041 20545	Flywheel motion was detected when the Actuate input transitioned from OFF (0) to ON (1).	• Visually check to make sure that the flywheel is not in motion. • Check the Flywheel Stopped input signal. • Reset the fault.
16#5042 20546	Safety Enable was OFF (0) when the Actuate input transitioned from OFF (0) to ON (1).	• Visually check that the permissive inputs tied to the Safety Enable input are functioning properly. • Check the Safety Enabled input signal. • Reset the fault.
16#5043 20547	The Keyswitch input was OFF (0) when the Actuate input transitioned from OFF (0) to ON (1).	• Turn the keyswitch on. • Check the Keyswitch input signal. • Reset the fault.

Diagnostic Codes and Corrective Actions

The diagnostic codes are listed in hexadecimal format followed by decimal format.

Diagnostic Code	Description	Corrective Action
0	No Fault	None.
16#20 32	The Input Status was OFF (0) when the instruction started.	Check the I/O module connection.
16#21 33	The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing.	Check the I/O module connection.
16#5000 20480	The Actuate input is held ON (1).	Set the Actuate input to OFF (0).
16#5040 20544	The slide was not at bottom-dead-center (BDC).	• Visually make sure that the slide is at bottom. • Check the Bottom input signal.
16#5041 20545	Flywheel motion detected.	• Visually make sure that the flywheel is not in motion. • Check the Flywheel Stopped input signal.
16#5042 20546	The Safety Enable signal is OFF (0).	• Visually make sure that the permissive inputs tied to the Safety Enable signal are operating properly. • Check the Safety Enable input signal.
16#5043 20547	The keyswitch is disabled.	Enable the Keyswitch input.

See also

Maintenance Manual Valve Control (MMVC) wiring and programming example on page 355

Index Through Arrays on page 540

Metal Form Instructions on page 239

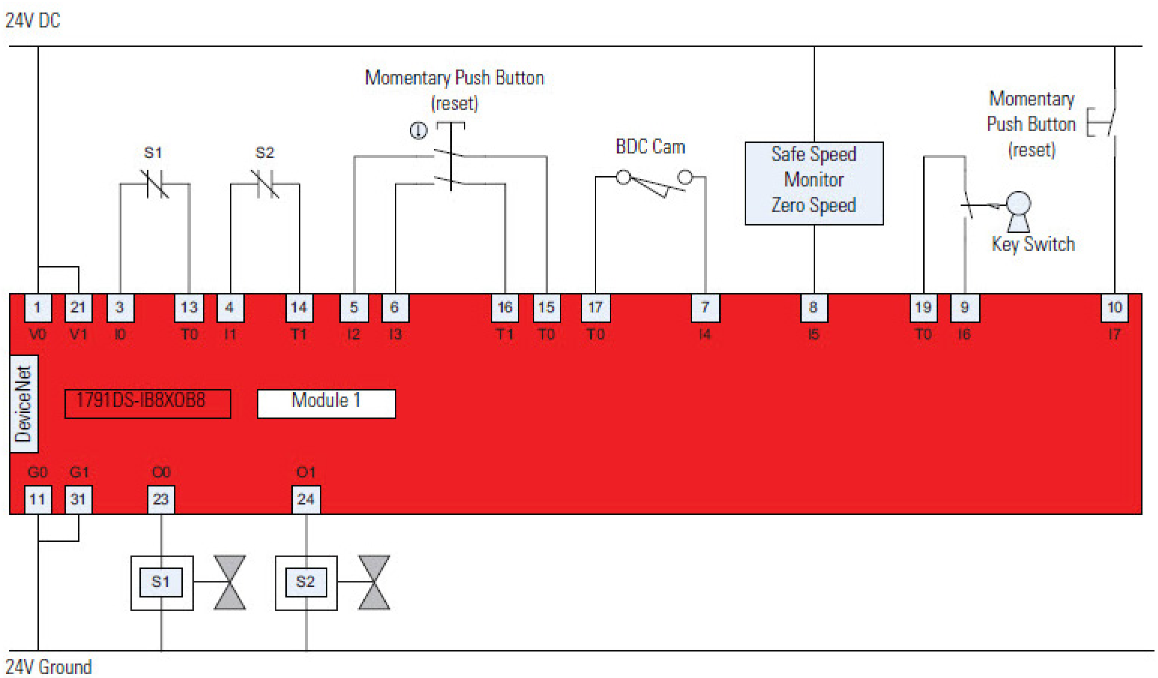
Maintenance Manual Valve Control (MMVC) wiring and programming example

This topic demonstrates how to wire the Guard I/O module and program the instruction in the safety control portion of an application.

This application example complies with ISO 13849-1, Category 4 operation.

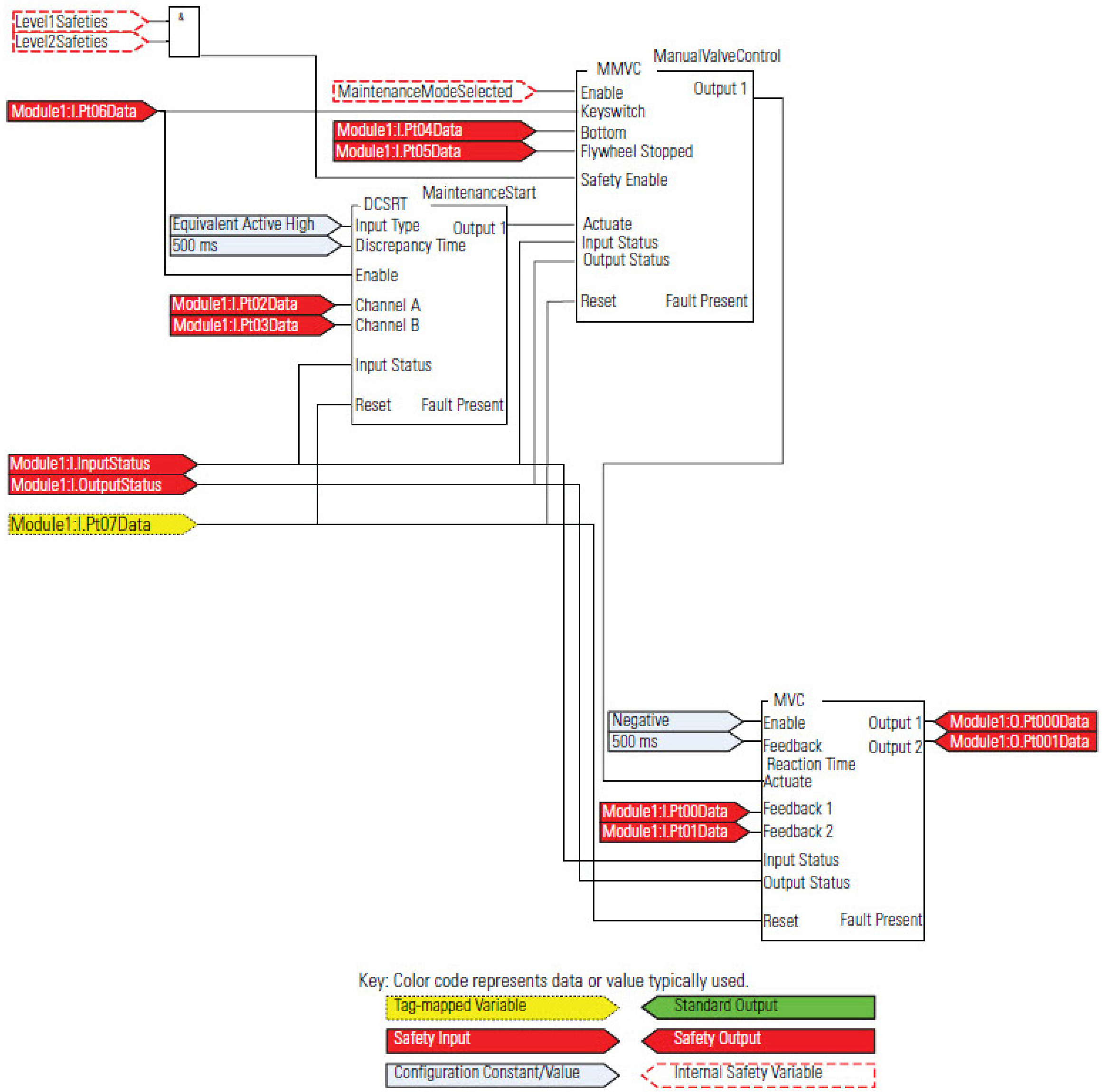
Tip: The standard control portion of the application is not shown in the following diagram.

Wiring Diagram

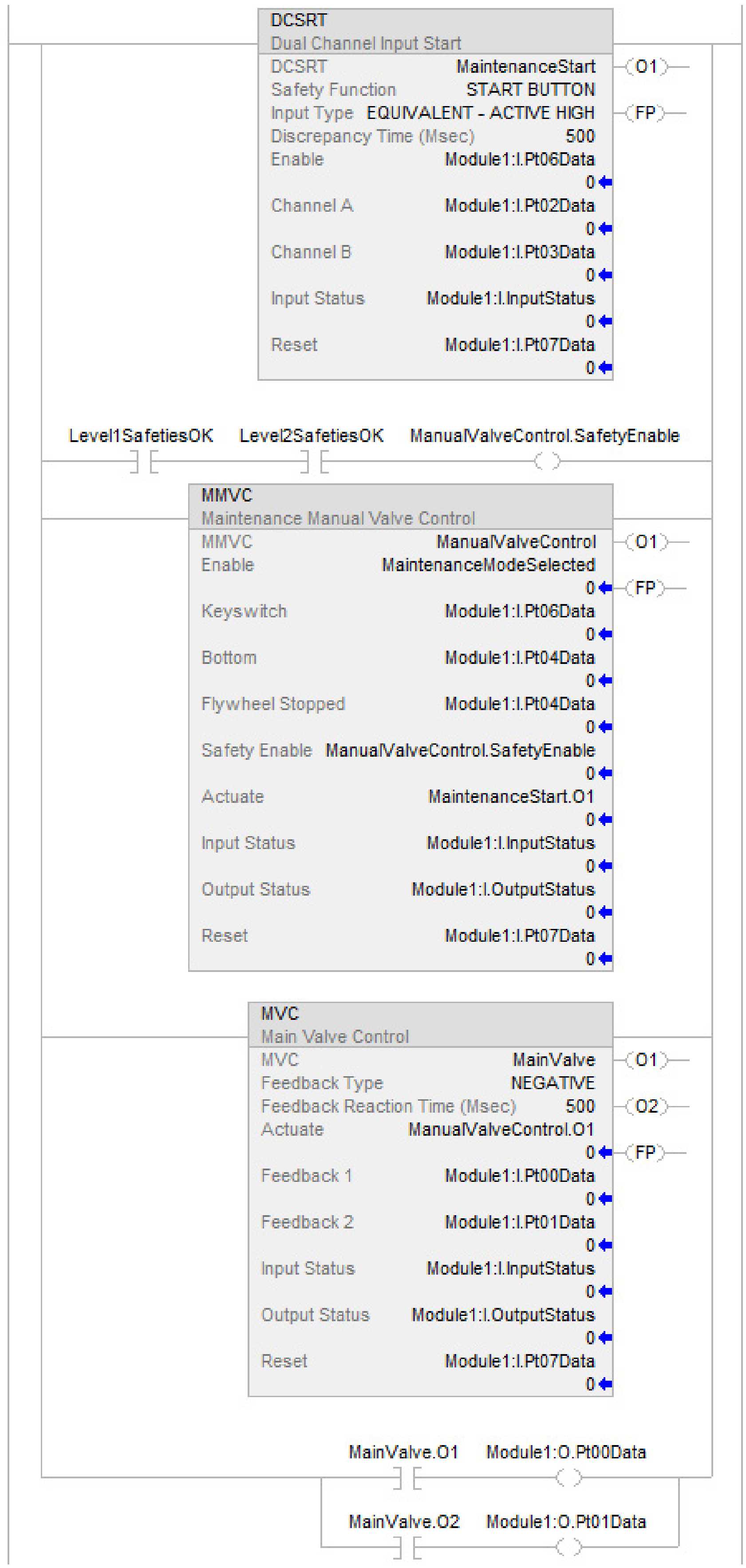


This programming diagram shows the MMVC instruction used with a Dual-channel Input Start (DCSRT) instruction and a Main Valve Control (MVC) instruction.

Programming Diagram

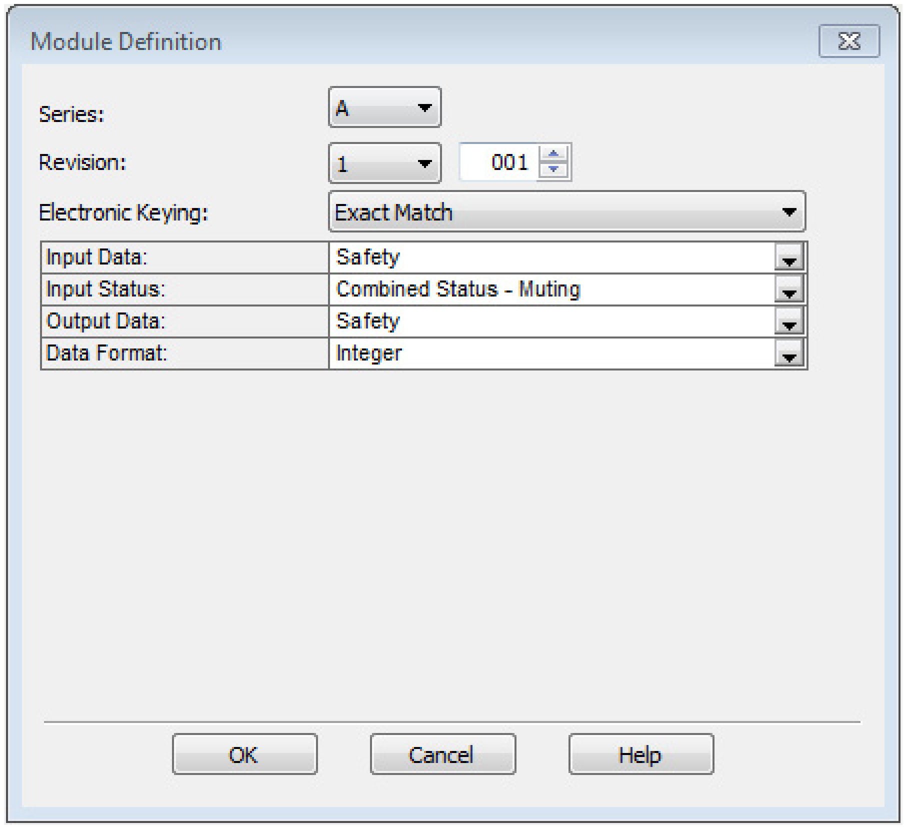


Ladder Diagram



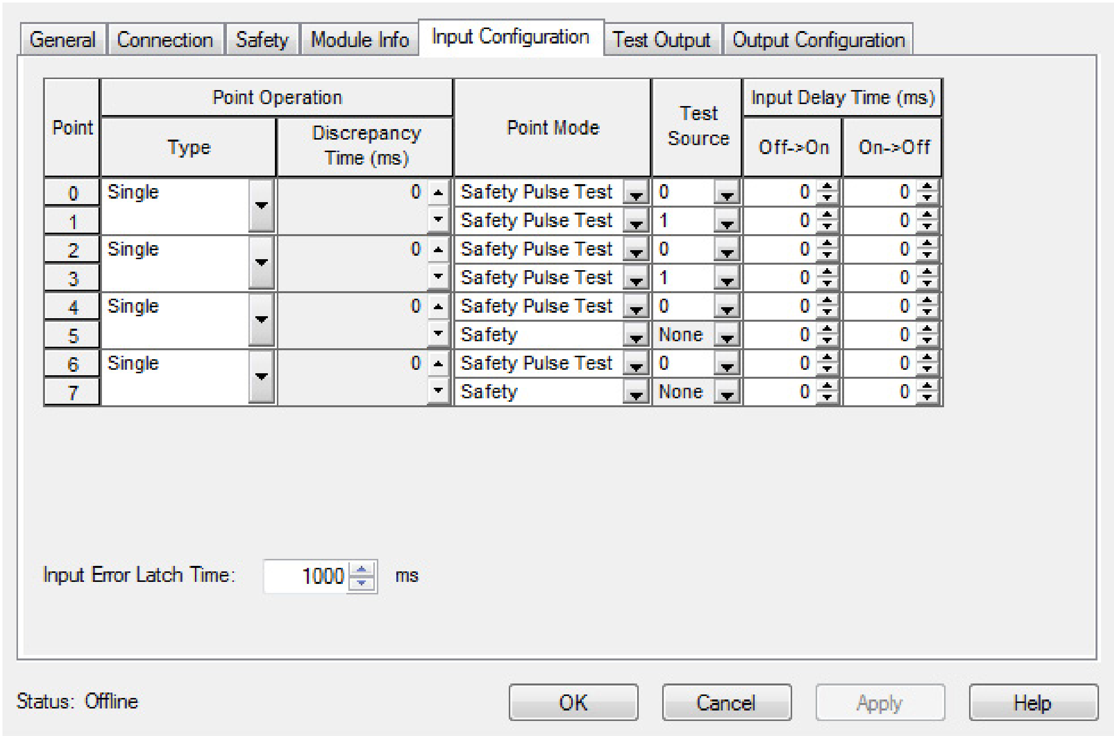
Module Definition

The Logix Designer application is used to configure the input and test output operands of the Guard I/O module, as illustrated.

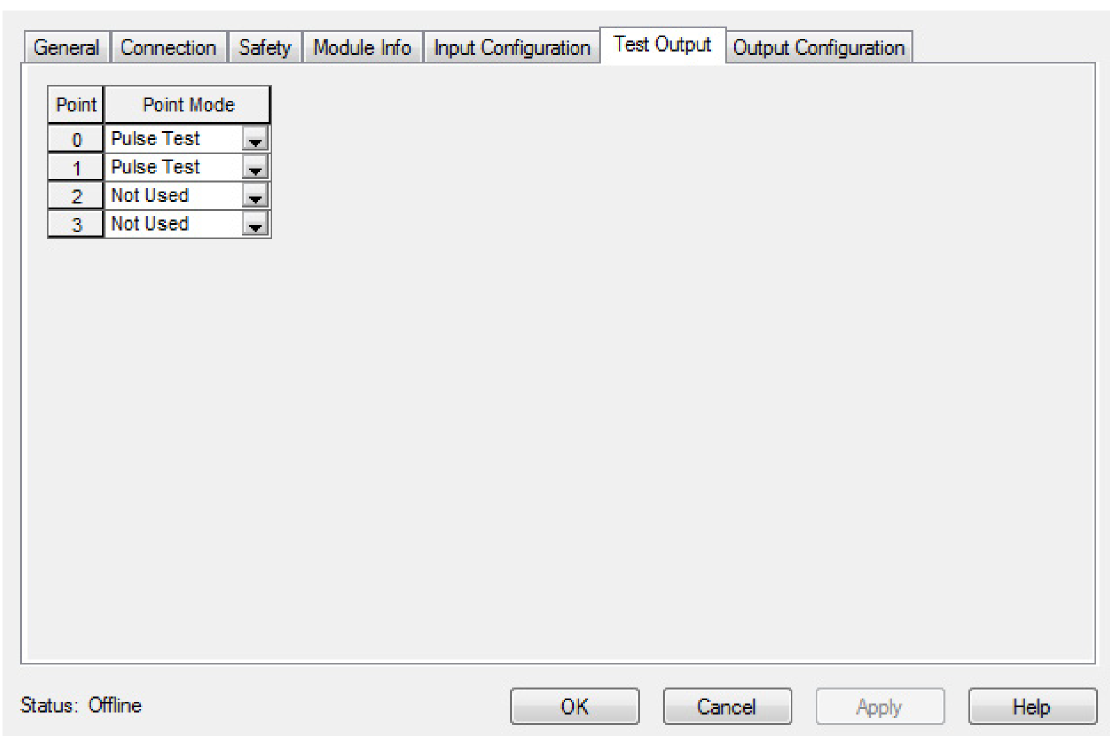


Rockwell Automation suggests selecting **Exact Match** for the **Electronic Keying** as shown. **Compatible Match** is also acceptable.

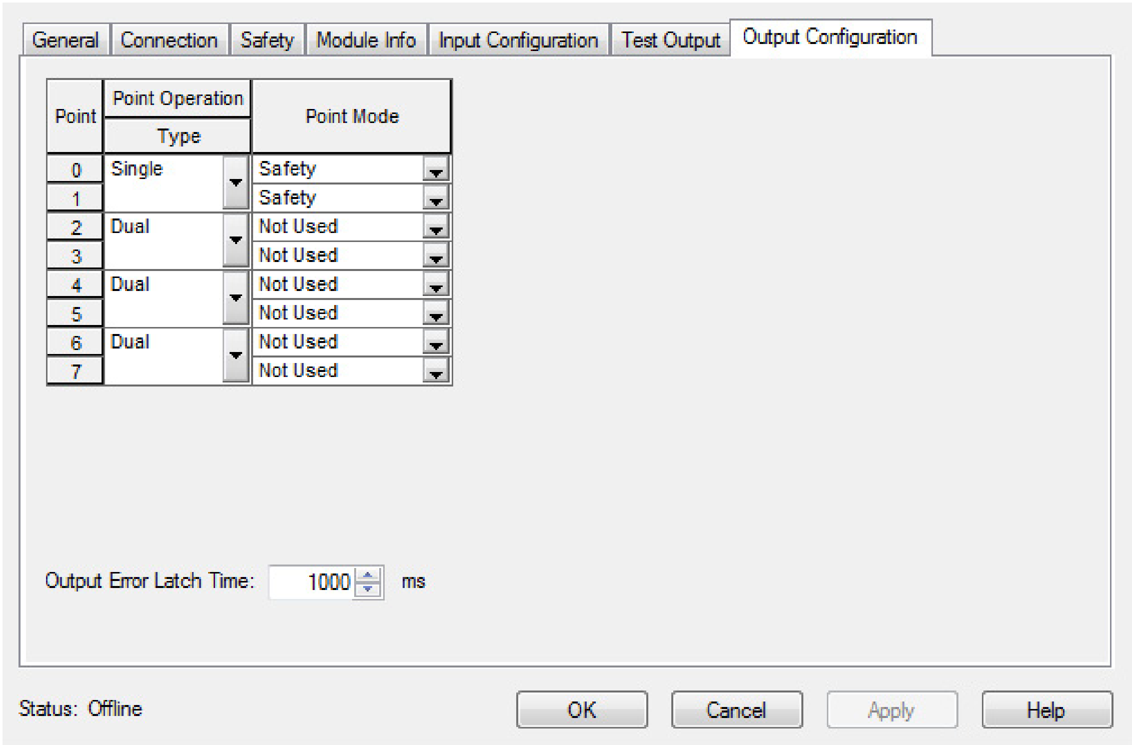
Module Input Configuration



Module Test Output Configuration



Module Output Configuration



See also

Maintenance Manual Valve Control (MMVC) on page 346

Drive Safety

Drive Safety Instructions

The Drive Safety instructions include the following:

Available Languages

Ladder Diagram

SDI	SFX	SLP	SLS	SOS	SS1	SS2	SBC

Function Block

Not available

Structured Text

Not available

See also

Safety Instructions on page 15

Metal Form Instructions on page 239

Safe Brake Control (SBC)

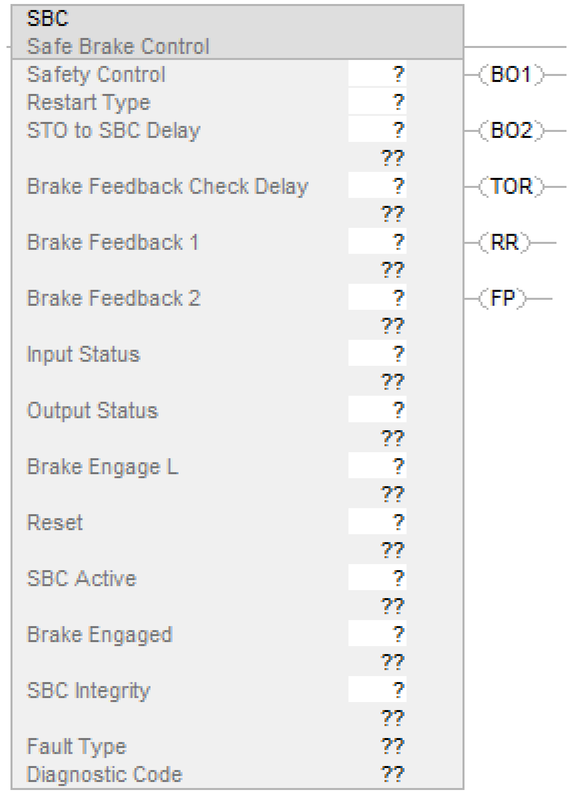
This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safe Brake Control (SBC) instruction:

- Controls safety outputs that actuate a brake.
- Sets timing between brake and Torque Off Request outputs.
- Monitors brake feedback and I/O status.

Available Languages

Ladder Diagram



Function Block

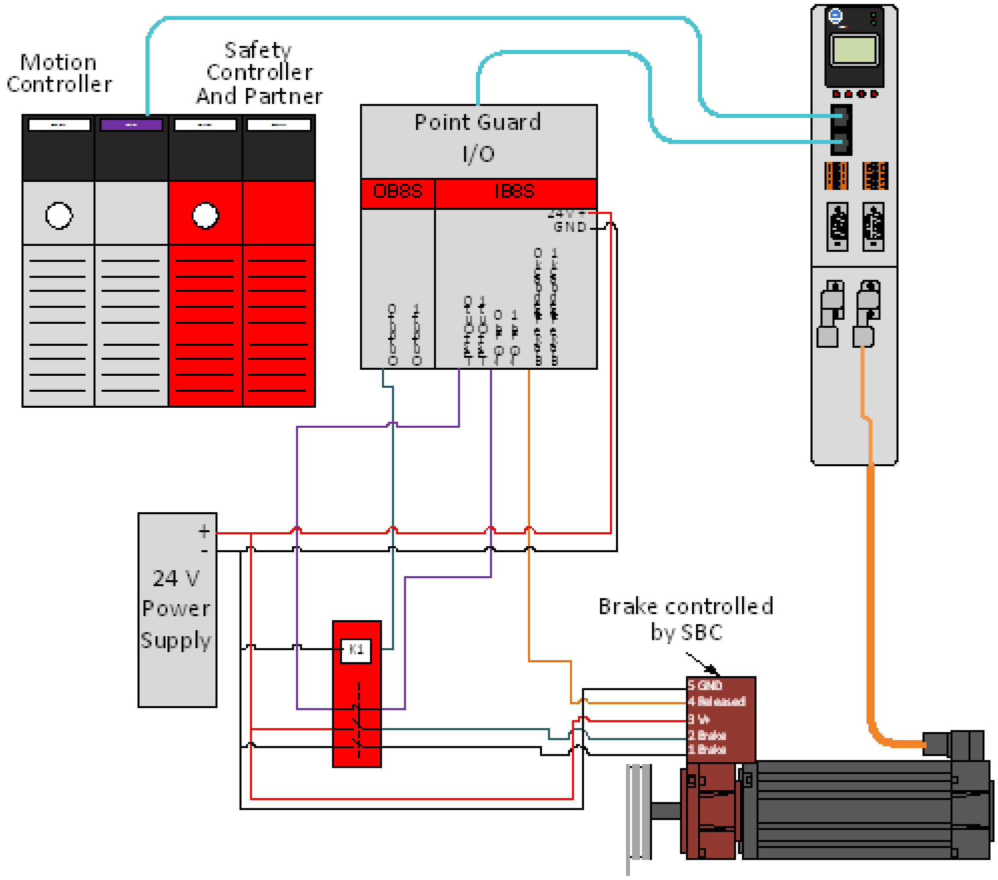
This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safe Brake Control Application

Use Safe Brake Control with safety I/O, and safety contactors, to control the brake and brake timing for STO. The following figure illustrates an application with an external brake mounted to a motor controlled using SBC, a GuardLogix controller, safety I/O, and a safety contactor.



Operands

IMPORTANT	Unexpected operation may occur if: • Output tag operands are overwritten. • Members of a structure operand are overwritten. • Structure operands are shared by multiple instructions.

ATTENTION: The SBC Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides operands used for configuring the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFE_BRAKE_CONTROL	tag	Data structure required for proper operation of instruction.

Operand	Data Type	Format	Description
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when he Request has been removed and no fault is present [FP]= OFF(0). Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in applications where it is determined that no unsafe conditions occur from its use.
Brake Feedback Check Delay	INT	immediate tag	Brake Feedback is continuously monitored during instruction execution. When the brake outputs change state the brake feedback 1 and 2 must change to the opposite state within the Brake Feedback Check Delay or the SBC instruction will fault. Range: 5 to 2000 Units: milliseconds **Tip:** When STO to SBC delay <= 0, then Brake Feedback Check delay must be ≤ (STO to SBC delay)|.
STO to SBC Delay	INT	immediate tag	Instruction operand that determines the delay between TOR (Torque Off Request) and SBC. For positive values the TOR output is asserted ON(1) followed by BO1 and BO2 outputs asserted OFF(0) after the delay. For negative values the order is reversed, BO1 and BO2 outputs are asserted OFF(0) followed by TOR ON(1) after the delay. Range: -32768 to 32767 Units: milliseconds **ATTENTION:** For applications where vertical loads are supported you must ensure that the STO to SBC Delay is a negative value and that the magnitude of the value is greater (longer) than the mechanical brake engage time. **Tip**: For negative values of STO to SBC Delay you must make the delay time longer than the Brake Feedback Check Delay to avoid an Invalid Configuration Fault.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Brake Feedback 1	BOOL	tag	When the brake outputs B01 and B02 transition from ON(1) to OFF(0) or vice versa and the SBC rung-condition-in is true, this input must transition to opposite state of Brake Output within the Brake Feedback Check Delay Time. Once the Brake Check Delay has expired this input must remain in the opposite state. If these conditions are not met the SBC instruction will fault.
Brake Feedback 2	BOOL	tag	When the brake outputs B01 and B02 transition from ON(1) to OFF(0) or vice versa and the SBC rung-condition-in is true, this input must transition to the opposite state of Brake Output within the Brake Feedback Check Delay Time. Once the Brake Check Delay has expired this input must remain in the opposite state. If these conditions are not met the SBC instruction will fault.
Input Status	BOOL	tag	This operand monitors the status of the I/O providing inputs Brake Feedback 1 and Brake Feedback 2 signals to this instruction. This input must be ON(1) while the instruction is enabled.
Output Status	BOOL	tag	This operand monitors the status of the I/O providing physical outputs for (B01) Brake Output 1 and (B02) Brake Output 2 from this instruction. This input must be ON(1) while the instruction is enabled.
Brake Engage L	BOOL	tag	This operand engages the brake. ON(1): Inactive state. Allows the SBC function to reset according to the Restart Type. OFF(0): Engages the brake by setting B01 and B02 OFF(0) according to the STO to SBC Delay. When Brake Engage L Transitions from ON(1) to OFF(0) the STO to SBC delay timer is started.
Reset[1]	BOOL	tag	This operand resets the SBC function. An OFF(0) to ON(1) transition resets the SBC function and Fault Present (FP) provided the Brake Engage L is ON(1) and fault conditions are not present. The Reset Required (RR) output indicates when a reset is required to reset the function.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename 'Reset Signal' tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table explains instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	**Data Type**	**Description**

Brake Output 1 [BO1]	BOOL	An active low redundant brake control output.
		ON(1): Brake Output 1 Release Brake
		OFF(0): Brake Output 1 Engage Brake
		• The rung-condition-in is false
		• An instruction fault occurs
		• The instruction restarts and:
		  • STO to SBC delay is >= 0 and Brake Engage transitions from ON(1) to OFF(0).
		  • STO to SBC delay is <0 and Brake Engage L transitions from ON(1) to OFF(0) and the STO to SBC timer expires.

Brake Output 2 [BO2]	BOOL	An active low redundant brake control output.
		ON(1): Brake Output 2 Release Brake
		OFF(0): Brake Output 2 Engage Brake
		• The rung-condition-in is false
		• An instruction fault has occurs
		• The instruction has restarts and:
		  • STO to SBC delay is > 0 and Brake Engage transitions from ON(1) to OFF(0).
		  • STO to SBC delay is < 0 and Brake Engage L transitions from ON(1) to OFF(0) and the STO to SBC expires.

Torque Off Request [TOR]	BOOL	This output is used as an activation source for Safe Torque Off.
		ON(1): TOR request
		• When STO to SBC delay is > 0, TOR transitions to ON(1) immediately after the input Engage Brake L transitions from ON(1) to OFF(0)
		• When STO to SBC delay is < 0 TOR transitions to ON(1) when:
		  • Engage Brake transitions from ON(1) to OFF(0) and
		  • The STO to SBC delay timer expires.
		  • There are no faults for the SBC function.
		OFF(0): SBC function resets.

Reset Required [RR]	BOOL	ON(1): Perform a reset to restart the instruction and/or clear faults. OFF (0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF (0): The instruction is operating normally.
Fault Type	SINT	Indicates the type of fault. See the Fault Codes and Corrective Actions section for specific codes and actions.
Diagnostic Code	SINT	Indicates information about the cause of a fault. See the Diagnostic Codes and Corrective Actions section for specific codes and actions.

This table explains instructions outputs that are written to the user-specified tag.

Operand	**Data Type**	**Format**	**Description**
SBC Active	BOOL	tag	The SBC instruction writes the SBC Active status to this tag. OFF(0): SBC function is not active ON(1): SBC function is active **Tip:** Assign the SBC Active operand to the SBC Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

Operand	Data Type	Format	Description
Brake Engaged	BOOL	tag	The SBC instruction writes the brake status to this tag: OFF(0): Brake released ON(1): Brake engaged **Tip:** Assign the SBC Active operand to the SBC Brake Engaged member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SBC Integrity	BOOL	tag	The SBC instruction writes the SBC brake status to this tag. SBC Integrity indicates that the SBC instruction is operating with no faults detected. OFF(0): SBC fault. The brake status, released or engaged, is undetermined. ON(1): No faults detected. **Tip:** Assigned this tag to the SBC Integrity member of the safety output tag structure corresponding to the safety instance of the drive module. The corresponding Axis Safety Status RA updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Ladder Diagram

Condition/State	Action Taken
Prescan	Outputs are initialized as: Brake Output 1 [BO1]: OFF(0) Brake Output 2 [BO2]: OFF(0) Torque Off Request [TOR]: OFF(0) SBC Active: OFF(0) Brake Engaged: ON(1) Fault Present [FP]: OFF(0) Reset Required [RR]: OFF(0) Fault Type: 1 Diagnostic Code: 0 SBC Integrity: OFF(0)
Rung-condition-in is false	.BO1, .BO2, .TOR, .RR and .FP are cleared OFF(0) If an instruction fault is present when the rung goes false, the fault condition remains and the diagnostic code appears
Rung-condition-in is true	The instruction executes.
Postscan	N/A

Operation

The SBC instruction is used to control and monitor a mechanical brake. Timing between Safe Torque Off and brake operation is controlled by STO to SBC delay, which may be either positive or negative. Two timing cases showing STO to SBC delay > 0, and STO to SBC delay =<0 are illustrated in the sections that follow.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SBC function:

SBC Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tag
SBC Active	module[1]:SO.SBCActive[instance[2]]	updates tag	axis[3].SBCActiveStatus
Brake Engaged	module[1]:SO.SBCBrakeEngaged[instance[2]]	updates tag	axis[3].SBCEngagedStatus
SBC Integrity	module[1]:SO.SBCIntegrity[instance[2]]	updates tag	axis[3].SafeBrakeIntegrityStatus

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

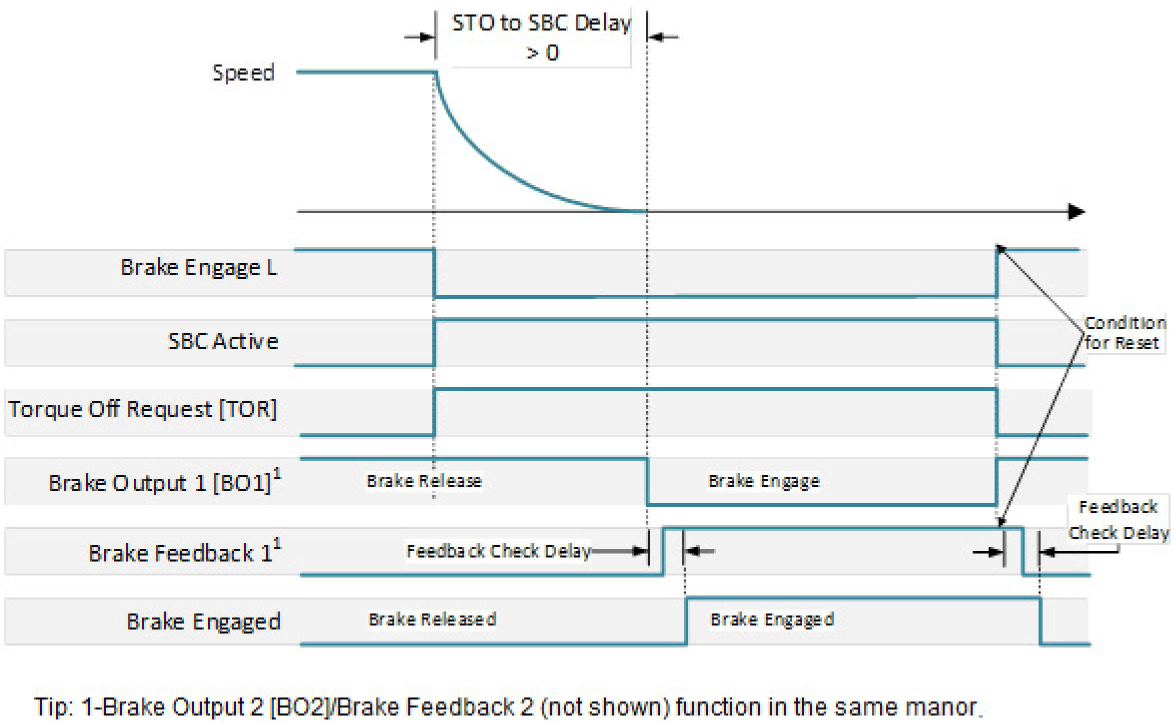
[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

When assigning the SBC Active, Brake Engaged and SBC Integrity instruction outputs to the motion safety instance pass-through tags, the corresponding axis tags automatically update in the motion controller. The motion control task of motion controller reads the axis tags to coordinate operation between the safety task and motion task.

Normal Operation, STO to SBC Delay > 0, Automatic Restart

When the STO to SBC delay is > 0 Category 0 stopping is typically used. With Category 0 stopping, torque is removed from the motor first and then, after the STO to SBC Delay, the brake is applied. In this case the motor coasts before the brake is applied. Typically Torque Off Request output is used within a safety application to initiate the STO function in a drive safety instance. The STO function in the drive will immediately remove torque from the motor without motion coordination. SBC Active and Brake Engaged are passed from the drive safety instance to the drive Axis Safety Status tag so that the motion controller responds accordingly.

SBC operation is described as follows. Assuming the SBC function has been reset, the SBC function becomes active when Brake Engage L input is cleared OFF(0). Upon Brake Engage L cleared OFF(0), SBC active and Torque Off Request are set ON(1). At the same time, the STO to SBC delay timer is started. The STO to SBC delay allows the motor to coast before Brake Output 1 and Brake Output 2 are cleared OFF(0). Whenever the Brake Outputs 1 and 2 change state, the feedback check delay timer is started. When the feedback check delay timer expires, the Brake Feedback 1 and 2 inputs are monitored and must be at and remain at the opposite state of the Brake Outputs. When the Brake Outputs are OFF(0) and the Brake feedback is ON(1), the Brake Engaged Signal is set ON(1) after Feedback Check Delay. With automatic restart, shown in the diagram below, the SBC function is restarted and ready for subsequent operation if it is not faulted and the Brake Engage L input returns to the inactive state ON(1).

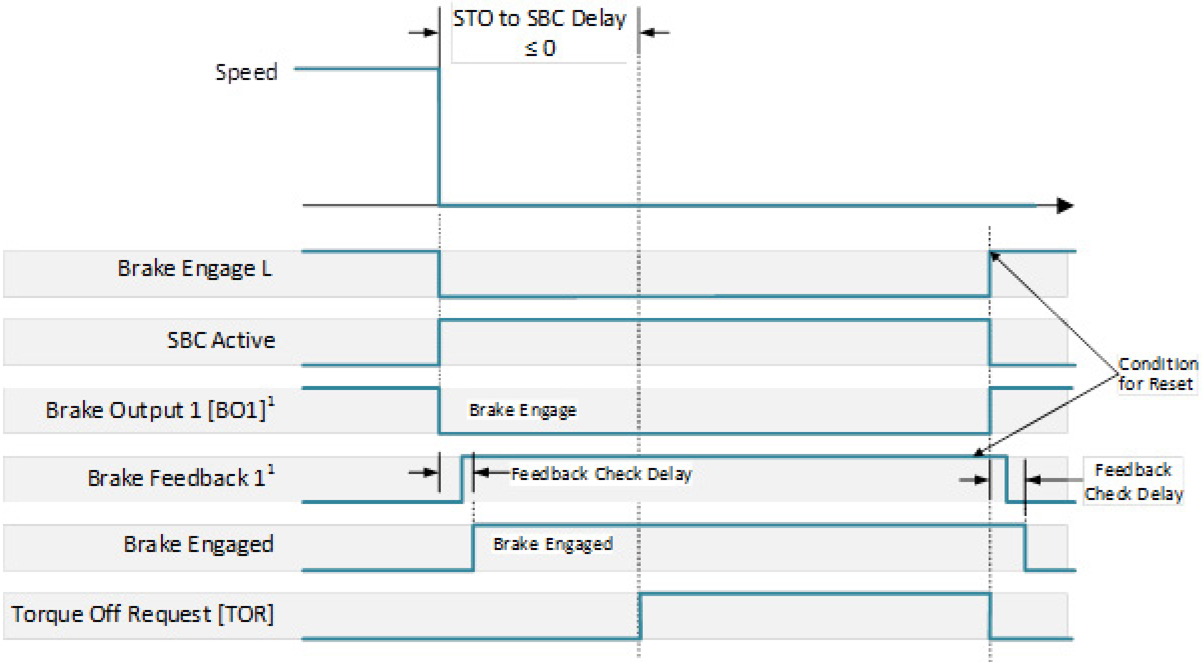


Normal Operation, STO to SBC Delay ≤ 0, Automatic Restart

When the STO to SBC delay is ≤ 0 typically the application will be using category 2 stopping. With category 2 stopping the motor is brought to a controlled stop, then actively held at standstill. With the motor held at standstill, SBC is activated, applying the brake first then after the STO to SBC delay, torque is removed. Torque is removed by use of the Torque Off Request output to initiate STO in the safety instance of a drive according to the particular Logix safety application. The SBC Active, SBC Integrity, and Brake Engaged outputs of the SBC instruction are sent to the drive safety instance, and then the associated axis status tag is updated. The motion controller application then reads the updated axis status tag and takes any required actions for the application.

SBC operation with STO to SBC Delay ≤ 0 is described as follows. After the SBC function has been Reset, the SBC function begins when Brake Engage L is cleared OFF(0). Upon Brake Engage L OFF(0), the brake outputs, BO1 and BO2 are cleared OFF(0) and SBC active is set ON(1). At the same time the STO to SBC delay timer is started. The STO to SBC delay allows the brake to engage before the Torque Off Request is set ON(1). Whenever the Brake Outputs 1 and 2 change state, the feedback check delay timer is started. When the feedback check delay timer expires, the Brake Feedback 1 and 2 inputs are monitored and must be at and remain at the opposite state of the Brake Outputs. When the brake outputs are OFF(0) and the Brake feedback is ON(1), the Brake

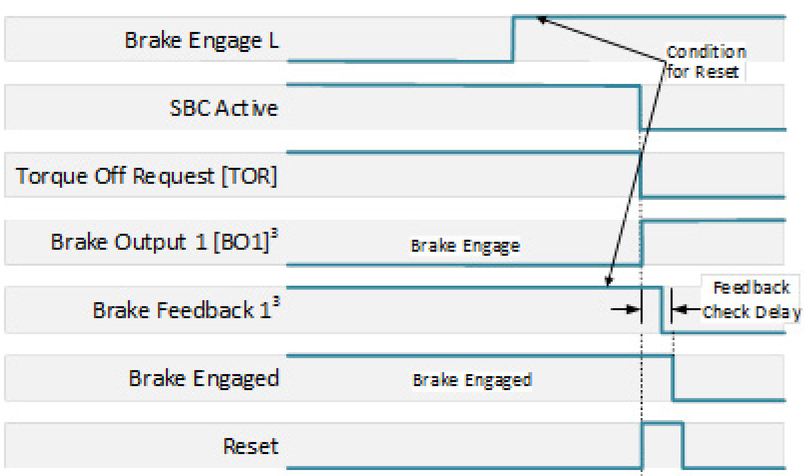
Engaged Signal is set ON(1) after Feedback Check Delay. With automatic restart, shown in the diagram below, the SBC function is reset and ready for subsequent operation if it is not faulted and the Brake Engage L input is set ON(1).



Tip: 1-Brake Output 2 [BO2]/Brake Feedback 2 (not shown) function in the same manor

Manual Restart

When Manual Restart is used, the SBC function is begins operation with the ON(1) to OFF(0) transition of Brake Engage L. The function will be reset if it is not faulted, Brake Engage L is ON(1) and an OFF(0) to ON(1) transition of the Reset input occurs.



Tip: 1-Brake Output 2 [BO2]/Brake Feedback 2 (not shown) function in the same manor.

Cold Start

The SBC function requires manual cold start. When the controller run mode begins the SBC instruction starts with the Brake Outputs OFF(0) and waiting for Reset. The SBC function requires a successful reset in order to release the brake and allow subsequent operation similar to a Manual Restart. For a successful reset the conditions below must be satisfied before Reset makes an OFF(0) to ON(1) transition:

Brake Feedback 1: ON(1)

Brake Feedback 2: ON(1)

Input Status: ON(1)

Output Status: ON(1)

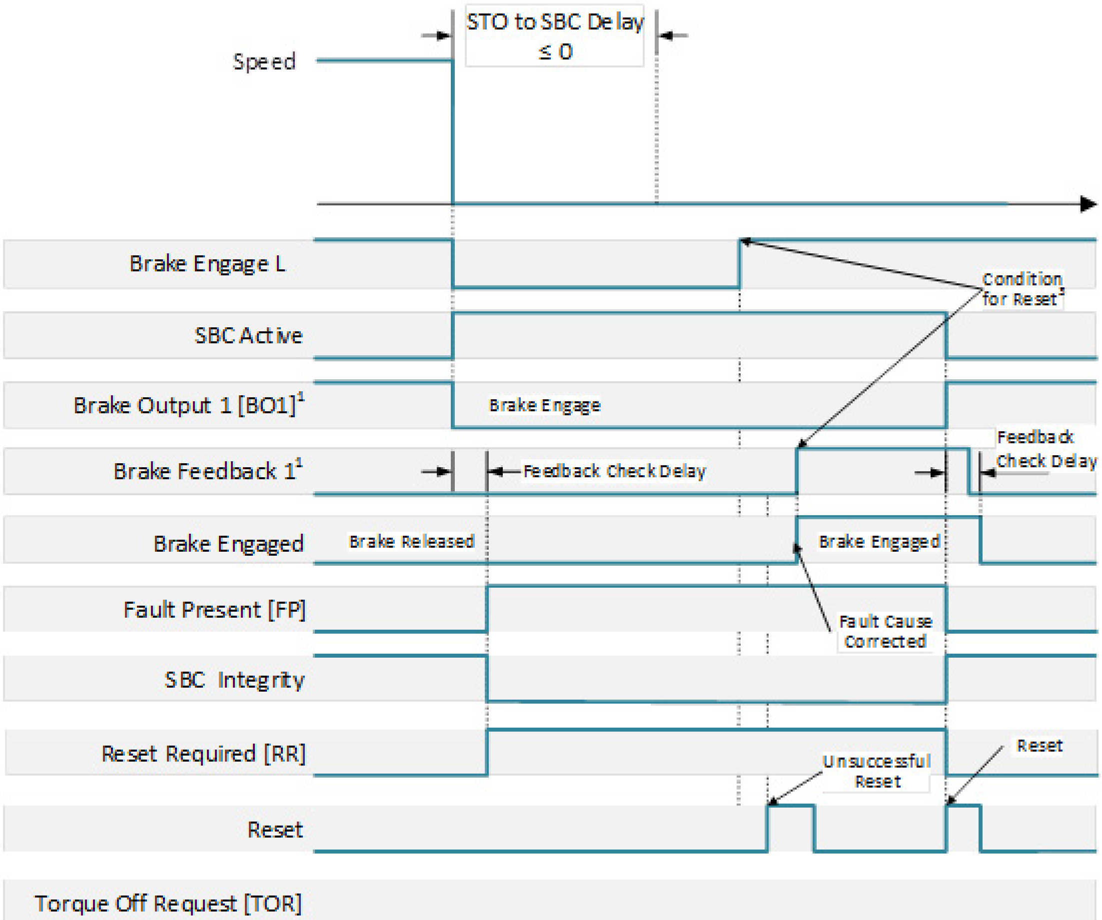
Brake Engage L: ON(1)

Faults and Fault Reset

The SBC instruction monitors the state of the brake feedback and the I/O module status bits continuously when the rung-condition-in is true. Faults are caused by invalid configuration, or by invalid inputs. Any condition that causes the SBC function to fault will clear Brake Output 1 and Brake Output 2 to OFF(0). The Brake Outputs will remain OFF(0) until the fault condition is corrected and the SBC instruction is reset. Torque Off Request Remains in its last state just before the fault.

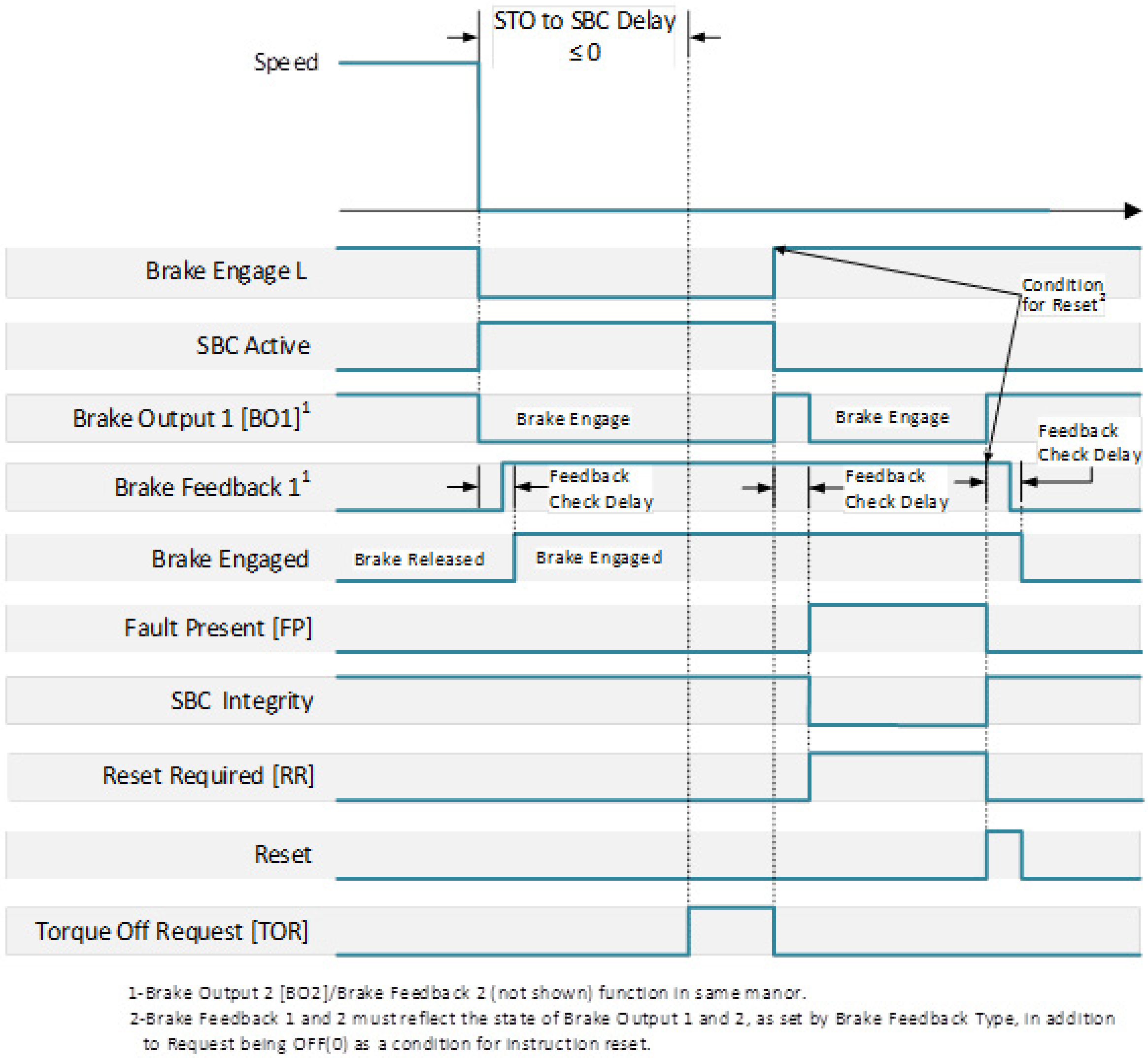
Brake Feedback Faults

Anytime the Brake Outputs, BO1 and BO2 change state the Feedback Check Delay timer is started. When the timer is running, the Brake Feedback signals are ignored. When the timer is no longer running the Brake Feedback 1 and Brake Feedback 2 signals are continuously monitored. The Brake Feedback signals must be in the opposite state of the Brake Output signals, otherwise the SBC function will fault. In the figure below, the Brake Feedback signal did not change to the ON(1) state after the Brake Output 1 changes to the OFF(0) state and the Feedback Check delay expires. This results in a Fault and also clears OFF(0) the SBC Integrity bit. The figure shows an unsuccessful attempt to reset the instruction before the fault condition has been corrected followed by a successful reset after the fault has been corrected. The drive Axis tag, Safe Brake Integrity Status, is cleared when the fault condition is detected. Since the actual state of the brake cannot be determined when the fault is present, the SBC Torque Off Request will not be asserted. The motion task is then able to maintain control of the motor which may be necessary for some applications including those where gravity may cause motion.



1-Brake Output 2 [BO2]/Brake Feedback 2 (not shown) function in same manor.
2-Brake Feedback 1 and 2 must reflect the state of Brake Output 1 and 2, as set by Brake Feedback Type, in addition to Request being OFF(0) as a condition for instruction reset.

If the brake feedback signal or I/O status signals are in the wrong state after the SBC function has been successfully reset then the SBC instruction will fault. The following figure shows the SBC function in Automatic Restart mode being reset initially by Brake Engage L set ON(1). Immediately upon reset the Brake Output 1 and 2 are set ON(1) and the Feedback check delay timer begins. After the timer expires, the Brake Feedback is in the incorrect state and SBC faults. In this case, the cause of the fault needs to be corrected in order for the instruction to not continue to fault after subsequent resets. In the figure, the fault is assumed to be corrected and does not fault again after the Reset OFF(0) to ON(1) transition and the final check delay time expires. For the case shown in the figure the fault indicates that the brake may have stayed engaged when it was supposed to be released. The SBC integrity is cleared to OFF(0) which will be reflected in the Axis tag, Safe Brake Integrity Status. This allows the motion task to keep the axis at standstill until the fault is corrected to avoid possible damage to system mechanical components.



Fault Codes and Corrective Actions

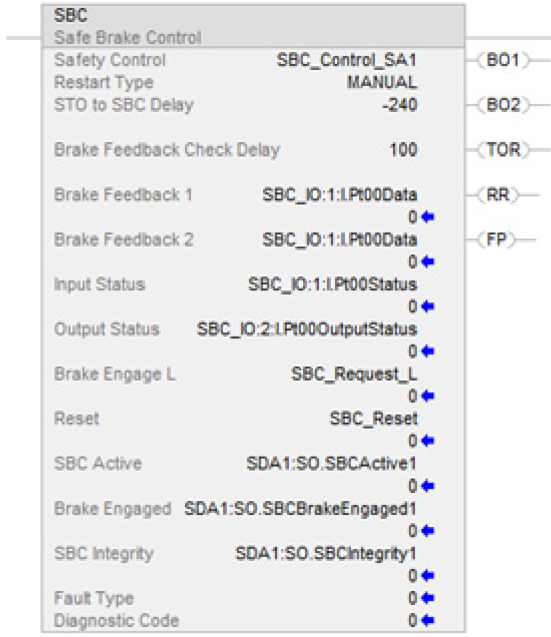
Fault Code	Description	Corrective Action
1	No Fault	None.
2	Invalid Configuration Fault	• Check the input values and correct out of range values. Check the diagnostic code for more information • Reset the fault.
101	Brake Feedback Fault	• Check the brake power, power wiring, safety contactor and or Brake Feedback wiring and correct any inconsistencies. • Ensure that the Brake Feedback Check delay is long enough for the Brake Feedback to settle to its final state after setting or releasing the brake. • Reset the fault.

Fault Code	Description	Corrective Action
102	Restart Attempt before Brake Engaged Fault	• If SBC is delayed meaning STO to SBC delay is positive, and the delay timer is running, then SBC cannot be restarted until after the brake has been engaged. Check the timing of events in your program.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information available.	None.
10	Rung went false while instruction was executing.	Make sure this instruction is enabled.
20	Brake Feedback Check Delay value not valid.	Check the speed scaling value.
22	The magnitude of the STO to SBC Delay value is less than Brake Feedback Check Delay (Only when STO to SBC Delay is less than 0).	Increase the Brake Feedback Check Delay, or make the STO to SBC Delay value longer.
101	Input Status input transitioned from ON (1) to OFF (0) while rung was true.	Check wiring to safety contactor.
102	Output Status input transitioned from ON (1) to OFF (0) while rung was true.	Check wiring to safety contactor.
103	Brake Feedback 1 and Brake Feedback 2 turned OFF (0) unexpectedly.	Check brake power and wiring.
104	Brake Feedback 1 turned OFF (0) unexpectedly.	Check brake power and wiring.
105	Brake Feedback 2 turned OFF (0) unexpectedly.	Check brake power and wiring.
106	Brake Feedback 1 and Brake Feedback 2 turned ON (1) unexpectedly.	Check brake power and wiring.
107	Brake Feedback 1 turned ON (1) unexpectedly.	Check brake power and wiring.
108	Brake Feedback 2 turned ON (1) unexpectedly.	Check brake power and wiring.
109	Brake Feedback 1 and Brake Feedback 2 did not turn ON (1) within the Brake Feedback Check Delay.	Check brake power and wiring.
110	Brake Feedback 1 did not turn ON (1) within the Brake Feedback Check Delay.	Check brake power and wiring.
111	Brake Feedback 2 did not turn ON (1) within the Brake Feedback Check Delay.	Check brake power and wiring.
112	Brake Feedback 1 and Brake Feedback 2 did not turn OFF (0) within the Brake Feedback Check Delay.	Check brake power and wiring.
113	Brake Feedback 1 did not turn OFF (0) within the Brake Feedback Check Delay.	Check brake power and wiring.
114	Brake Feedback 2 did not turn OFF (0) within the Brake Feedback Check Delay.	Check brake power and wiring.

Example



See also

Drive Safety Instructions on page 361

Index Through Arrays on page 540

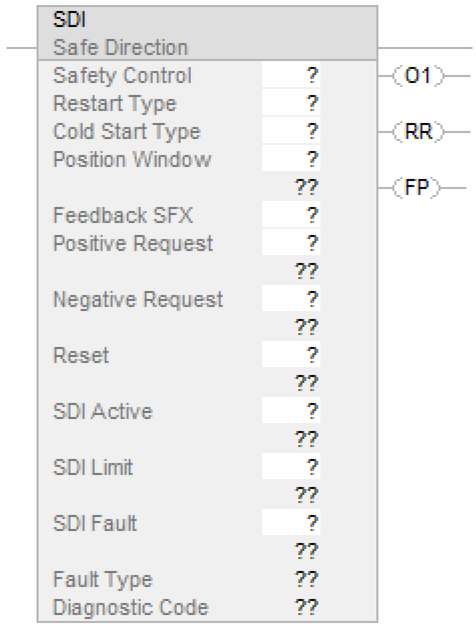
Safe Direction (SDI)

This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safe Direction instruction monitors position of a motor or axis to detect movement of more than a defined amount in the unintended direction.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safe Direction Application

Safe Direction is used with a CIP safety drive that supplies position of a motor or axis and a Safe Feedback Interface (SFX) instruction to scale the feedback. During operation, the SDI instruction signals when the motor moves in the unintended direction more than a specified limit. The output is used to initiate an application specific action such as SS1, SS2 or STO.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The SDI Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used for configuring the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFE_DIRECTION	tag	Data structure required for proper operation of instruction.
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when the Request has been removed and no fault is present [FP] = OFF (0). Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in applications where it is determined that no unsafe conditions occur from its use.
Cold Start Type		list item	This input selects the behavior when applying controller power or a controller mode change to Run. **MANUAL (0)** A 0 to 1 transition of the Reset input is required with the Request removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction resets when the Request has been removed.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Position Window	REAL	immediate tag	This operand sets the amount of incremental movement allowed in the unintended direction before faulting. Range: Any REAL value greater than zero.
Feedback SFX	SAFETY_FEEDBACK_INTERFACE	tag	This operand provides position data. Assign this operand to the SFX Safety Control tag that is used by this SDI instruction. The following members of the SFX Safety Control tag are used: FeedbackSFX.FeedbackPosition Units: Feedback Counts FeedbackSFX.PositionScalingOut Units: Feedback Counts / Position Unit
Positive Request	BOOL	tag	This operand enables the SDI function to begin checking for unintended positive motion. ON(1): Begins positive motion checking. OFF(0): Allows function reset according to Restart Type
Negative Request	BOOL	tag	This operand enables the SDI function to begin checking for unintended negative motion. ON(1): Begins negative motion checking. OFF(0): Allows function reset according to Restart Type

Operand	Data Type	Format	Description
Reset[1]	BOOL	tag	This operand resets the SDI function. An OFF(0) to ON(1) transition resets the SDI function and Fault Present [FP] provided the Request is OFF(0) and any fault condition has been removed. The Reset Required [RR] output indicates when a reset is required to reset the function.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename the Reset Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table explains instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1): Indicates the instruction is executing and the function is not faulted. OFF(0): Any of the conditions below: • The rung in condition is no longer true • An instruction fault has occurred
Reset Required [RR]	BOOL	ON(1): Indicates that an Reset is required to restart the instruction and or to clear faults. See Reset Input for Reset sequence. OFF(0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.
Diagnostic Code	SINT	This output indicates the diagnostic status of the instruction. See Diagnostic Codes and Corrective Actions for specific codes and actions.
Fault Type	SINT	This output indicates the type of fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.

This table explains instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
SDI Active	BOOL	tag	The SDI instruction writes the SDI Active status to this tag. OFF(0): SDI not active ON(1): SDI active **Tip:** Assign the SDI Active operand to the SDI Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

Operand	Data Type	Format	Description
SDI Limit	BOOL	tag	The SDI instruction writes the SDI Limit status to this tag OFF(0): Axis movement is in the safe direction. ON(1): Axis movement in the unintended direction occurred. **Tip:** Assign the SDI Limit operand to the SDI Limit member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SDI Fault	BOOL	tag	The SDI instruction writes the SDI Fault status to this tag OFF(0): Not faulted ON(1): Faulted SDI Fault is set ON (1) for the following fault types and corresponding conditions: • Configuration Fault An instruction input operand value is out of range. • SFX Instruction Not Ready Fault The feedback used for monitoring is not valid or the SFX instruction is not running when SDI is requested. **Tip:** Assign the SDI fault operand to the SDI Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults tag updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .01, .FP, .RR, .SDIActive, .SDILimit, and .SDIFault outputs are cleared to OFF(0). The Diagnostic Code output is set to 0. The Fault Type output is set to 1

Condition/State	Action Taken
Rung-condition-in is false	The .O1, .SDIActive, and .SDILimit are cleared to OFF(0). If an instruction fault is present when rung went false the fault condition will be maintained and Diagnostic Code displayed.
Rung-condition-in is true	The instruction executes.
Postscan	N/A

Operation

Normal Operation

The SDI function begins if it has been previously reset and the Positive Request input or the Negative Request Input is asserted ON(1). At this point the current position is captured. If there is movement in the unintended direction beyond the position window limit relative to the current position, then the corresponding Limit output is set. If there is movement in the allowed direction that is greater than the captured position then the captured position is updated according to the extent of movement in the allowed direction. Once a limit output is set it remains set until the SDI function is reset.

All position values used in the SDI instruction are in Position Units A position unit is user defined according to the particular application and is configured in the SFX instruction.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SDI function:

SDI Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tag
SDI Active	module[1]:SO.SDIActive[instance[2]]	updates tag	axis[3].SDIActiveStatus
SDI Limit	module[1]:SO.SDILimit[instance[2]]	updates tag	axis[3].SDILimitStatus
SDI Fault	module[1]:SO.SDIFault[instance[2]]	updates tag	axis[3].SDIFault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

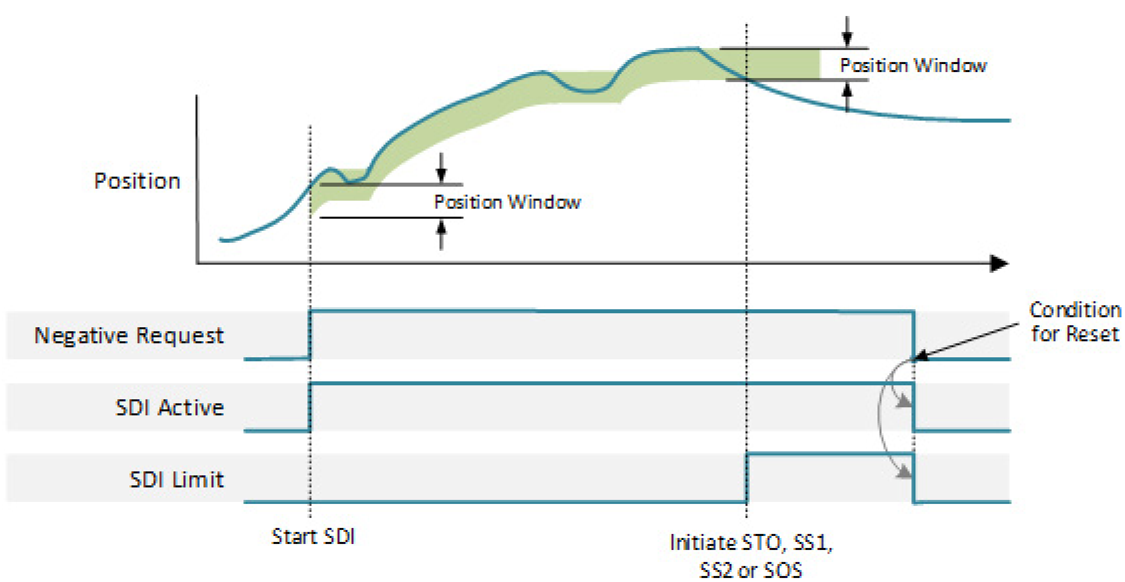
[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

When assigning the SDI Active, SDI Limit and SDI Fault instruction outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status and Axis Safety Faults tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task. The following is a typical sequence of events:

1. The safety application receives an input to prevent axis movement in the negative travel direction.
2. The safety application sets Negative Request input ON(1) to request the SDI function.
3. SDI instruction sets the SDI Active output and writes the module:SO.SDIActive[instance] tag of the motion safety instance in the drive.
4. The motion safety instance in the drive updates the Axis Safety Status tag read in the motion controller.
5. The motion application continues operating the axis with movement in the positive travel direction only.

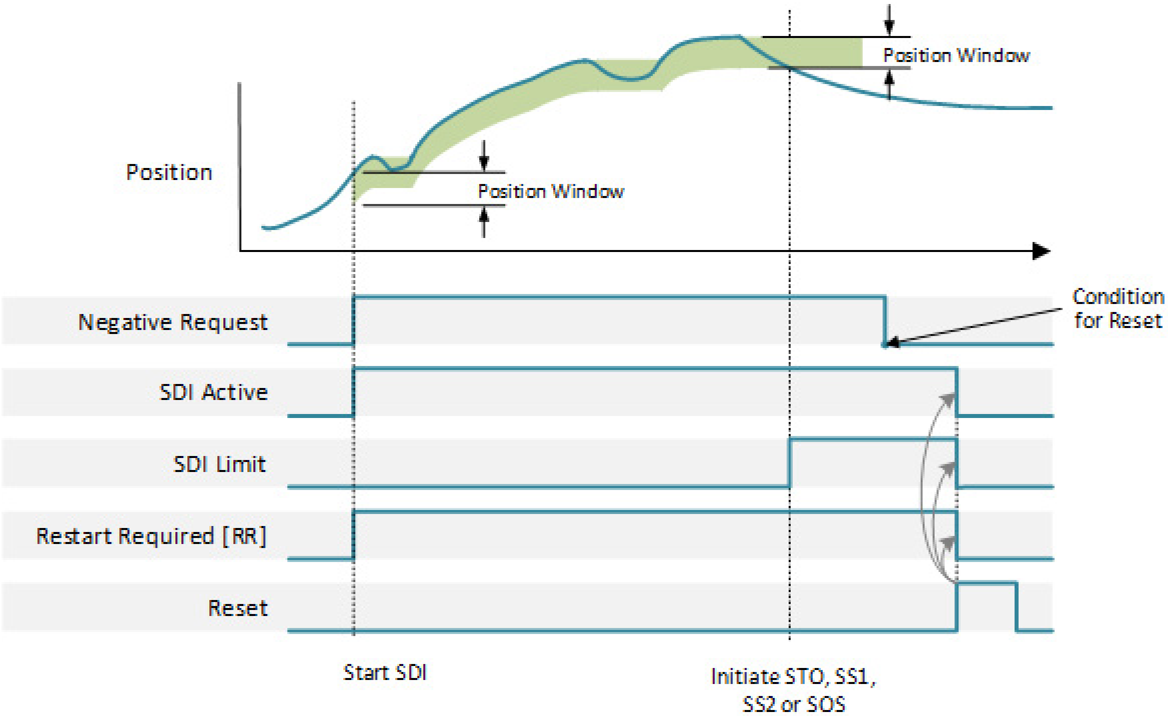
Normal Operation, Automatic Restart

The following diagram shows normal operation with Automatic Restart. Once Negative Request is asserted ON(1) the SDI function operates. If the incremental position moves in the negative direction a distance greater than the Position Window then the SDI Limit is set. Once the SDI limit is set the function must be reset by removing the Negative Request OFF(0).



Normal Operation, Manual Restart

When manual restart is configured, the SDI function must be reset before subsequent operation. The Reset Required output indicates that the Reset input must make an OFF(0) to ON(1) transition to reset the instruction after the Request input is removed OFF(0). The following diagram shows normal operation with manual restart.



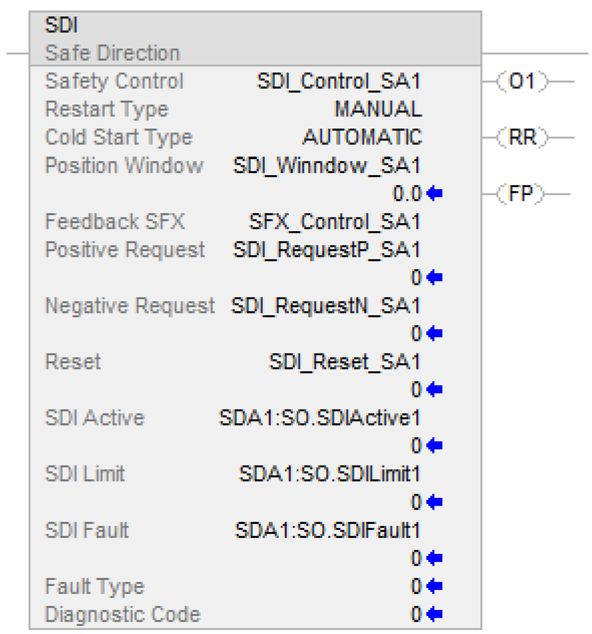
Fault Codes and Corrective Actions

Fault Code	Description	Corrective Action
1	No Fault	None
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
101	Position Window Calculation Overflow Fault. The Position Scaling from the Feedback SFX tag multiplied by the Position Window exceeds (2^31 – 1)	• Ensure that the SFX instruction that supplies inputs to this SDI instruction has correct values. • Use a smaller Position Window value.
102	SFX Instruction Not Ready Fault	Ensure that the SFX instruction that supplies inputs to this SDI instruction is executing and not faulted before requesting SDI.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information	None
10	Rung went false while the SDI function was executing.	Make sure this instruction is enabled.
15	Both the Negative Request input and Positive Request input were in the ON(1) state in the same scan.	Only checking for movement in either positive or negative direction is allowed at the same time.
20	Position Window value not valid.	Position window must be a positive value
21	Limit exceeded in the positive direction	• Ensure movement is only in the negative direction • Decrease the position window
22	Limit exceeded in the negative direction.	• Ensure movement is only in the positive direction • Increase the position window

Example



See also

Index Through Arrays on page 540

Drive Safety Instructions on page 361

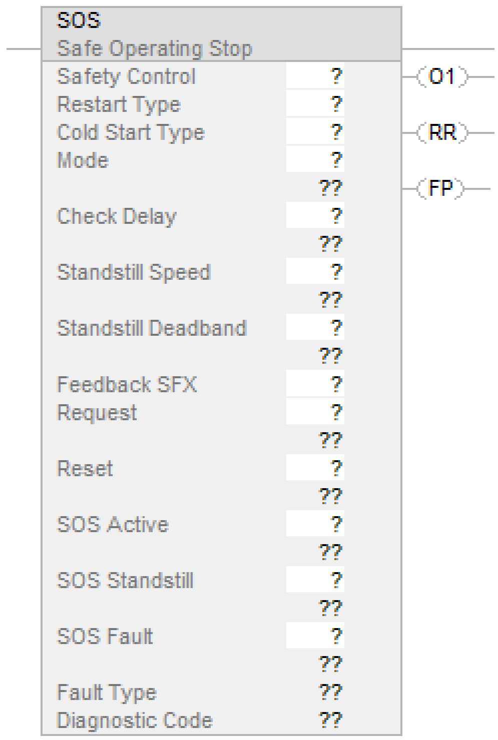
Safe Operating Stop (SOS)

This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safe Operating Stop instruction monitors the speed or position of a motor or axis to ensure the deviation from standstill speed or position, is not more than a defined amount.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safe Operating Stop Application

Safe Operating Stop is used with a CIP safety drive that supplies the speed and position of a motor or axis and a Safe Feedback Interface (SFX) instruction to scale the feedback. During operation, the SOS instruction signals with the SOS Standstill output when the motor speed is at or below the Standstill Speed or position, depending on the Mode input.

Operands

IMPORTANT Unexpected operation may occur if:
- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The SOS Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides operands used for configuring the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFE_OPERATING_STOP	tag	Data structure required for proper operation of instruction.
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when the Request has been removed and no fault is present [FP] = OFF(0). Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in applications where it is determined that no unsafe conditions occur from its use.
Cold Start Type		list item	This input selects the behavior when applying controller power or a controller mode change to Run. **MANUAL (0)** A 0 to 1 transition of the Reset input is required with the Request removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction resets when the Request has been removed.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Mode	SINT	immediate tag	This operand selects speed or position checking Range: 1 or 2. 1: Position Check 2: Speed Check
Check Delay	INT	immediate tag	This operand defines the delay time between the SOS function request and the start of standstill monitoring. Range: 0 to 32767 Units: milliseconds (Ms)

Operand	Data Type	Format	Description
Standstill Speed	REAL	immediate tag	This input sets the maximum speed that is allowed before the instruction will fault after Check Delay expires. Range: >= 0
Standstill Deadband	REAL	immediate tag	This operand sets the maximum incremental deviation from the position that is captures at the expiration of Check Delay. If the maximum deviation is exceeded then this instruction will fault. Range: >= 0
Feedback SFX	SAFETY_FEEDBACK_INTERFACE	tag	This operand provides position and velocity data. Assign this operand to the SFX instruction Safety Control tag that is used by the SOS instruction. The following members of the SFX Safety Control tag are used: FeedbackSFX.FeedbackPosition Units: Feedback Counts FeedbackSFX.ActualSpeed Units: Postion Unit / Time Unit FeedbackSFX.PositionScalingOut Units: Feedback Counts / Position Unit
Request	BOOL	tag	This operand enables the SOS function. ON(1): allows SOS function to begin monitoring. OFF(0): allows function reset according to Restart Type
Reset[1]	BOOL	tag	This operand resets the SOS function. An OFF(0) to ON(1) transition resets the SOS function and Fault Present [FP] provided the Request is OFF(0) and any fault condition has been removed. The Reset Required [RR] output indicates when a reset is required to reset the function.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename the Reset Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table explains instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1): Indicates the instruction is executing and the function is not faulted. OFF(0): One of the following occurs: • The rung in condition is no longer true • An instruction fault has occurred
Reset Required [RR]	BOOL	ON(1): Indicates that an Reset is required to restart the instruction and or to clear faults. See Reset Input for Reset sequence. OFF(0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.

Operand	Data Type	Description
Diagnostic Code	SINT	This output indicates the diagnostic status of the instruction. See Diagnostic Codes and Corrective Actions for specific codes and actions.
Fault Type	SINT	This output indicates the type of fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.
Check Delay Active	BOOL	ON(1): Indicates that Check Delay timer is active.
Standstill Set Point	REAL	This output shows the position that was captured at the end of the Check Delay period. This position is the standstill position used in Position Check Mode.

This table explains instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
SOS Active	BOOL	tag	The SOS instruction writes the SOS Active status to this tag. OFF(0): SOS not active ON(1): SOS active **Tip:** Assign the SOS Active operand to the SOS Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SOS Standstill	BOOL	tag	The SOS instruction writes the SOS Standstill status to this tag. OFF(0): Speed or position not at standstill. ON(1): Speed or position is within standstill limits. **Tip:** Assign the SOS Standstill operand to the SOS Standstill member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SOS Fault	BOOL	tag	The SOS instruction writes the SOS Fault status to this tag. OFF(0): Not Faulted ON(1): Faulted SOS Fault bit to be set to ON (1) state for the following fault type and corresponding condition: • Configuration Fault An instruction input operand value is out of range. • Standstill Position Fault Standstill deadband was exceeded while monitoring. • Standstill Speed Fault Standstill speed limit was exceeded while monitoring. • SFX Instruction Not Ready Fault The feedback used for monitoring is not valid or the SFX instruction is not running when SOS is requested. **Tip:** Assign the SOS Fault operand to the SOS Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults tag updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .O1, .FP, .RR, .SOSActive, .SOSStandstill, .SOSFault, and .CheckDelayActive outputs are cleared to OFF(0). The Diagnostic Code output is set to 0. The Fault Type output is set to 1
Rung-condition-in is false	The .O1, .SOSActive, .SOSStandstill, and .CheckDelayActive outputs are cleared to OFF(0). If an instruction fault is present when rung went false the fault condition will be maintained and Diagnostic Code displayed.
Rung-condition-in is true	The instruction executes.
Postscan	N/A

Operation

Normal Operation

The SOS function begins if it has been previously reset and the Request input is asserted ON(1). At this point the Check Delay Timer begins. When the Check Delay Timer expires Standstill monitoring begins. When the timer expires the current position is captured. The speed or position, provided by an SFX instruction, is compared to the Standstill Speed or Position Deadband according to the Mode. If the speed of the monitored axis exceeds the limit then the SOS function will Fault. After the Check Delay Timer expires and the function is not faulted, the Standstill output is set ON(1).

Position values used in the SOS instruction are in Position Units. Speed values used in the SOS instruction are in Position Units / Time Unit. A position unit is user defined according to the particular application and is configured in the SFX instruction. Time units are also configured in the SFX instruction and may be selected as seconds or minutes.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SOS function:

SOS Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tag
SOS Active	module[1]:SO.SOSActive[instance[2]]	updates tag	axis[3].SOSActiveStatus
SOS Standstill	module[1]:SO.SOSStandstill[instance[2]]	updates tag	axis[3].SOSStandstillStatus
SOS Fault	module[1]:SO.SOSFault[instance[2]]	updates tag	axis[3].SOSFault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

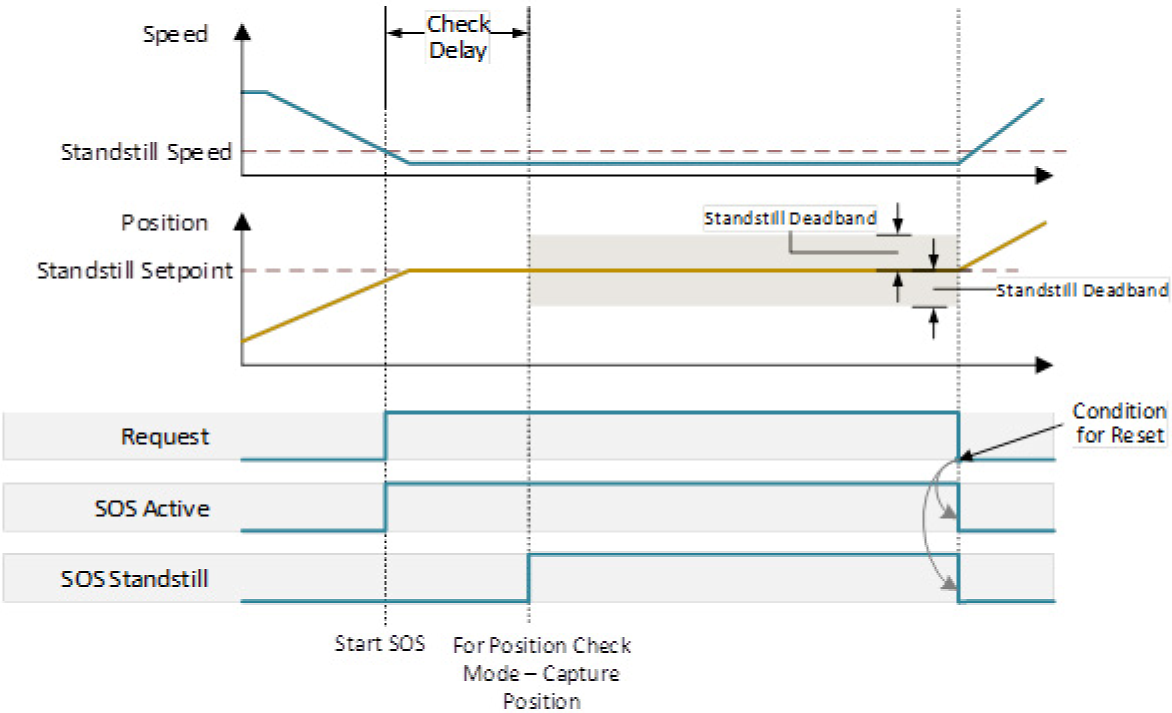
[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

When assigning the SOS Active, SOS Standstill and SOS Fault outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status and Axis Safety Faults tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task. The following is a typical sequence of events:

1. The safety application receives an input to hold an axis at standstill.
2. The Safety application sets the Request input ON(1) to request the SOS function.
3. The SOS instruction sets SOS Active output and writes the module:SO.SOSActive[instance] tag of the motion safety instance in the drive.
4. The motion safety instance in the drive updates the Axis Safety Status tag read in the motion controller.
5. The motion application stops the axis motion and holds the position or speed at zero
6. When the SOS function detects SOS Standstill the SOS instruction writes module:SO.SOSStandstill[instance] tag of the motion safety instance of the drive.
7. The motion application reads the Axis Safety Status tags and continues to hold the position or maintain zero speed.

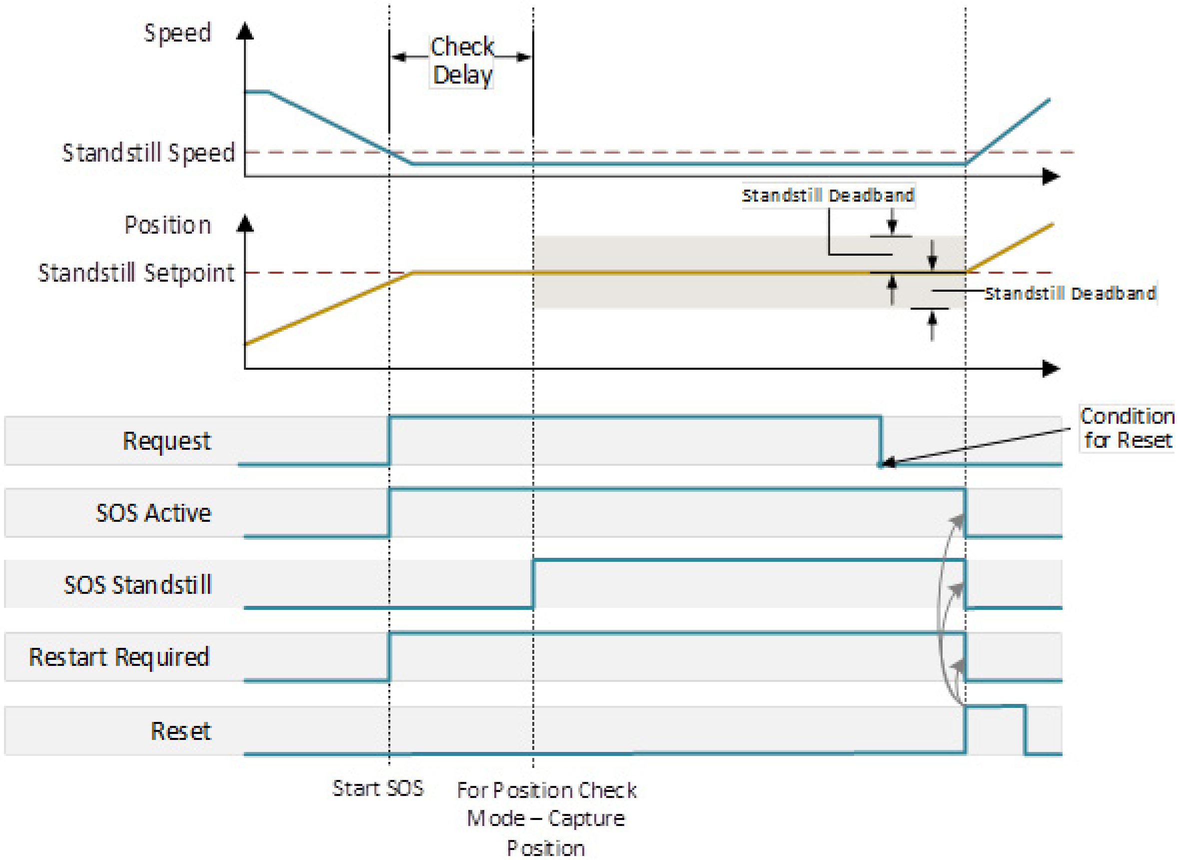
Normal Operation, Automatic Restart

The following diagram shows Normal operation with Automatic Restart. After Check Delay expires the speed must stay below the Standstill Speed when in Speed Check mode and if in Position Check mode the Position must not deviate from the position captured at the end of the Check Delay Time by more than the Standstill Deadband. For automatic restart operation, the SOS function is reset when the Request is removed, OFF(0), provided no SOS faults have occurred.



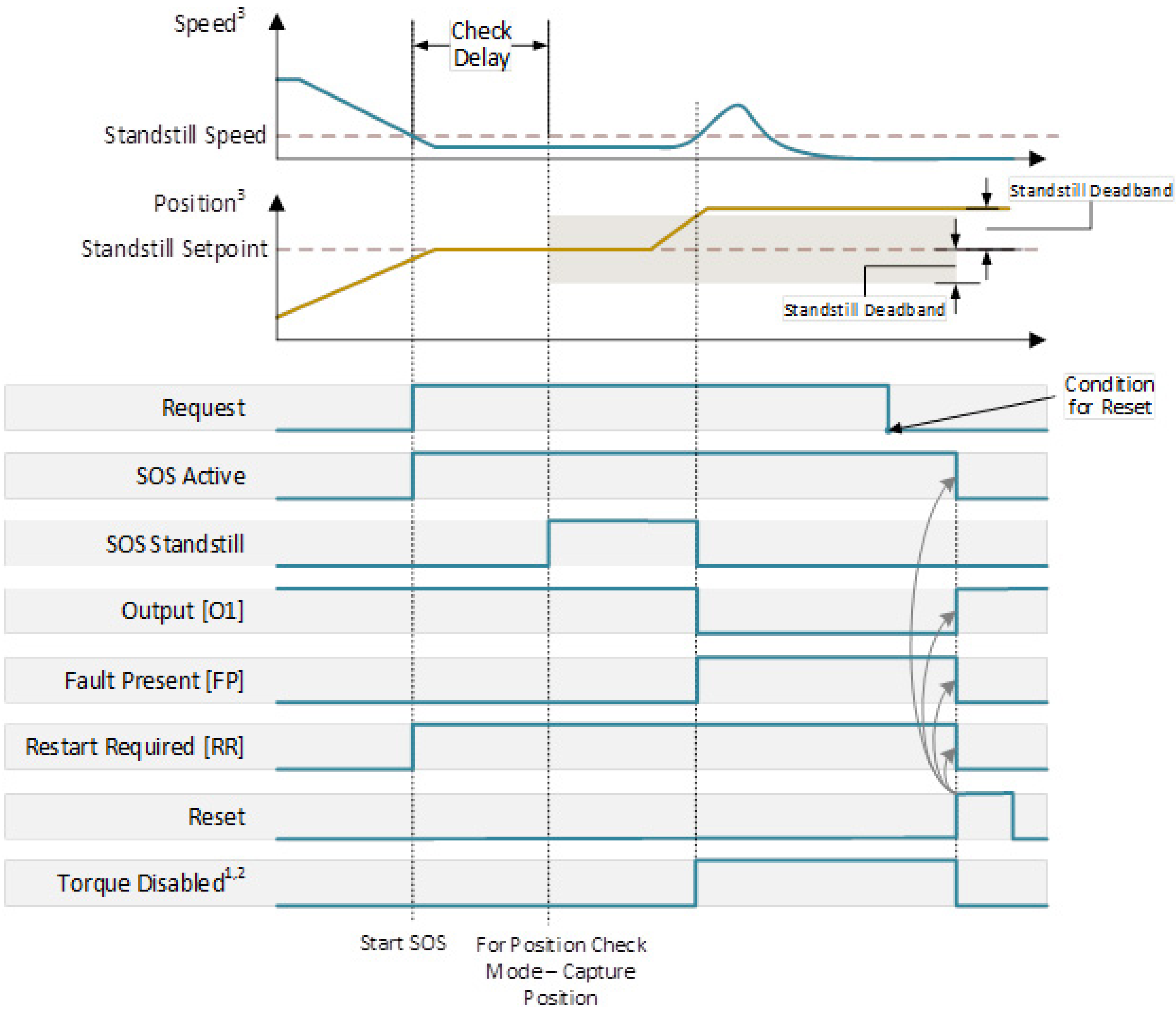
Normal Operation, Manual Restart

When manual restart is configured, the SOS function must be reset before subsequent operation. The Reset Required output indicates that the Reset input must make an OFF(0) to ON(1) transition to reset the SOS function after the Request input is removed OFF(0). The following diagram shows normal operation with manual restart.



Faulted Operation

Faults for SOS may be for invalid configuration, or SFX Instruction Not Ready, described in Fault Codes and Corrective Actions. While monitoring is active, a fault occurs if the speed exceeds the standstill speed in Speed Check mode or if the position deviates from the initial position at the start of monitoring by more than the Standstill Deadband in Position Check mode. The diagram below shows speed and position faults.



1 - STO initiated outside SOS instruction by programmer using instruction Output O1 as a condition for STO
2 - Timing shown with STO Delay = 0 in driver
3 - Both Position and Speed cases shown. The instruction performs speed or position checking, according to Mode operand.

Fault Codes and Corrective Actions

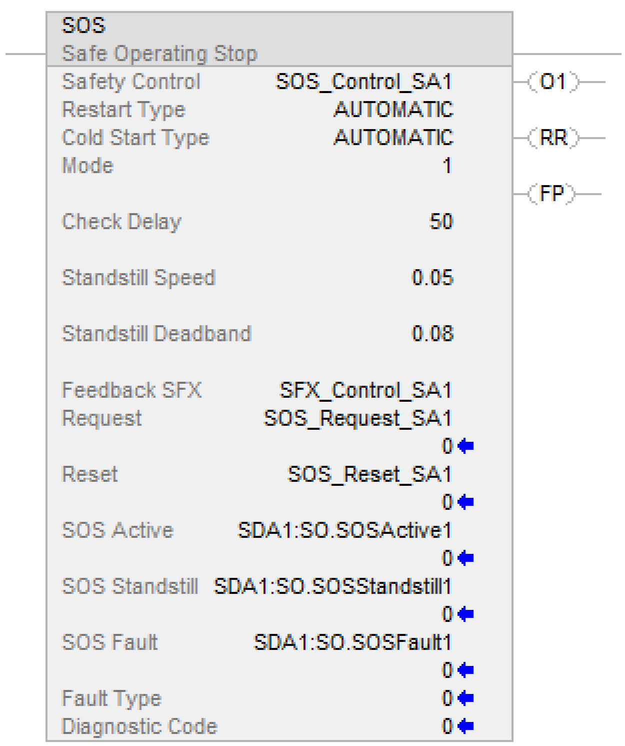
Fault Code	Description	Corrective Action
1	No fault	None
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
3	Standstill Position Fault	Ensure movement is within the Standstill Deadband after check delay time expires.
4	Standstill Speed Fault	Ensure speed is below the Standstill limit before check delay time expires.

Fault Code	Description	Corrective Action
101	Position Window Calculation Overflow Fault. The Position scaling from the Feedback SFX tag multiplied by the Position Window exceeds (2^31 – 1)	• Ensure that the SFX instruction that supplies inputs to this SOS instruction has correct values. • Use a smaller Position Window value.
102	SFX Instruction Not Ready Fault	Ensure that the SFX instruction that supplies inputs to this SOS instruction is executing and not faulted before requesting SOS.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information.	None
10	Rung went false while SOS function was executing.	Make sure this instruction rung is enabled.
20	Mode value not valid.	Only values of 1 Speed Check or 2 Position Check are allowed.
21	Check Delay value not valid.	Check the Check Delay value to ensure it is >= 0 and <= 32767
22	Standstill Deadband not valid	Standstill Deadband cannot be negative
23	Standstill Speed not valid	Standstill Speed cannot be negative

Example



See also

Drive Safety Instructions on page 361

Index Through Arrays on page 540

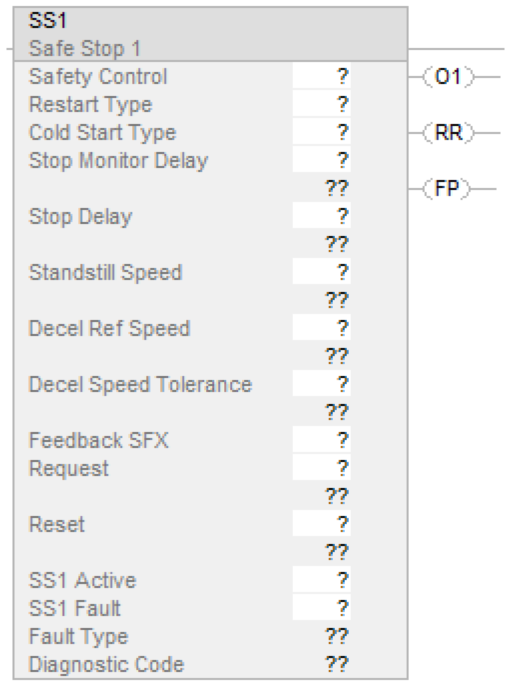
Safe Stop 1 (SS1)

This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safe Stop 1 instruction initiates and monitors the motor deceleration within set limits to ensure the motor stops in a controlled manner.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safe Stop 1 Application

Safe Stop 1 is used with a CIP safety drive that supplies speed and position of an axis or motor, and a Safety Feedback Interface (SFX) instruction to scale the feedback. During operation the SS1 instruction signals when the motor speed is at or below the Standstill Speed. The output is then used to initiate Safe Torque Off (STO) in the drive.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The SS1 Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used for configuring the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFE_STOP_1	tag	Data structure required for proper operation of instruction.
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when he Request has been removed and no fault is present [FP] = OFF(0). Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in application situations where it is determined that no unsafe conditions will occur from its use.
Cold Start Type		list item	This input selects the behavior when applying controller power or a controller mode change to Run. **MANUAL (0)** A 0 to 1 transition of the Reset input is required with the Request removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction resets when the Request has been removed.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Stop Monitor Delay	INT	immediate tag	This operand defines the delay time between the SS1 function Request input and the start of the deceleration monitoring Stop Delay. See timing diagrams in Normal Operation for illustration of Stop Monitor Delay and SS1 timing. Range: 0 to 32767 Units: milliseconds

Operand	Data Type	Format	Description
Stop Delay	DINT	immediate tag	This operand that defines the maximum time allowed for the motor to reach Standstill Speed after the Stop Monitor Delay time expires. This input is also used to compute a velocity ramp or deceleration that the axis must remain below during function execution. See timing diagrams in Normal Operation for illustration of Stop Delay and SS1 timing. Range: 1 to 3000000 Units: milliseconds
Standstill Speed	REAL	immediate tag	This operand defines the speed limit that is used to declare motion as stopped. The drive is at standstill when the speed detected is less than or equal to the configured Standstill Speed. See timing diagrams in Normal Operation for illustration of Standstill Speed and SS1 timing. Range: ≥ 0 Units: Position Units / Time Unit
Decel Ref Speed	REAL	immediate tag	This operand is used to compute a velocity ramp or deceleration that the axis must remain below during function execution. See timing diagrams in Normal Operation for illustration of Decel Ref Speed and SS1 timing. Range: ≥ 0 Units: Position Units / Time Unit
Decel Speed Tolerance	REAL	immediate tag	This operand is used to compute a velocity tolerance around the velocity ramp that the axis must remain below during function execution. See timing diagrams in Normal Operation for illustration of Decel Speed Tolerance and SS1 timing. Range: ≥ 0 Units: Position Units / Time Unit
Feedback SFX	SAFETY_FEEDBACK_INTERFACE	tag	This operand provides velocity data. Assign this operand to the Safety Controller tag of the SFX instruction that is used with this SS1 instruction. The following members of the SFX Safety Controller tag are used: FeedbackSFX.ActualVelocity is provided in Position Unit / Time Unit
Request	BOOL	tag	When set to ON(1) this operand initiates the SS1 function. Start Monitor Delay timer is started when SS1 begins. See diagrams in Normal Operation for illustrations of timing.
Reset[1]	BOOL	tag	This operand resets the SS1 function. An OFF(0) to ON(1) transition resets the SS1 function and Fault Present [FP] provided the Request is OFF(0) and any fault condition has been removed. The Reset Required [RR] output indicates when a reset is required to reset the function.

[1]ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename the Reset_Signal tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table explains the instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1): Indicates the instruction is executing and the instruction is not faulted. OFF(0): Any of the conditions below: • The rung condition is no longer true • An instruction fault has occurred • Monitoring sequence has completed successfully. The axis speed is less than or equal to the standstill speed before the end of Stop Delay time. This output is normally used to initiate Safe Torque Off in the drive that controls the axis being monitored the SS1 instruction.
Reset Required [RR]	BOOL	ON(1): Indicates that an Reset is required to restart the instruction and or to clear faults. See Reset Input for Reset sequence. OFF(0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.
Diagnostic Code	SINT	This output indicates the diagnostic status of the instruction. See Diagnostic Codes and Corrective Actions for specific codes and actions.
Fault Type	SINT	This output indicates the type of fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.
Stop Monitor Delay Active	BOOL	ON(1): Indicates that Stop Monitor Delay timer is active.
Speed Limit	REAL	When Stop Delay is ON(1) this output indicates the real speed limit of the monitored axis. If this speed is exceeded then the instruction will fault. The speed limit will be a ramp function decreasing to zero during Stop Delay as shown in the figures in Normal Operation. Units: Position Unit/ Time Unit.
Deceleration Ramp	REAL	This output indicates the real time ramp function without the Deceleration Speed Tolerance term as shown in the figures in Normal Operation. Units: Position Unit/ Time Unit.

This table explains instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
SS1 Fault	BOOL	tag	SS1 instruction writes the SS1 Fault status to this tag. OFF(0): Not Faulted ON(1): Faulted SS1 Fault is set to ON(1) for the following fault types and corresponding conditions: • Configuration Fault - An instruction input operand value is out of range. • Deceleration Fault - The motor speed exceeded the computed speed limit ramp value. • Maximum Time Fault - Stop Delay time expires and motor speed is > Standstill Speed. **Tip:** Assign the SS1 fault operand to the SS1 Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Fault Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SS1 Active	BOOL	tag	The SS1 instruction writes the SS1 Active status to this tag. OFF(0): SS1 not active ON(1): SS1 active SS1 Active is set to ON(1) when SS1 is requested after being reset. SS1 Active is reset to OFF(0) when the SS1 function resets. **Tip:** Assign the SS1 Active operand to the SS1 Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .O1, .FP, .RR, .SS1Active, .SS1Fault, and .StopMonitorDelayDelayActive outputs are cleared to OFF(0). The Diagnostic Code output is set to OFF(0). The Fault Type output is set to ON(1). The .SpeedLimit and .DecelerationRamp outputs are set to OFF(0).
Rung-condition-in is false	The .O1, .SS1Active, and .StopMonitorDelayDelayActive outputs are cleared to OFF(0). The .SpeedLimit and .DecelerationRamp outputs are set to OFF(0). If an instruction fault is present when rung goes false the fault condition is maintained and the Diagnostic Code is displayed.
Rung-condition-in is true	The instruction executes.
Postscan	N/A

Operation

Normal Operation

The SS1 function begins if it has been previously reset and the Request input is asserted ON(1). At this point the Stop Monitor Delay Timer will begin. When the Stop Monitor Delay Timer expires the current axis speed is captured and the Stop Delay timer begins. As the Stop Delay Timer runs, the speed of the axis is monitored in real time according to the Speed Limit function, S(t), starting with Stop Delay Timer:

Speed Limit Function

$S(t) = S0 + St - (Sr/ Ts)(t)$

Where:

$S(t)$ = Speed Limit

$S0$ = Speed captured at the end of Stop Monitor Delay

St= Decel Speed Tolerance

Sr = Decel Ref Speed

Ts = Stop Delay

t = the Stop Delay Timer value

When the Standstill Speed is reached the output O1 is cleared to OFF(0). Standstill speed is reached before the Stop Delay timer expires in normal operation.

All speed values in the Speed Limit Function are expressed in Position Units / Time Unit. A position unit is user defined according to the particular application and is configured in the SFX instruction. Time units are also configured in the SFX instruction and may be selected as seconds or minutes.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SS1 function:

SS1 Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tag
SS1 Active	module[1]:SO.SS1Active[instance[2]]	updates tag	axis[3].SS1ActiveStatus
SS1 Fault	module[1]:SO.SS1Fault[instance[2]]	updates tag	axis[3].SS1Fault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

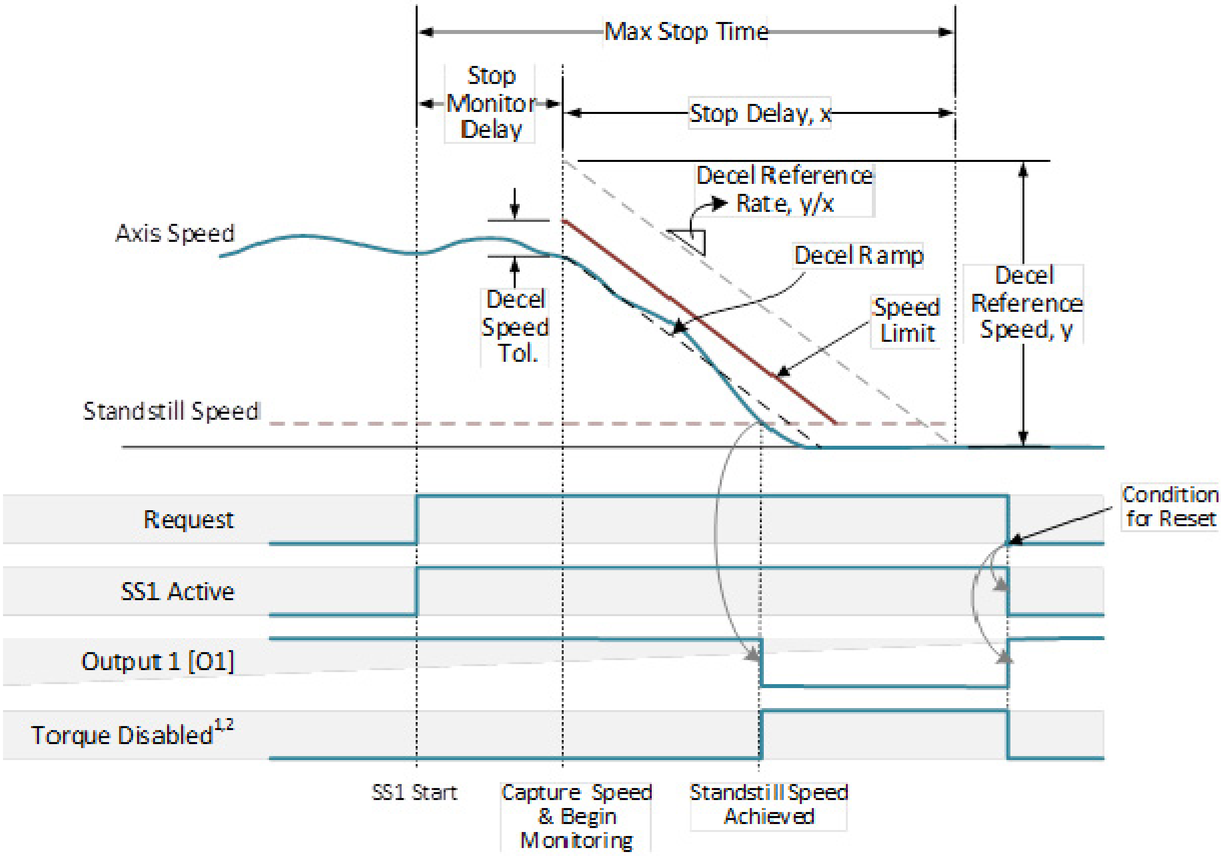
[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

When assigning the SS1 Active and SS1 Fault instruction outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status and Axis Safety Faults tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task. The following is a typical sequence of events:

1. The safety application receives an input to stop the axis.
2. The safety application sets Request input ON(1) to request the SS1 function.
3. The SS1 instruction sets SS1 Active output and writes the module:SO.SS1Active[instance] tag of the motion safety instance of the drive.
4. The motion safety instance in the drive updates the Axis Safety Status tag read in the motion controller.
5. Next the motion application stops the drive according to a stopping ramp profile
6. The SS1 function monitors the axis to ensure the stopping speed vs time ramp is not exceeded
7. When the SS1 function detects Standstill Speed the SSI Output1 is cleared OFF(0).
8. The safety application is typically written so that the SS1 Output1 [01] results in STO request in the motion safety instance of the drive.

Normal Operation, Automatic Restart

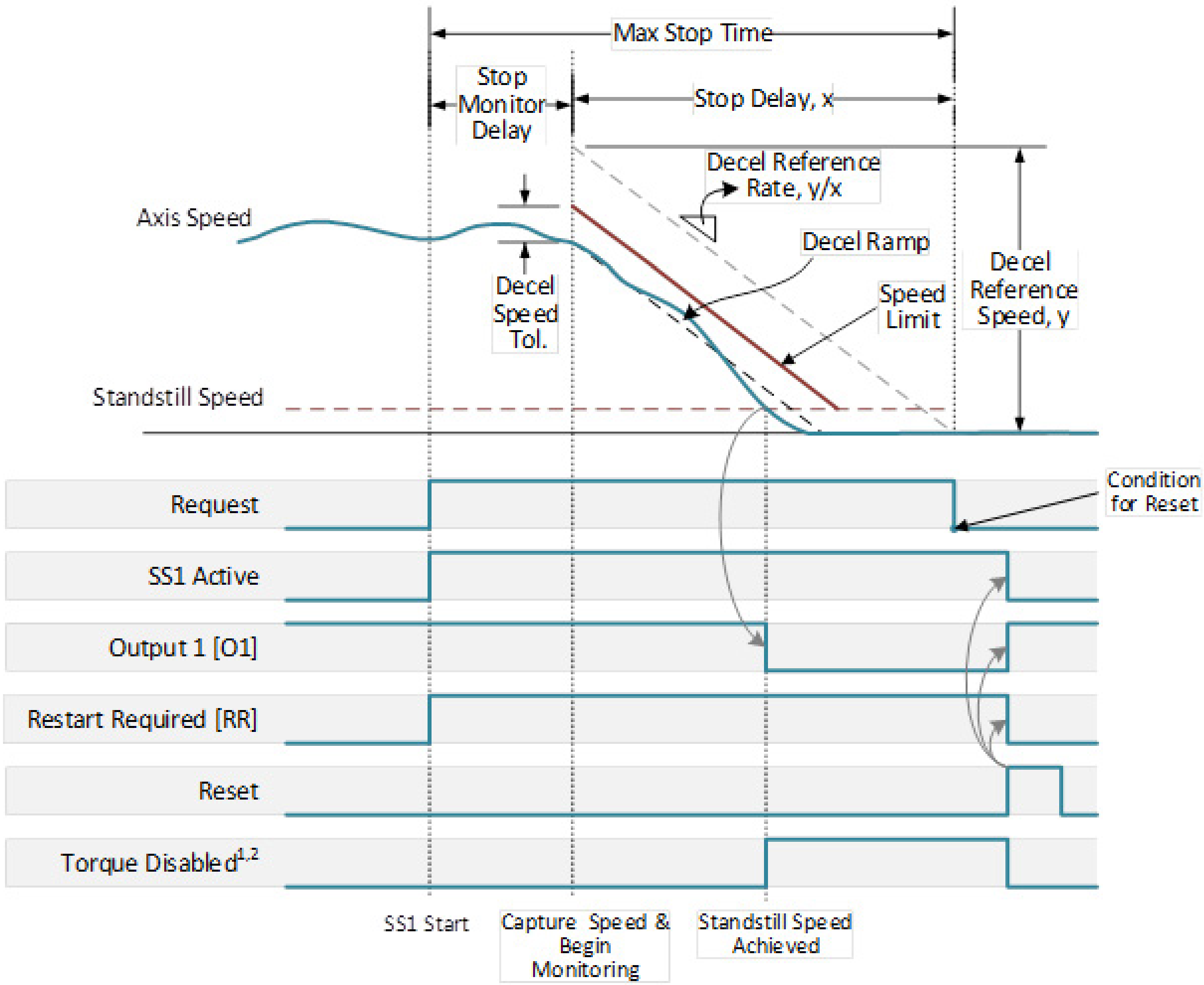
The following diagram shows a timing diagram for normal operation. In the diagram, the Speed Limit function is shown as a solid red line ramping towards zero speed. The speed must stay below the Speed Limit function to maintain normal operation. For automatic restart operation, the SS1 function will be reset when the Request is removed OFF(0) provided no SS1 faults have occurred. When the SS1 function is reset, the output O1 will be set to ON(1) indicating the function is ready to operate.



1 - STO initiated outside SS1 instruction by programmer using instruction Output 1 as a conditioner for STO.
2 - STO Delay in drive set to zero in the Add-On Profile in the Logix Designer software.

Normal Operation, Manual Restart

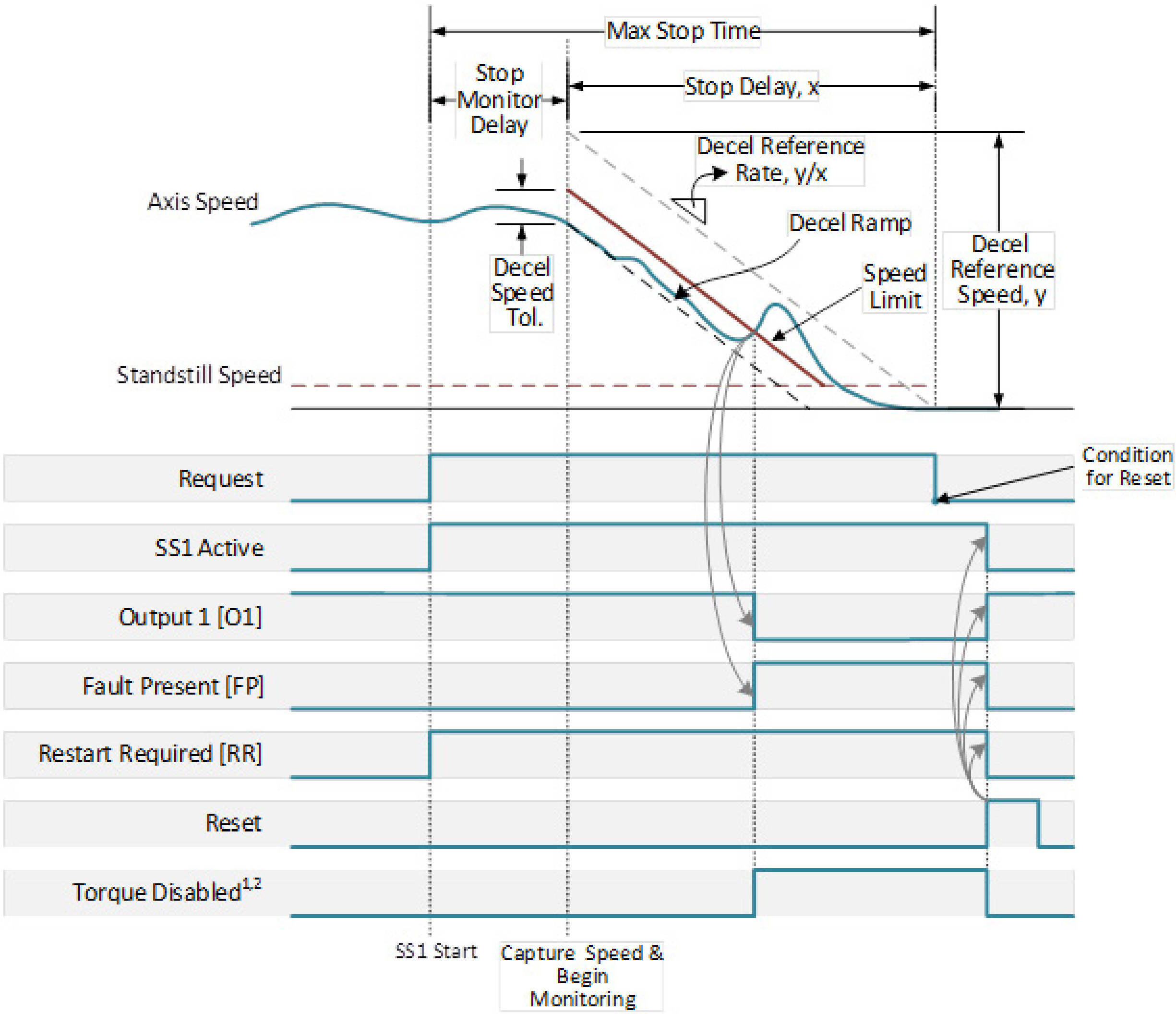
When manual restart is enabled then the SSI operation requires an OFF(0) to ON(1) transition of the Reset input to reset the instruction before subsequent operation. The Reset Required output indicates that the Reset input must make an OFF(0) to ON(1) transition to reset the instruction. The following diagram shows normal operation with Manual Restart. The Speed Limit Function is calculated according to the Speed Limit Equation.



1 - STO initiated outside SS1 instruction by programmer using instruction Output 1 as a conditioner for STO.
2 - STO Delay in drive set to zero in the Add-On Profile in the Logix Designer software.

Faulted Operation, Deceleration Fault

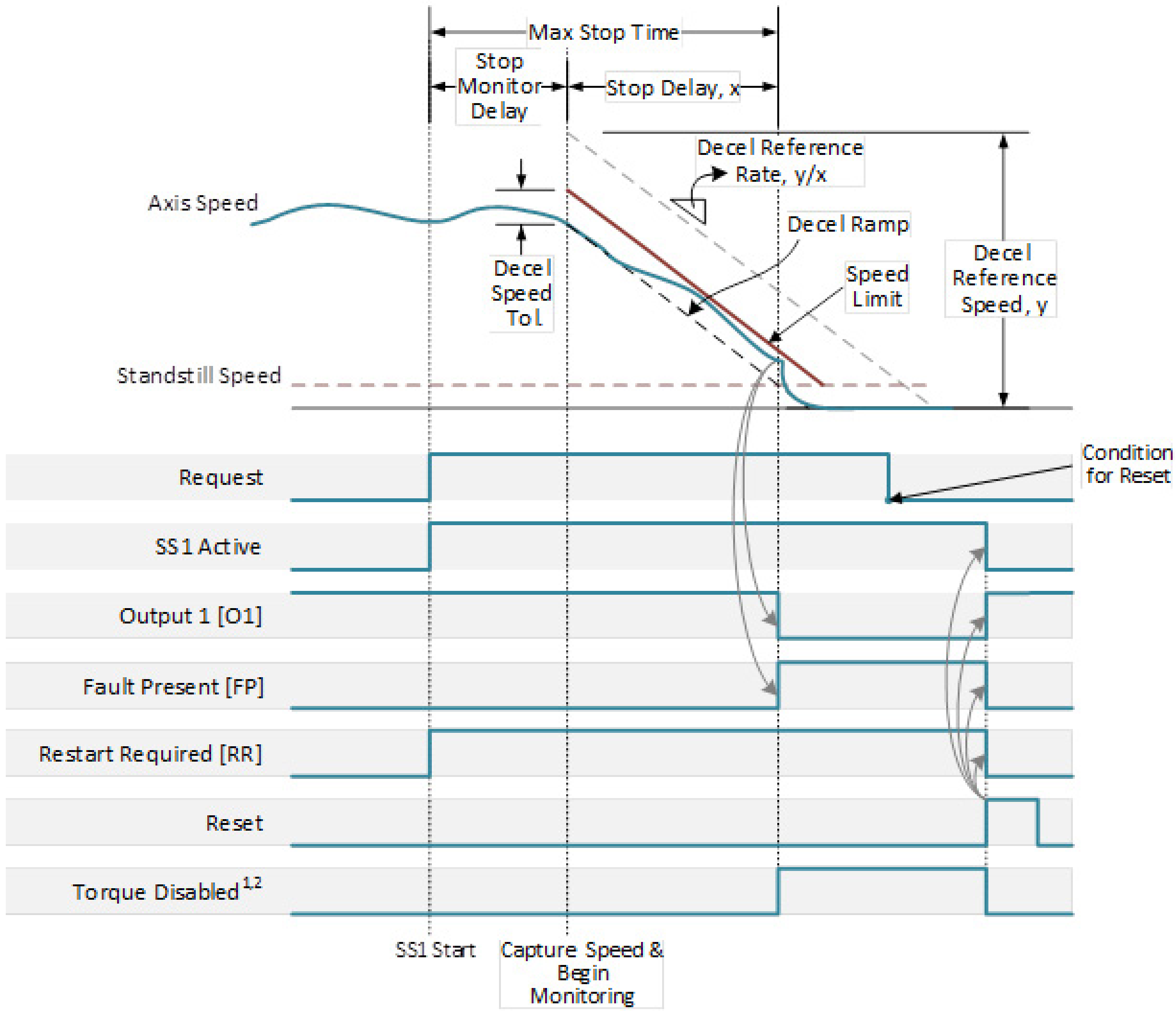
The following figure, a timing diagram of SS1 where a Deceleration Fault occurs, is shown. In the figure the axis speed being monitored exceeded the Speed Limit Function, resulting in a Deceleration Fault.



1 - STO initiated outside SS1 instruction by programmer using instruction Output 1 as a conditioner for STO.
2 - STO Delay in drive set to zero in the Add-On Profile in the Logix Designer software.

Faulted Operation, Maximum Time Fault

A timing diagram of SS1 where a Maximum Time Fault occurs is shown in the following figure. As shown, the axis speed being monitored did not reach the zero speed limit before the Stop Delay Timer expired and a Maximum Time Fault occurred.



1 - STO initiated outside SS1 instruction by programmer using instruction Output 1 as a conditioner for STO.
2 - STO Delay in drive set to zero in the Add-On Profile in the Logix Designer software.

Fault Codes and Corrective Actions

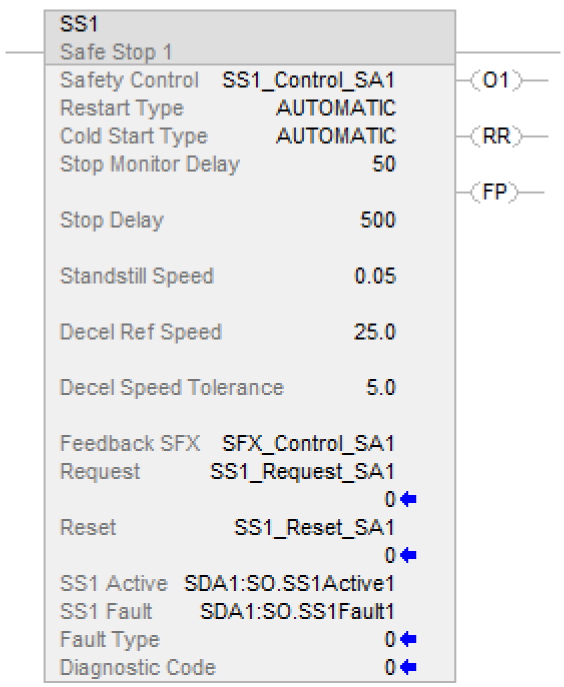
Fault Code	Description	Corrective Action
1	No fault.	None.
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
3	Deceleration Fault - the axis being monitored for stopping exceeded the speed limit ramp computed by the instruction.	• Reset the fault and check the motion application to ensure the axis is decelerated as required when SS1 Active is asserted ON(1).
4	Maximum Time Fault - the maximum time to reach standstill was exceeded.	• Increase the allowable time, increase the deceleration, or reduce the initial speed of the axis • Reset the fault.

Fault Code	Description	Corrective Action
102	SFX Instruction Not Ready Fault	Ensure that the SFX function that supplies inputs to this SS1 instance is running and not faulted before requesting SS1.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information.	None
10	Rung went false while instruction was executing.	Make sure this instruction is enabled.
20	Stop Monitor Delay value not valid.	Check the Stop Monitor Delay value to ensure it is within the allowed range.
21	Stop Delay value not valid.	Check the Stop Delay value to ensure it is within the allowed range.
22	Standstill Speed value not valid.	Check the Standstill Speed value to ensure it is within the allowed range.
23	Deceleration Reference Speed value not valid.	Check the Decel Ref Speed value to ensure it is within the allowed range.
24	Deceleration Speed Tolerance value not valid.	Check the Decel Speed Tolerance value to ensure it is within the allowed range.

Example



See also

Index Through Arrays on page 540

Drive Safety Instructions on page 361

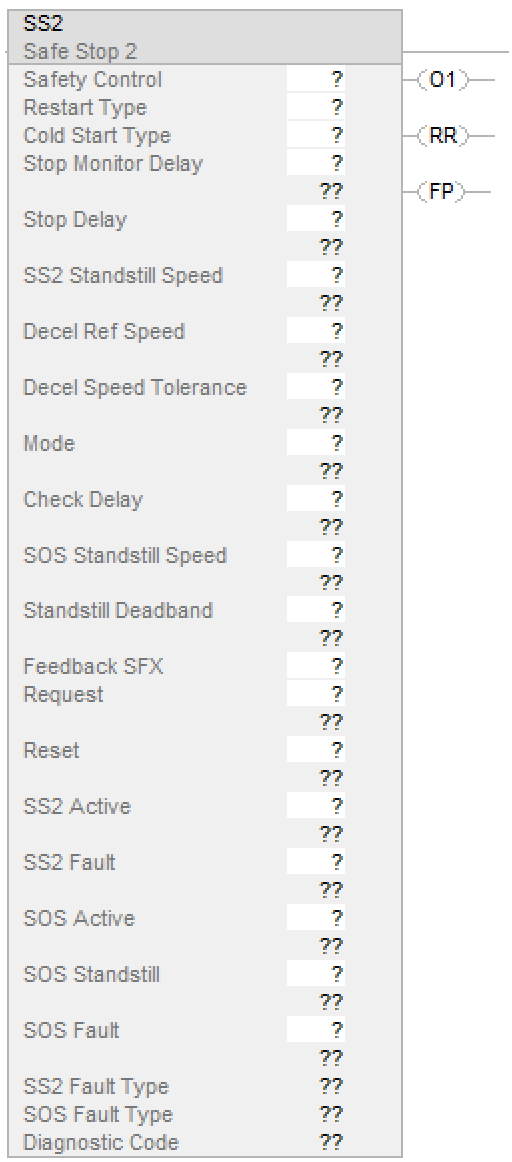
Safe Stop 2 (SS2)

This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safe Stop 2 instruction initiates and monitors the motor or axis deceleration within set limits to ensure the motor is brought to an operational stop. Once stopped, SS2 continues to monitor the operational stop of the motor.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safe Stop 2 Application

Safe Stop 2 is used with a CIP safety drive that supplies speed and position of a motor or axis and a Safe Feedback Interface (SFX) instruction to scale the feedback. During operation, the SS2 instruction signals when the axis speed is at or below the Standstill Speed. When standstill is reached, SS2 then initiates SOS (Safe Operational Stop) to continue standstill monitoring.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The SS2 Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands used for configuring the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFE_OPERATING_STOP	tag	Data structure required for proper operation of instruction.
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when the Request has been removed and no fault is present [FP=0]. Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in applications where it is determined that no unsafe conditions occur from its use.

Operand	Data Type	Format	Description
Cold Start Type		list item	This input selects the behavior when applying controller power or a controller mode change to Run. **MANUAL (0)** A 0 to 1 transition of the Reset input is required with the Request removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction resets when the Request has been removed.

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Stop Monitor Delay	INT	immediate tag	This operand defines the delay time between the SS2 function request and the start of deceleration monitoring Stop Delay. See timing diagrams in Normal Operation for illustration of Stop Monitor Delay And SS2 timing. Range: 0 to 32767 Units: milliseconds
Stop Delay	DINT	immediate tag	This operand defines the maximum time allowed for the axis to reach Standstill Speed after the Stop Monitor Delay time expires. This input is also used to compute a speed ramp or deceleration that the axis must remain below during instruction execution. See timing diagrams in Normal Operation for illustration of Stop Delay and SS2 timing. Range: 1 to 3000000 Units: milliseconds
SS2 Standstill Speed	REAL	immediate tag	This operand defines the speed limit that is used to declare motion as stopped. The drive is at standstill when the speed detected is less than or equal to the configured Standstill Speed. When SS2 Standstill Speed is reached then SOS Standstill monitoring begins. See timing diagrams in Normal Operation for illustration of Standstill Speed and SS2 timing. Range: ≥ 0 Units: Position Units / Time Unit
Decel Ref Speed	REAL	immediate tag	This operand is used to compute a speed ramp or deceleration that the axis must remain below during function execution. The deceleration is computed internally by the SS2 instruction as Decel Ref Speed / Stop Delay. See timing diagrams in Normal Operation for illustration of Decel Ref Speed and SS2 timing. Range: ≥ 0 Units: Position Units / Time Unit **Tip:** Enter the maximum axis speed for Decel Ref Speed and the maximum time to decelerate to standstill for the Stop Delay.

Operand	Data Type	Format	Description
Decel Speed Tolerance	REAL	immediate tag	This operand sets a speed tolerance around the speed ramp that the axis must remain below during function execution. See timing diagrams in Normal Operation for illustration of Decel Speed Tolerance and SS2 timing. Range: ≥ 0 Units: Position Units / Time Unit
Mode	SINT	immediate tag	This operand selects speed or position checking during SOS monitoring. Range: 1 or 2 1: Position Check 2: Speed Check
Check Delay	INT	immediate tag	This operand defines the delay time between the SOS function start and the start of standstill monitoring. Range: 0 to 32767 Units: milliseconds
SOS Standstill Speed	REAL	immediate tag	This operand sets the maximum speed that is allowed before the instruction will fault during SOS standstill monitoring when Speed Checking Mode is selected. Range: ≥ 0
Standstill Deadband	REAL	immediate tag	This operand sets the maximum incremental deviation from the position that is captured at the expiration of Check Delay. If the maximum deviation is exceeded then this instruction will fault. Range: ≥ 0
Feedback SFX	SAFETY_FEEDBACK_INTERFACE	tag	The Feedback SFX operand provides position and speed data. Assign this operand is to the Safety Control tag of the SFX instruction that is used with the SS2 instruction instance. The following members of the SFX Safety Control tag are used: • FeedbackSFX.FeedbackPosition Units: Feedback Counts • FeedbackSFX.ActualSpeed Units: Postion Unit / Time Unit • FeedbackSFX.PositionScalingOut Units: Feedback Counts / Position Unit
Request	BOOL	tag	The Request input enables the SS2 function to operate. ON(1): Start SS2 function to execution. OFF(0): Allows function reset according to Restart Type
Reset[1]	BOOL	tag	This operand resets the SS2 function. An OFF(0) to ON(1) transition resets the SS2 function and Fault Present [FP] provided the Request is OFF(0) and any fault condition has been removed. The Reset Required [RR] output indicates when a reset is required to reset the function.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately

before this instruction. Rename the 'Reset Signal' tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table explains the instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1) : Indicates the instruction is executing and the function is not faulted. OFF(0): Any of the conditions below: • The rung in condition is no longer true • An instruction fault has occurred
Reset Required [RR]	BOOL	ON(1) : Indicates that an Reset is required to restart the instruction and or to clear faults. See Reset Input for Reset sequence. OFF(0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.
Diagnostic Code	SINT	This output indicates the diagnostic status of the instruction. See Diagnostic Codes and Corrective Actions for specific codes and actions.
SS2 Fault Type	SINT	This output indicates the type of SS2 fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.
SOS Fault Type	SINT	This output indicates the type of SOS fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.
Stop Monitor Delay Active	BOOL	ON(1): Indicates that Stop Monitor Delay timer is active.
Check Delay Active	BOOL	ON(1): Indicates that Check Delay timer is active.
Speed Limit	REAL	When Stop Delay is ON (1) this output indicates the real speed limit of the monitored axis. If this speed is exceeded then the instruction will fault. The speed limit will be a ramp function decreasing to zero during Stop Delay as shown in the figures in Normal Operation. Units: Position Unit/ Time Unit.
Deceleration Ramp	REAL	This output indicates the real time ramp function without the Deceleration Speed Tolerance term as shown in the figures in Normal Operation. Units: Position Unit/ Time Unit.
Standstill Set Point	REAL	This output is set to the Actual Position when SOS monitoring begins.

This table explains instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
SS2 Active	BOOL	tag	The SS2 instruction writes the SS2 Active status to this tag. OFF(0): SS2 not active ON(1): SS2 active SS2 Active is set to ON(1) when SS2 is requested after being reset. SS2 Active is reset to OFF(0) when the SS2 function resets. **Tip:** Assign the SS2 Active operand to the SS2 Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

Operand	Data Type	Format	Description
SS2 Fault	BOOL	tag	The SS2 instruction writes the SS2 Fault status to this tag. OFF(0): Not faulted ON(1): Faulted SS2 Fault is set to ON (1) for the following fault types and corresponding conditions: • Configuration Fault An instruction input operand value is out of range. • Deceleration Fault The axis speed exceeded the defined speed limit value. • Maximum Time Fault Stop Delay time expires and axis speed is greater than Standstill Speed. • SFX Instruction Not Ready Fault The feedback used for monitoring is not valid or the SFX instruction is not running when SS2 is requested. **Tip:** Assign the SS2 Fault operand to the SS2 Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults tag updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SOS Active	BOOL	tag	The SS2 instruction writes the SOS Active status to this tag. OFF(0): SOS not active ON(1): SOS active **Tip:** Assign the SOS Active operand to the SOS Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SOS Standstill	BOOL	tag	The SS2 instruction writes the SOS Standstill status to this tag. OFF(0): Speed or position not at standstill. ON(1): Speed or position is within standstill limits. **Tip:** Assign the SOS Standstill operand to the SOS Standstill member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

Operand	Data Type	Format	Description
SOS Fault	BOOL	tag	The SS2 instruction writes the SOS Fault status to this tag. OFF(0): Not faulted ON(1): Faulted SOS Fault is set to ON (1) state for the following fault types and corresponding conditions: • Configuration Fault An instruction input operand value is out of range. • Standstill Position Fault Standstill deadband was exceeded while monitoring. • Standstill Speed Fault Standstill speed limit was exceeded while monitoring. • SFX Instruction Not Ready Fault The feedback used for monitoring is not valid or the SFX instruction is not running when SS2 is requested. **Tip:** Assign the SOS Fault operand to the SOS Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults tag updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT	Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .O1, .FP, .RR, .SS2Active, .SS2Fault, .StopMonitorDelayActive, .SpeedLimit, .DecelerationRamp, .SOSActive, .SOSStandstill, .SOSFault, and .CheckDelayActive outputs are cleared to OFF(0). The Diagnostic Code output is set to 0. The Fault Type output is set to 1
Rung-condition-in is false	The .O1, .SS2Active, .SOSActive, .SOSStandstill, .StopMonitorDelayActive, .CheckDelayActive, are cleared to OFF(0). The Speed Limit output is set to 0 The Deceleration Ramp is set to 0 The Standstill Setpoint is set to 0 If an instruction fault is present when rung went false the fault condition will be maintained and Diagnostic Code displayed.

Condition/State	Action Taken
Rung-condition-in is true	The instruction executes.
Postscan	N/A

Operation

Normal Operation

The SS2 function begins if it has been previously reset and the Request input is asserted ON(1). At this point the Stop Monitor Delay Timer will begin. When the Stop Monitor Delay Timer expires the current axis speed is captured and the Stop Delay timer begins. As the Stop Delay Timer runs, the speed of the axis is monitored in real time according to the Speed Limit function, S(t), starting with Stop Delay Timer:

Speed Limit Function

$S(t) = S0 + St - (Sr/ Ts)(t)$

Where:

S(t) = Speed Limit

S0 = Speed captured at the end of Stop Monitor Delay

St= Decel Speed Tolerance

Sr = Decel Ref Speed

Ts = Stop Delay

t = the Stop Delay Timer value

When the SS2 Standstill Speed is reached then Safe Operating Stop (SOS) monitoring function within the SS2 function begins. Note that SS2 Standstill speed is reached before the Stop Delay timer expires in normal operation.

When the SOS monitoring begins, the Check Delay timer is started. After the check delay timer expires the position is captured. Either the speed or position, provided by an SFX instruction, is compared to the SOS Standstill Speed or Standstill Deadband according to the Mode setting. After Check Delay expires, Standstill output will be set to ON(1) as long as the speed is below the SOS Standstill Speed and the function is not faulted. The SOS monitoring remains active as long as it is not faulted and the Request input is ON(1). If the speed of the monitored axis exceeds the Standstill limit then the SOS function will Fault.

Position values used in the SS2 instruction are in Position Units. Speed values used in the SS2 instruction are in Position Units / Time Unit. A position unit is user defined according to the particular application and is configured in the SFX instruction. Time units are also configured in the SFX instruction and may be selected as seconds or minutes.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SS2 function:

SS2 Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tags
SS2 Active	module[1]:SO.SS2Active[instance[2]]	updates tag	axis3.SS2ActiveStatus
SS2 Fault	module[1]:SO.SS2Fault[instance[2]]	updates tag	axis3.SS2Fault
SOS Active	module[1]:SO.SOSActive[instance[2]]	updates tag	axis3.SOSActiveStatus
SOS Standstill	module[1]:SO.SOSStandstill[instance[2]]	updates tag	axis3.SOSStandstillStatus
SOS Fault	module[1]:SO.SOSFault[instance[2]]	updates tag	axis3.SOSFault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree.

[2]instance is 1 or 2 for dual axis drives otherwise null

[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

When assigning the SS2 Active, SOS Active, SOS Standstill, SS2 Fault and SOS Fault outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status and Axis Safety Faults tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task. The following is a typical sequence of events:

1. The safety application receives an input to stop an axis.
2. The safety application sets the Request input ON(1) to request the SS2 function.
3. The SS2 instruction sets SS2 Active output and writes the module:SO.SS2Active[instance] tag of the motion safety instance in the drive.
4. The motion safety instance in the drive updates the Axis Safety Status tag read in the motion controller.

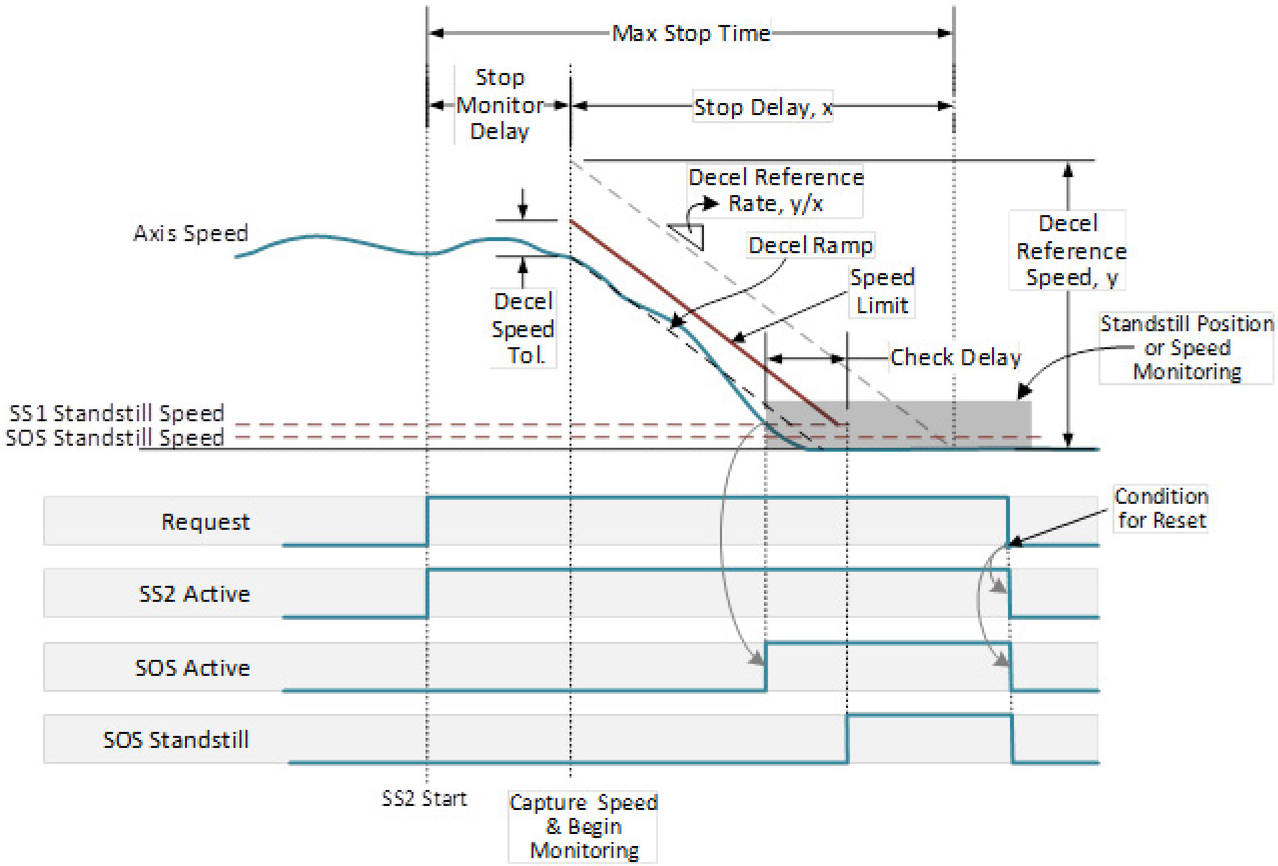
5. Next the motion application stops the drive according to a stopping ramp profile.
6. The SS2 function monitors the axis to ensure stopping speed vs time ramp is not exceeded.
7. When the SS2 function detects SS2 Standstill the SS2 instruction writes the module:SO.SOSActive[instance] tag of the motion safety instance of the drive.
8. When the SOS function detects SOS Standstill the SS2 instruction writes module:SO.SOSStandstill[instance] tag of the motion safety instance of the drive.
9. The motion application reads the Axis Safety Status tags and continues to hold the position or maintain zero speed.

Normal Operation, Automatic Restart

The following diagram shows a timing diagram for normal operation with Automatic Restart. In normal operation the SS2 Active output will remain ON(1) as long as the SS2 function has not been reset. For automatic restart operation, the SS2 function will be reset when the Request is removed OFF(0) provided no faults have occurred. When the SS2 function is reset the output O1 will be set to ON(1) indicating the function is ready to operate.

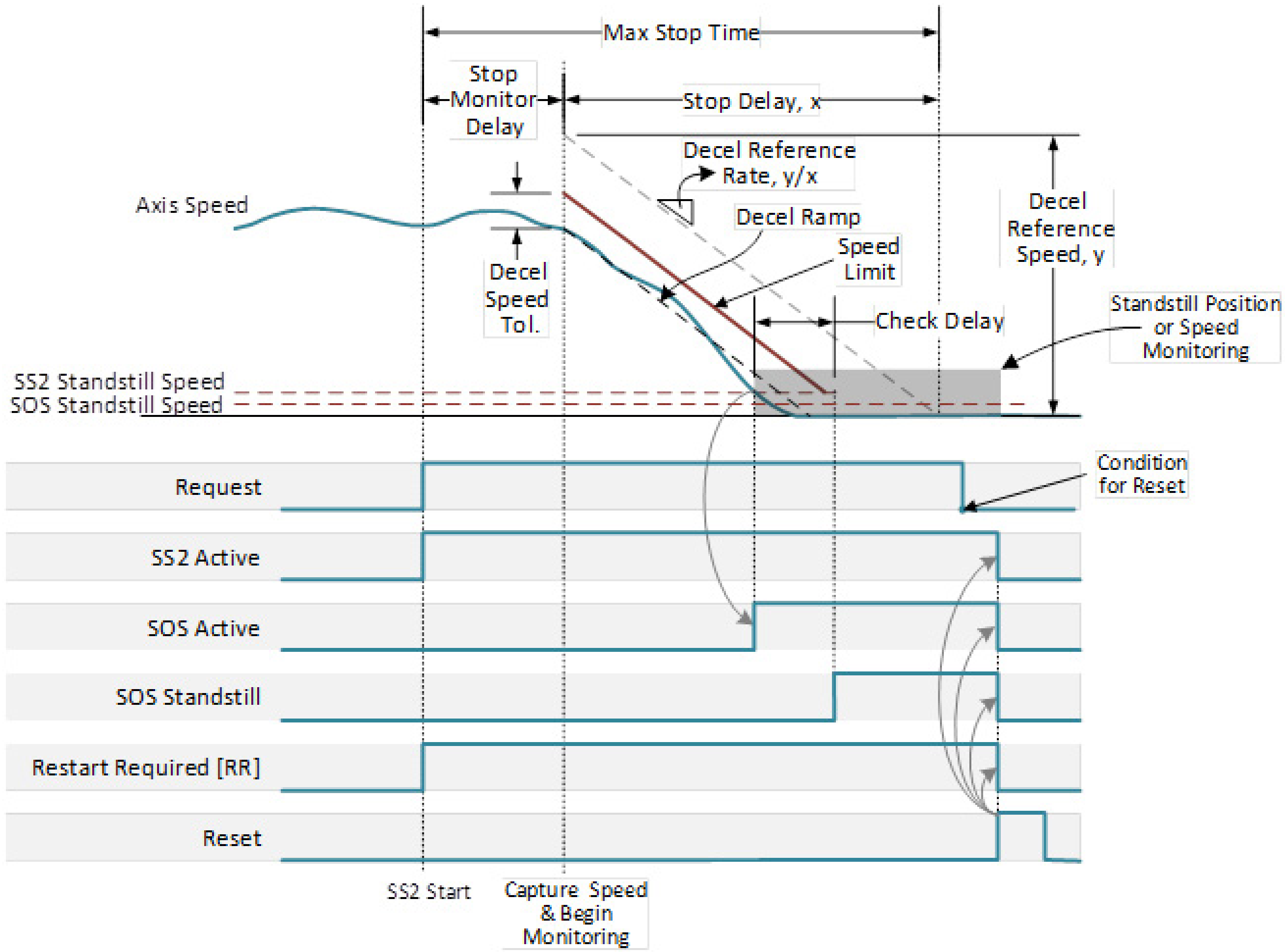
In the diagram, the Speed Limit function is shown as a solid red line ramping towards zero speed. The speed must stay below the Speed Limit function to maintain normal operation. After the SS2 Standstill Speed is reached the SOS

Active Output is ON(1) indicating that the SOS function within SS2 is active and remains ON(1) as long as the Request remains ON(1).



Normal Operation, Manual Restart

When manual restart is configured, the SS2 function reset before subsequent operation. The Reset Required output indicates that the Reset input must make an OFF(0) to ON(1) transition to reset the instruction after the Request input is removed OFF(0). The following diagram shows normal operation with manual restart.

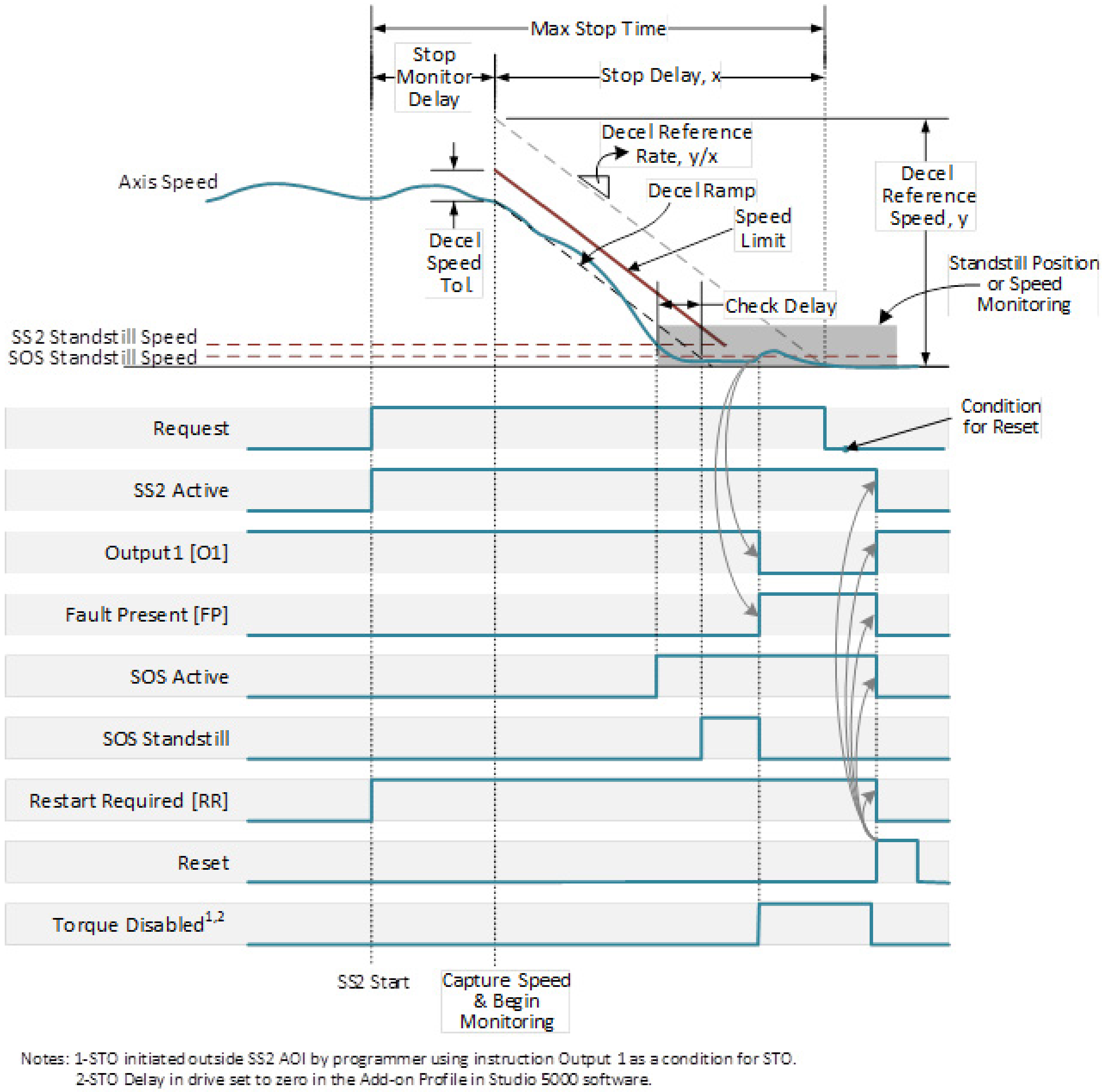


Faulted Operation

Faulted Operation, Deceleration Fault

The following diagram, a timing diagram of SS2 where a Deceleration Fault occurs, shows the axis speed exceeding the Speed Limit Function, resulting in a Deceleration Fault. Note that the timing diagram is shown for Manual

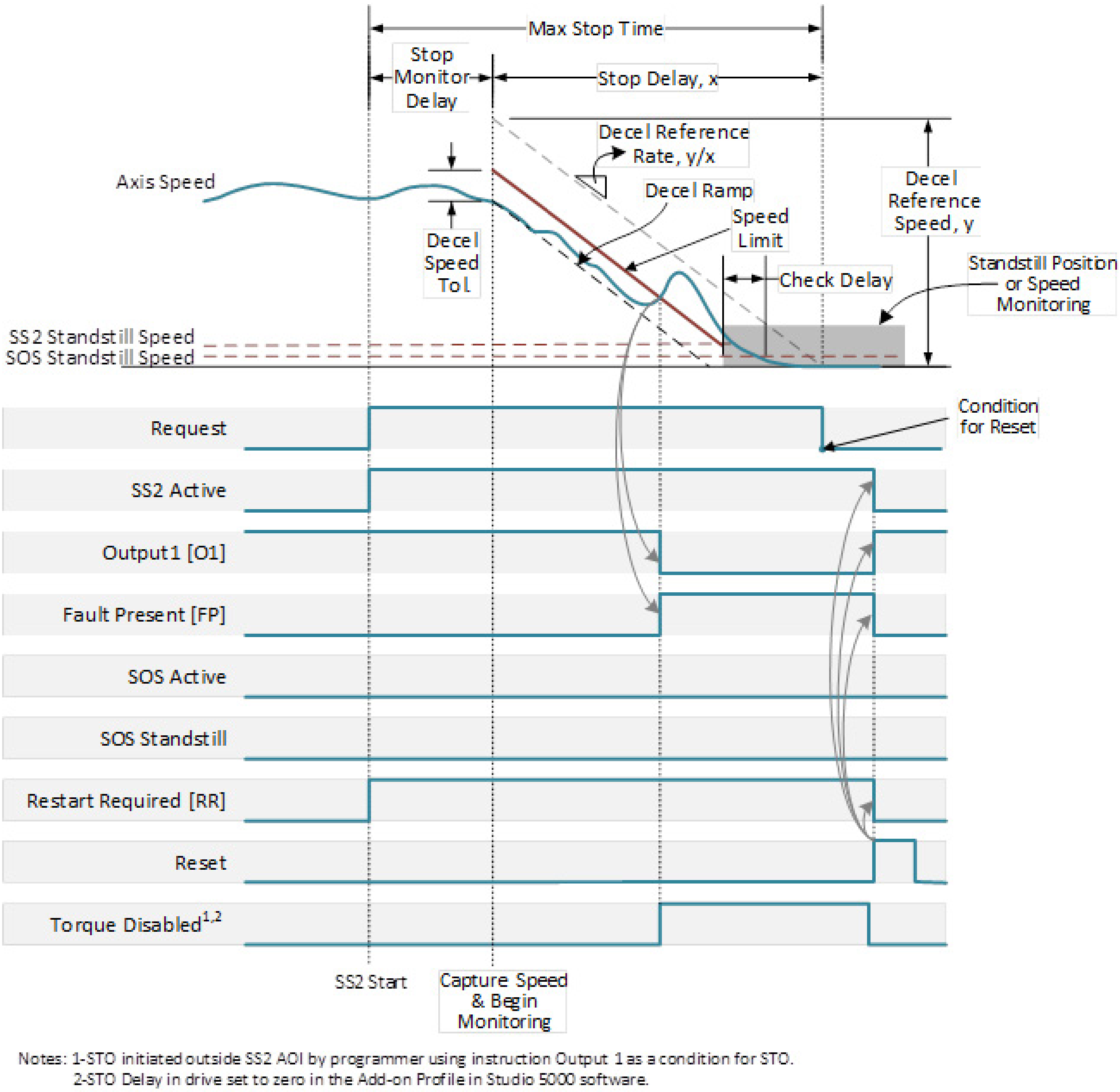
Restart. For Automatic Restart the timing is similar except that the Reset Required [RR] output will not turn ON(1) until a fault occurs.



Faulted Operation, Standstill Speed Fault

The following diagram shows SS2 where a Standstill Speed Fault occurs. As shown, the axis speed reached SS2 and SOS Standstill Speed but during the SOS function the Speed increased until the SOS Standstill Speed was exceeded, resulting in a fault. Note that the timing diagram is shown for

Manual Restart. For Automatic Restart, the timing is similar except that the Reset Required [RR] output will not turn ON(1) until the fault occurs.



Fault Codes and Corrective Actions

SS2 Fault Codes

Fault Code	Description	Corrective Action
1	No Fault	None.

Fault Code	Description	Corrective Action
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
3	Deceleration Fault - the axis being monitored for stopping exceeded the speed limit ramp computed by the instruction.	• Reset the fault and check the motion application to ensure the axis is decelerated as required when SS2 Active is asserted ON(1).
4	Maximum Time Fault - the maximum time to reach SS2 standstill was exceeded.	• Increase the allowable time, increase the deceleration, or reduce the initial speed of the axis • Reset the fault.
102	SFX Instruction Not Ready Fault	Ensure that the SFX instruction that supplies inputs to this SS2 instance is running and not faulted before requesting SS2.

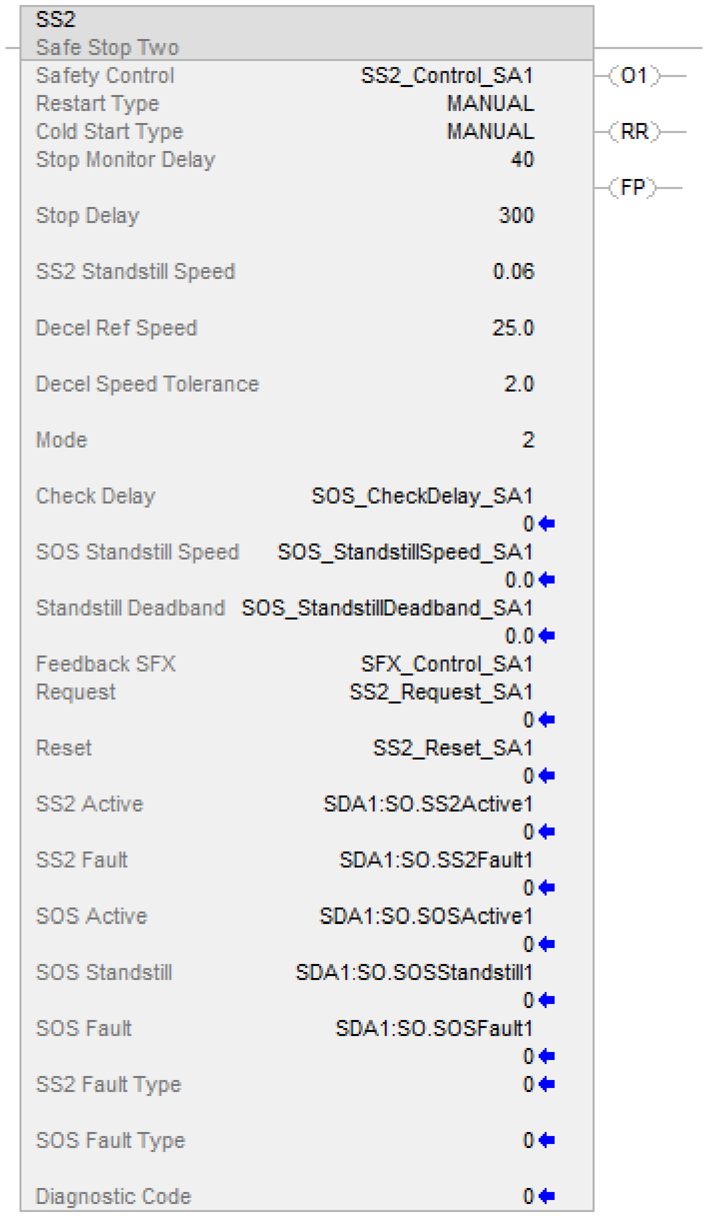
SOS Fault Codes

Fault Code	Description	Corrective Action
1	No Fault	None.
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
3	Standstill Position Fault	Ensure movement is within the Standstill Deadband after check delay time expires.
4	Standstill Speed Fault	Ensure speed is below the Standstill limit before check delay time expires.
101	Position Window Calculation Overflow Fault. The Position scaling from the Feedback SFX tag multiplied by the Position Window exceeds (2^31 – 1)	• Ensure that the SFX instruction that supplies inputs to this SS2 instruction has correct values. • Use a smaller Position Window value.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information.	None
10	Rung went false while instruction was executing.	Make sure this instruction is enabled.
20	Stop Monitor Delay value not valid.	An INT value from 0 to 32767 must be used
21	Stop Delay value not valid.	A DINT value must be between 0 and 3,000,000 must be used
22	SS2 Standstill Speed value not valid.	SS2 Standstill Speed must be a non negative REAL
23	Deceleration Reference Speed value not valid.	Must be a non negative REAL
24	Deceleration Speed Tolerance value not valid.	Must be a non negative REAL
25	Mode value not valid.	An INT value of 1 (Speed Check) or 2 (Position Check) must be used.
26	Check Delay value not valid.	An INT value between 0 and 32767 must be used.
27	Standstill Deadband not valid	Must be a non negative REAL.
28	Standstill Speed not valid	Must be a non negative REAL.

Example



See Also

Index Through Arrays on page 540

Drive Safety Instructions on page 361

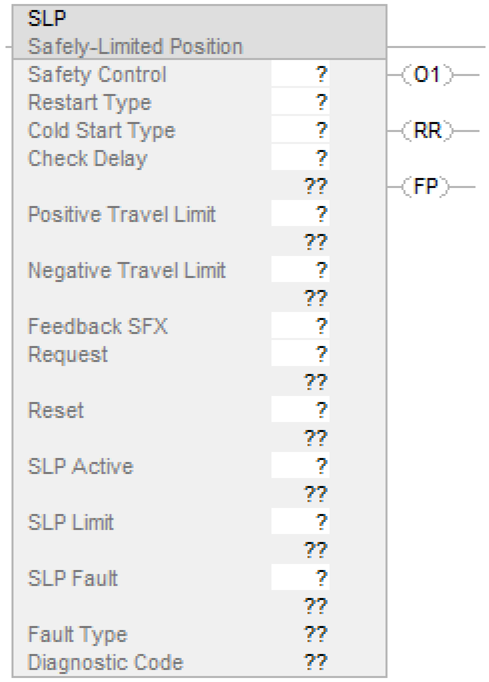
Safely-Limited Position (SLP)

This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safely-Limited Position instruction monitors the position of a motor or axis to ensure that the position does not deviate above or below defined limits.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safely-Limited Position Application

Safely-Limited Position is used with a CIP safety drive that supplies speed of a motor or axis and a Safe Feedback Interface (SFX) instruction to scale the feedback. During operation, the SLP instruction sets the limit output when the motor position moves outside of the specified limits. During operation of the SLP function the limits may be adjusted. The output is used to initiate an application specific action such as STO, SS1, SS2 or STO.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten
- Members of a structure operand are overwritten
- Structure operands are shared by multiple instructions

ATTENTION: The SLP Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides operands used for configuring the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFELY_LIMITED_POSITION	tag	Data structure required for proper operation of instruction.
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when the Request has been removed and no fault is present [FP] = OFF(0). Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in applications where it is determined that no unsafe conditions occur from its use.
Cold Start Type		list item	Selects the Behavior when applying controller power or a controller mode change to Run. **MANUAL (0)** A 0 to 1 transition of the Reset input is required with the Request removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction resets when the Request has been removed.
Check Delay	INT	immediate tag	This operand defines the delay time between the SLP function request and the start of position monitoring. Range: 0 to 32767 Units: mSec

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Positive Travel Limit	REAL	immediate tag	This operand sets the maximum position allowed before the SLP Limit Output is set. A change in this value takes effect immediately when the function is operating. For linear motion (SFX Unwind = 0) Range: REAL For rotary motion application (SFX Unwind > 0) Range: Negative Travel Limit to (Unwind/Position Scaling) Units: Position Units
Negative Travel Limit	REAL	immediate tag	This operand sets the maximum position allowed before the SLP Limit Output is set. A change in this value takes effect immediately when the function is operating. For linear motion (SFX Unwind = 0) Range: REAL For rotary motion application (SFX Unwind > 0) Range: 0 to Positive Travel Limit Units: Position Units
Feedback SFX	SAFETY_FEEDBACK_INTERFACE	tag	This operand provides position data. Assign this operand is to the Safety Control tag of the SFX instruction that is used with this SLP instruction. The following members of the SFX Safety Control tag are used: FeedbackSFX.ActualPosition Units: Feedback Counts FeedbackSFX.PositionScalingOut Units: Feedback Counts / Position Unit FeedbackSFX.UnwindOut Units: Counts / Cycle FeedbackSFX.ActualCycles Units: Cycles
Request	BOOL	tag	This operand enables the SLP function to operate. ON(1): allows SLP function to begin monitoring. OFF(0): allows function reset according to Restart Type
Reset[1]	BOOL	tag	This operand resets the SLP function. An OFF(0) to ON(1) transition resets the SLP function and Fault Present (FP) provided the Request is OFF(0) and any fault condition has been removed. The Request Required (RR) output indicates when a reset is required to reset the instruction.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename the ‘Reset Signal’ tag in this example to the

reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

This table explains instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1): Indicates the instruction is executing and the function is not faulted. OFF(0): Any of the following conditions below: • The rung in condition is no longer true • An instruction fault has occurred
Reset Required [RR]	BOOL	ON(1): Indicates that a Reset is required to restart the SLP function instruction and or to clear faults. See Reset Input for Reset sequence. OFF(0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.
Diagnostic Code	SINT	This output indicates the diagnostic status of the instruction. See Diagnostic Codes and Corrective Actions for specific codes and actions.
Fault Type	SINT	This output indicates the type of fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.
Check Delay Active	BOOL	ON(1): Indicates that Check Delay timer is active.

This table explains instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
SLP Active	BOOL	tag	The SLP instruction writes the SLP Active status to this tag. OFF(0): SLP not active ON(1): SLP active **Tip:** Assign the SLP Active operand to the SLP Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SLP Limit	BOOL	tag	The SLP instruction writes the SLP Limit status to this tag. OFF(0): Position has not reached the limit ON(1): The position limit was reached or exceeded **Tip:** Assign the SLP Limit operand to the SLP Limit member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

Operand	Data Type	Format	Description
SLP Fault	BOOL	tag	The SLP instruction writes the SLP Fault status to this tag. OFF(0): Not faulted ON(1): Faulted SLP Fault bit to be set to ON (1) state for the following fault type and corresponding condition: • Configuration Fault An instruction input operand value is out of range. • Axis Not Homed Fault SLP requires that a home position be defined in the SFX instruction. • SFX Instruction Not Ready Fault The feedback used for monitoring is not valid or the SFX instruction is not running when SLP is requested. **Tip:** Assign the SLP Fault operand to the SLP Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults tag updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Ladder Diagram

Condition/State	Action Taken
Prescan	The .01, .FP, .RR, .SLPActive, .SLPLimit, .SLPFault, and .CheckDelayActive outputs are cleared to OFF(0). The Diagnostic Code output is set to 0. The Fault Type output is set to 1
Rung-condition-in is false	The .01, .SLPActive, .SLPLimit and .CheckDelayActive outputs are cleared to OFF(0). If an instruction fault is present when rung went false the fault condition will be maintained and Diagnostic Code displayed.
Rung-condition-in is true	The instruction executes.

Condition/State	Action Taken
Postscan	N/A

Operation

Normal Operation

The SLP function begins if it has been previously reset and the Request input is asserted ON(1). At this point the Check Delay Timer begins. When the Check Delay Timer expires, position monitoring begins. The Actual Position, provided by an SFX instruction, is compared to the Positive and Negative Position Limits. If the position is not within these limits then the Limit Output is set to ON(1) and remains set until the SLP function is reset. The SFX instruction must be homed before the SLP function operates.

Position values used in the SLP instruction are in Position Units. A position unit is user defined according to the particular application and is configured in the SFX instruction.

During operation the Position Limits may be programmatically changed. If the limits are changed while the function is operating then the new limits will take effect immediately.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SLP function:

SLP Instruction Output	Pass-Through Tags for Motion Safety Instances	Safe Motion Monitoring Drive Action	Axis Tag
SLP Active	module[1]:SO.SLPActive[instance[2]]	updates tag	axis[3].SLPActiveStatus
SLP Limit	module[1]:SO.SLPLimit[instance[2]]	updates tag	axis[3].SLPLimitStatus
SLP Fault	module[1]:SO.SLPFault[instance[2]]	updates tag	axis[3].SLPFault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

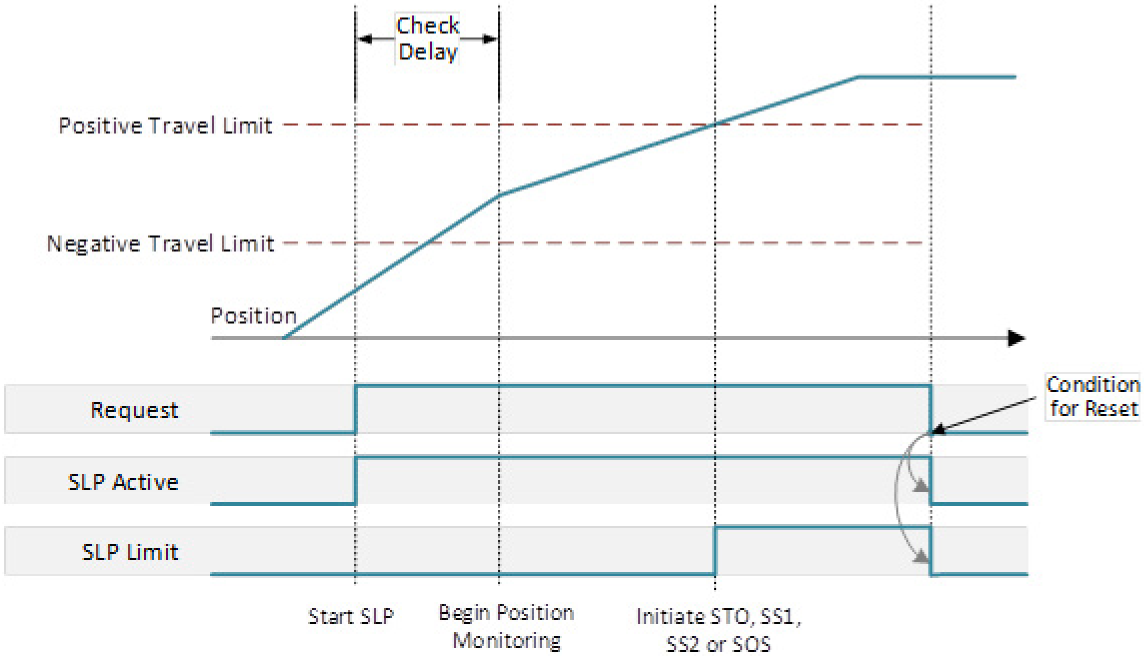
When assigning the SLP Active, SLP Limit and SLP Fault instruction outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status and Axis Safety Faults tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task. The following is a typical sequence of events:

1. The safety application receives an input to begin speed position monitoring.
2. The safety application sets the Request input ON(1) to request the SLP function.
3. The SLP instruction sets SLP Active output and writes the module:SO.SLPActive[instance] tag of the motion safety instance of the drive.
4. The motion safety instance in the drive updates the Axis Safety Status tag read in the motion controller.
5. The motion application controls the axis position to keep within the SLP Travel Limits.

In many applications it is necessary for the SLP Positive Travel Limit or Negative Travel Limit to change dynamically. Changes to the SLP Travel Limits are range checked and then applied to the SLP function even if the function is active. It may also be necessary for the motion application to coordinate speed control with Active Limit changes. To accommodate motion coordination the safety controller tag list contains two general purpose 16 bit tags for each motion safety instance. These tags appear as module:SO.PassThruData[A|B][instance]. Axis tags named axis.AxisSafetyDataA and axis.AxisSafetyDataB are updated whenever the corresponding pass-through tags module:SO.PassThruDataA[instance] and module:SO.PassThruDataB[instance] change values.

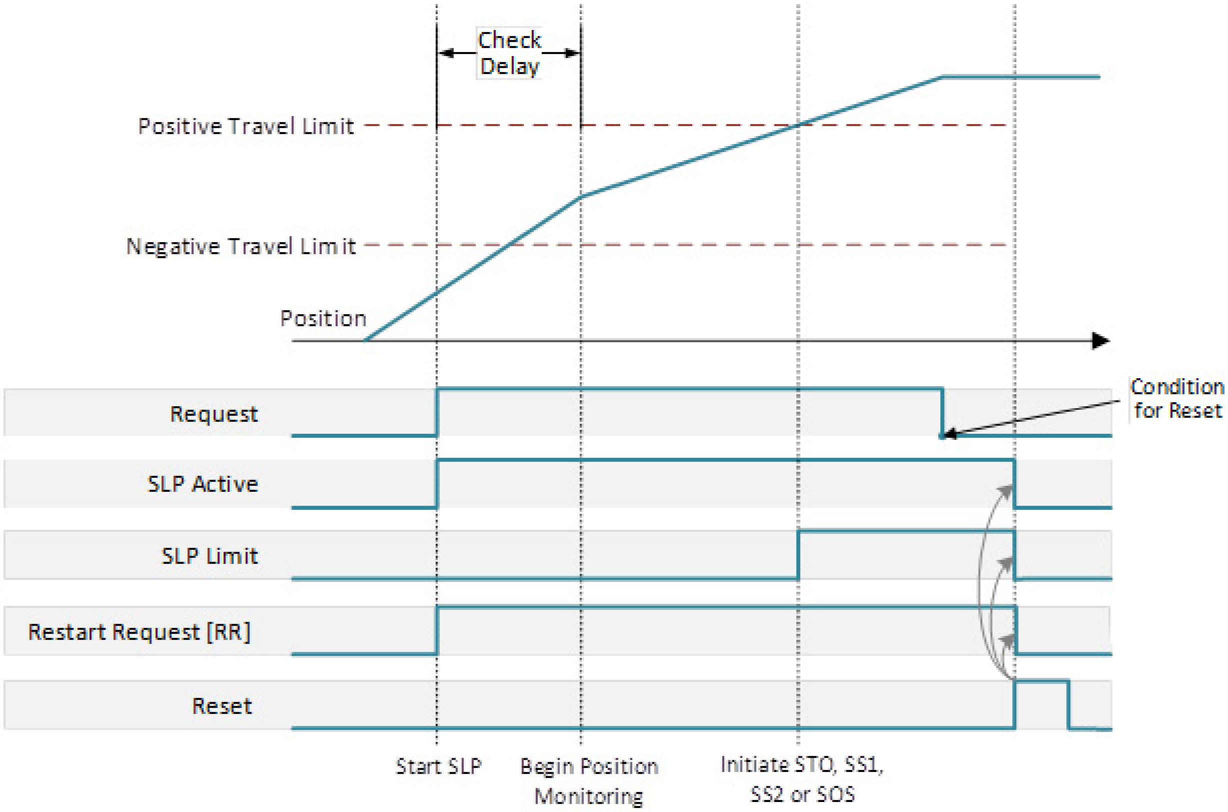
Normal Operation, Automatic Restart

The following diagram shows normal operation with Automatic Restart. After Check Delay expires the Position is shown to be within the Positive and Negative Travel Limits. The diagram then shows the position moving outside of the limits and the Limit Output is set to ON(1). For automatic restart operation, the SLP function is reset when the Request is removed, OFF(0), provided no SLP faults have occurred.



Normal Operation, Manual Restart

When manual restart is enabled, the SLP function requires a reset before subsequent operation. The Reset output indicates that the Reset input must make an OFF(0) to ON(1) transition to reset the function after the Request input is removed OFF(0). The following diagram shows normal operation with manual restart.



Faulted Operation

Faults for SLP may be for invalid configuration, SFX Instruction not ready or not homed as described in the Fault Codes and Corrective Actions section.

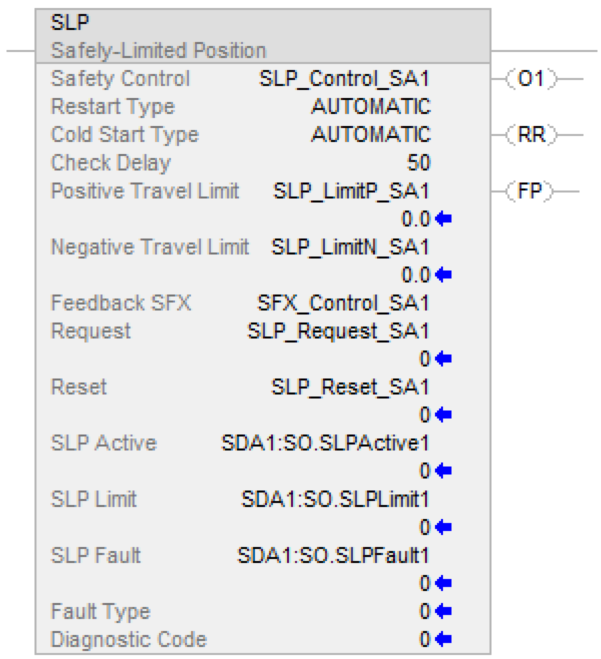
Fault Codes and Corrective Actions

Fault Code	Description	Corrective Action
1	No Fault	None.
2	Invalid Configuration Fault	Check the Positive and Negative Travel limits. For Rotary motion, these values must be less than (unwind * position scaling) and the positive limit must be greater than the negative limit. After the configuration is correct then reset the fault.
101	Axis Not Homed Fault	The SFX instruction used with SLP must be homed. SLP only works with absolute positions. Home the SFX instruction used with this SLP instruction.
102	SFX Instruction Not Ready	Ensure that the SFX function that supplies inputs to this SLP instance is executing and not faulted before requesting SLP.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information.	None
10	Rung went false while SLP function was executing.	Make sure this instruction is enabled.
20	Positive Travel Limit value not valid	If unwind is > 0 then the Limit value must be less than (Unwind/Position Scaling). The Positive Travel Limit must be > Negative Travel Limit.
21	<<<Negative Travel Limit value not valid.>>>	<<<The Negative Travel Limit must be less than the Positive Travel Limit.>>>
22	<<<Check Delay value not valid>>>	<<<Check the Check Delay value to ensure it is ≥ 0 and ≤ 32767.>>>
23	<<<Positive Travel Limit exceeded>>>	<<<Move the axis to a lower position.>>>
<<<24>>>	<<<Negative Travel Limit exceeded>>>	<<<Move the axis to a larger position.>>>

Example



See Also

Drive Safety Instructions on page 361

Index Through Arrays on page 540

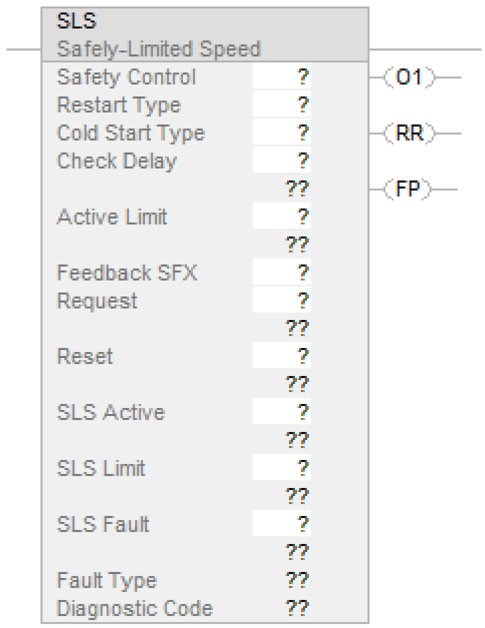
Safely-Limited Speed (SLS)

This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safely-Limited Speed instruction monitors the speed of a motor or axis and sets the SLS Limit output if the speed exceeds the Active Limit input value.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safely-Limited Speed Application

Safely-Limited Speed is used with a CIP safety drive that supplies motor or axis speed and a Safe Feedback Interface (SFX) instruction to scale the feedback. During operation, the SLS instruction signals when the motor speed exceeds a specified limit. During operation of the SLS function, the limit may be changed. The output is used to initiate an application specific action such as STO, SS1, SS2 or STO.

Operands

IMPORTANT Unexpected operation may occur if:

- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

ATTENTION: The SLS Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides operands used for configuring the instructions.

Operand	Data Type	Format	Description
Safety Control	SAFELY_LIMITED_SPEED	tag	Data structure required for proper operation of instruction.
Restart Type		list item	This input selects the Restart Type for the instruction. **MANUAL (0)** A 0 to 1 transition of the Reset input is required after Request has been removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction will reset when the Request has been removed and no fault is present [FP] = OFF(0). Once reset, the instruction will be able to operate. **ATTENTION:** Only use Automatic Restart in applications where it is determined that no unsafe conditions occur from its use.
Cold Start Type		list item	Selects the Behavior when applying controller power or a controller mode change to Run. **MANUAL (0)** A 0 to 1 transition of the Reset input is required with the Request removed to enable the instruction to operate. **AUTOMATIC (1)** The instruction resets when the Request has been removed.

Inputs

The following table explains the instruction inputs.

Operand	Data Type	Format	Description
Request	BOOL	tag	When set to ON(1) this operand initiates operation of SLS monitoring.
Active Limit	REAL	immediate tag	This operand defines the speed limit trip point. Range: $>$ zero Units: Position Unit / Time Unit

Operand	Data Type	Format	Description
Check Delay	INT	immediate tag	This operand sets the delay time between the instruction Request input and the start of the speed monitoring. Range: 0 to 32,767 Units: mSec
Feedback SFX	SAFETY_FEEDBACK_INTERFACE	tag	This operand provides velocity data. Assign this operand is to the Safety Control tag of the SFX instruction that is used with this SLS instruction. The following members of the SFX Safety Control tag are used: FeedbackSFX.ActualVelocity units: Position Unit / Time Unit
Reset[1]	BOOL	tag	This operand resets the SLS function. An OFF(0) to ON(1) transition resets the SLS function and Fault Present [FP] provided the Request is OFF(0) and any fault condition has been removed. The Reset Required [RR] output indicates when a reset is required to reset the function.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename the 'Reset_Signal' tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.

Reset-Signal Example

Outputs

This table explains the instruction outputs. The outputs are external tags (safety output modules) or internal tags used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1): Indicates the instruction is executing and the function is not faulted. OFF(0): Any of the conditions below: • The rung in condition is no longer true. • An instruction fault has occurred.
Reset Required [RR]	BOOL	ON(1): Indicates that a reset is required to restart the instruction and or to clear faults. See Reset Input for Reset sequence. OFF(0): Normal operation under Automatic Restart operation.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.
Diagnostic Code	SINT	This output indicates the diagnostic status of the instruction. See Diagnostic Codes and Corrective Actions for specific codes and actions.

Operand	Data Type	Description
Fault Type	SINT	This output indicates the type of fault that occurred. See the Fault Codes and Corrective Actions section for specific codes and actions.
Check Delay Active	BOOL	ON(1): Indicates that Check Delay timer is active.

This table explains the instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
SLS Active	BOOL	tag	The SLS instruction writes the SLS Active status to this tag. OFF(0): SLS not active ON(1): SLS active **Tip:** Assign the SLS Active operand to the SLS Active member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.
SLS Limit	BOOL	tag	The SLS instruction writes the SLS Limit status to this tag. OFF(0): Speed has not reached the limit. ON(1): The speed limit was reached or exceeded. **Tip:** Assign the SLS Limit operand to the SLS Limit member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status updates automatically in the drive axis tag structure so that any necessary actions by the motion controller can be taken.
SLS Fault	BOOL	tag	The SLS instruction writes the SLS Fault status to this tag. OFF(0): Not faulted ON(1): Faulted SLS Fault is set to ON (1) state for the following fault type and corresponding condition: • Configuration Fault An instruction input operand value is out of range. • SFX Instruction Not Ready Fault The feedback used for monitoring is not valid or the SFX instruction is not running when SLS is requested. **Tip:** Assign the SLS Fault operand to the SLS Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults tag updates automatically in the drive axis tag structure so that any necessary actions by the motion controller can be taken.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .O1, .FP, .RR, .SLSActive, .SLSLimit, .SLSFault, and .CheckDelayActive outputs are cleared to OFF(0). The Diagnostic Code output is set to OFF(0). The Fault Type output is set to ON(1).
Rung-condition-in is false	The .O1, .SLSActive, .SLSLimit and .CheckDelayActive outputs are cleared to OFF(0). If an instruction fault is present when rung went false the fault condition will be maintained and Diagnostic Code displayed.
Rung-condition-in is true	The instruction executes.
Postscan	N/A

Operation

Normal Operation

The SLS function begins if it has been previously reset and the Request input is asserted ON(1). At this point the Check Delay Timer will begin. When the Check Delay Timer expires speed monitoring begins. The speed provided by an SFX instruction is compared to the active limit. If the axis speed exceeds the Active Limit then the SLS Limit is set to ON(1) and remains on until the SLS function is reset.

All speed values used in the SLS instruction are in Position Units / Time Unit. A position unit is user defined according to the particular application and is configured in the SFX instruction. Time units are also configured in the SFX instruction and may be selected as seconds or minutes.

Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SLS function:

SLS Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tag
SLS Active	module[1]:SO.SLSActive[instance[2]]	updates tag	axis[3].SLSActiveStatus
SLS Limit	module[1]:SO.SLSLimit[instance[2]]	updates tag	axis[3].SLSLimitStatus
SLS Fault	module[1]:SO.SLSFault[instance[2]]	updates tag	axis[3].SLSFault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

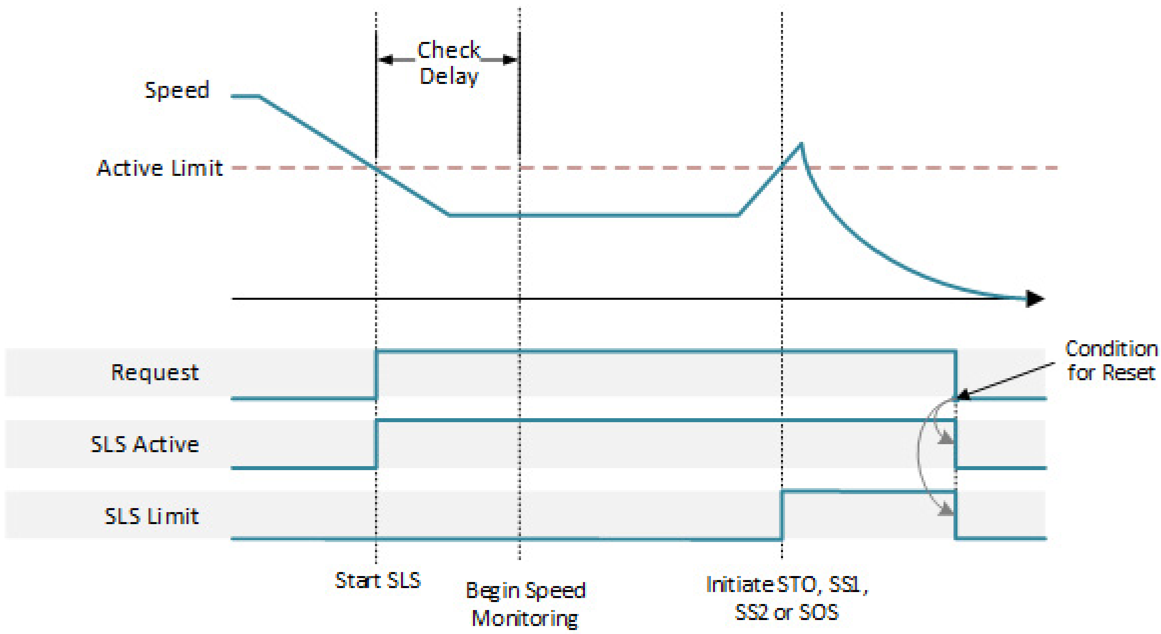
When assigning the SLS Active, SLS Limit and SLS Fault instruction outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status and Axis Safety Faults tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task. The following is a typical sequence of events:

1. The safety application receives an input to begin speed monitoring.
2. The safety application sets the Request input ON(1) to request the SLS function.
3. The SLS instruction sets SLS Active output and writes the module:SO.SLSActive[instance] tag of the motion safety instance of the drive.
4. The motion safety instance in the drive updates the Axis Safety Status tag read in the motion controller.
5. The motion application reduces the axis speed or continues to maintain the axis speed below the SLS Active Limit.

In many applications it is necessary for the SLS Active Limit to change dynamically. Changes to the SLS Active limit are range checked and then applied to the SLS function even if the function is active. It may also be necessary for the motion application to coordinate speed control with Active Limit changes. To accommodate motion coordination the safety controller tag list contains two general purpose 16 bit tags for each motion safety instance. These tags appear as module:SO.PassThruData[A|B][instance]. Axis tags named axis.AxisSafetyDataA and axis.AxisSafetyDataB are updated whenever the corresponding pass-through tags module:SO.PassThruDataA[instance] and module:SO.PassThruDataB[instance] change values.

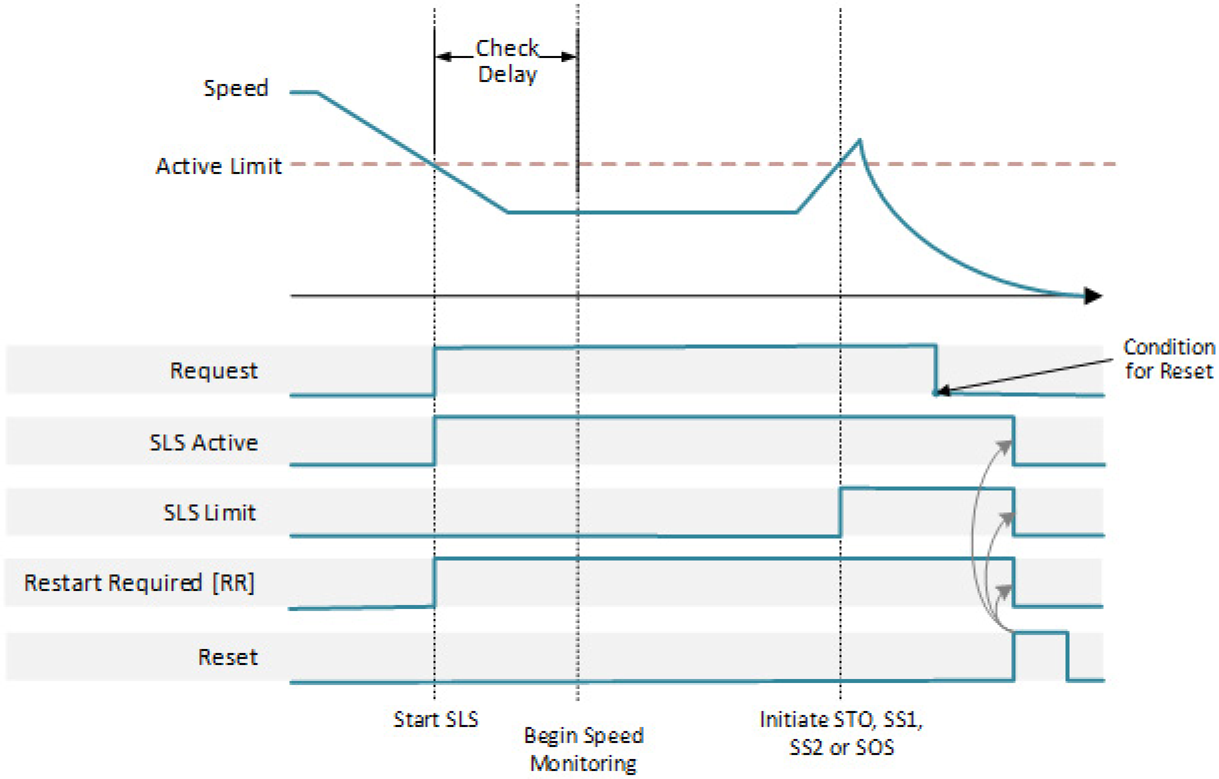
Normal Operation, Automatic Restart

Normal operation with Automatic Restart is shown in the following diagram. After Check Delay expires the speed must stay below the Active Limit or the SLS Limit will be set to ON(1). The SLS Limit, once set will remain ON(1) until the SLS function is reset. For automatic restart operation, the SLS function will be reset when the request is removed OFF(0) provided no SLS faults have occurred.



Normal Operation, Manual Restart

When manual restart is enabled, the SLS function requires an OFF(0) to ON(1) transition of the Reset input to reset the SLS function instruction before subsequent operation. The Reset Required output indicates that the Reset input must make an OFF(0) to ON(1) transition to reset the instruction. The following diagram shows normal operation with Manual Restart.



Faulted Operation

Faults for the SLS Limit function are for invalid configuration, and SFX Instruction Not Ready described in the following section, Fault Codes and Corrective Actions. If the Active Limit is exceeded a Fault is not asserted, only SLS Limit is set to ON(1)

Fault Codes and Corrective Actions

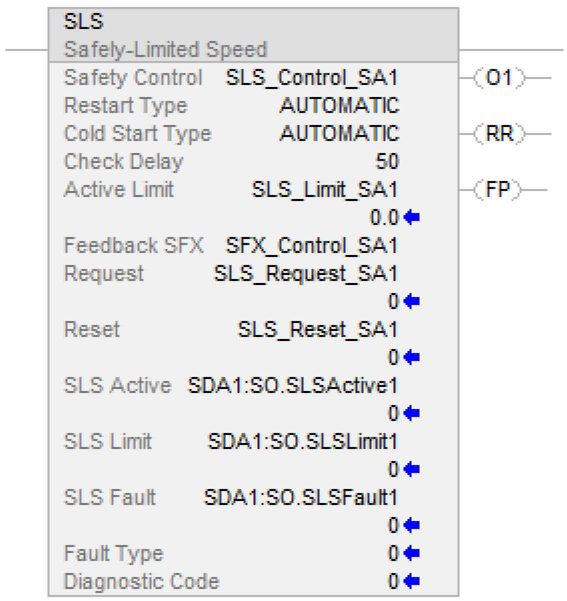
Fault Code	Description	Corrective Action
1	No Fault	None.
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
102	SFX Instruction Not Ready Fault	Ensure that the SFX function that supplies inputs to this SLS instance is executing and not faulted before requesting SLS.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information.	None

Diagnostic Code	Description	Corrective Action
10	Rung went false while SLS function was executing.	Make sure this instruction rung is enabled.
20	Active Limit value not valid.	Check the Active Limit value to ensure it is within the allowed range.
21	Check Delay value not valid.	Check the Check Delay value to ensure it is within the allowed range.
22	Active Limit exceeded.	Reduces the axis speed before Check Delay expires.

Example



See also

Drive Safety Instructions on page 361

Index Through Arrays on page 540

Safety Feedback Interface (SFX)

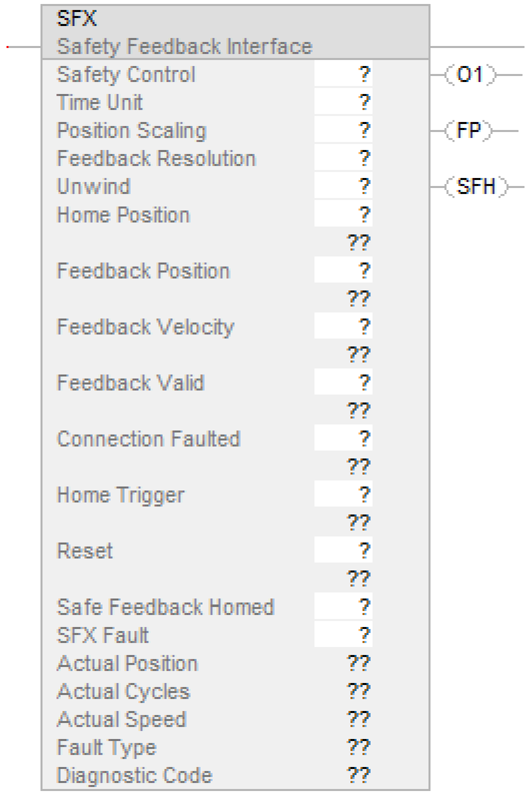
This instruction only applies to the Compact GuardLogix 5380 and GuardLogix 5580 controllers.

The Safety Feedback Interface instruction scales feedback position into position units and feedback velocity into position units per time unit. Feedback Position and Velocity are read from a Safety Input assembly. SFX also allows a reference position to be set from a home input. SFX performs position unwind in rotary applications.

The outputs of this instruction are used as inputs to other drive safety instructions. An SFX instruction must be used for every safe feedback from a drive providing position or velocity to a drive safety instruction.

Available Languages

Ladder Diagram



Function Block

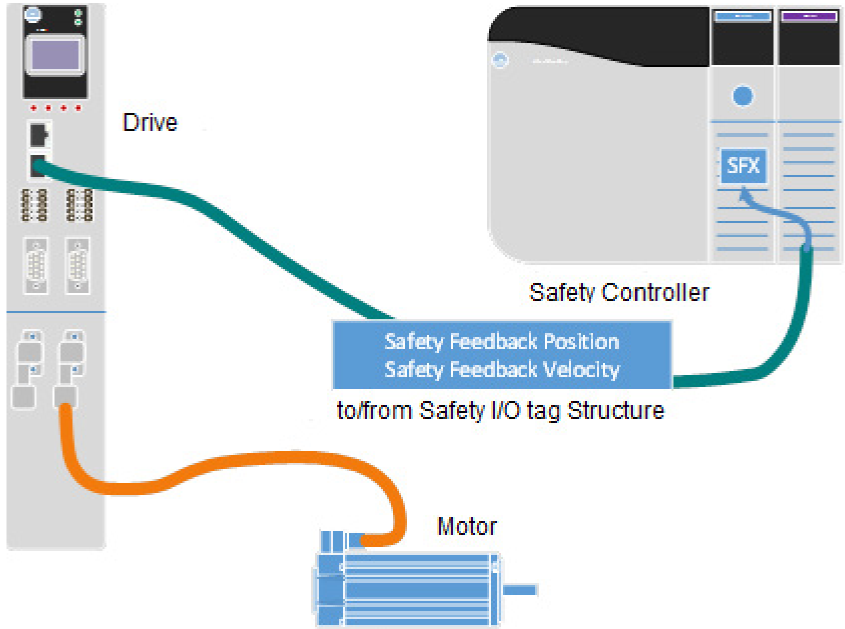
This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Safety Feedback Interface Application

Safety Feedback Interface is used with a CIP Safety Drive and a motor or axis that supplies safe Feedback Position and Velocity to a safety controller. The actual position and actual velocity outputs, scaled according to the users application are supplied to other drive safety instructions.



Operands

IMPORTANT Unexpected operation may occur if:
- Output tag operands are overwritten.
- Members of a structure operand are overwritten.
- Structure operands are shared by multiple instructions.

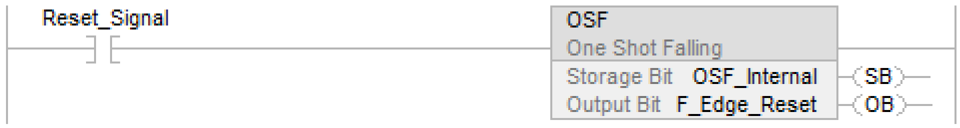
ATTENTION: The SFX Safety Control structure contains internal state information. If any of the configuration operands are changed while in run mode, accept the pending edits and cycle the controller mode from Program to Run for the changes to take effect.

The following table provides the operands that are used to configure the instruction.

Operand	Data Type	Format	Description
Safety Control	SAFETY_FEEDBACK_INTERFACE	tag	Data structure required for proper operation of instruction.
Time Unit		list item	This operand scales the Actual Speed output according to the selected time unit. **SECONDS (0)** Actual Speed is in Position Units / Second **MINUTES (1)** Actual Speed is in Position Units / Minute
Position Scaling	REAL	immediate tag	The conversion factor required to convert position counts into user units. The value is evaluated once on rung true and Output 1 [01] is ON(1). Range: > 0 Units: Feedback Counts / Position Unit

Operand	Data Type	Format	Description
Feedback Resolution	DINT	immediate tag	The number of Feedback Position counts per revolution of the safety feedback encoder. This value must match the value used by the drive's Safety Feedback Object. Range: > 0
Unwind	DINT	immediate tag	The rollover point for Feedback Position. The value is evaluated once on rung true and Output 1 [O1] ON(1). 0: Unwind Disabled > 0: Unwind Enabled Units: Feedback Counts / Unwind Cycle When set to 0, the rollover unwind is disabled. The Actual Position output will wrap around from (Unwind / Position Scaling) to 0 and vice versa depending on the direction of movement.
Home Position	REAL	immediate tag	The value assigned to the Actual Position after a successful instruction home. The value is read once after rung true and Output 1 [O1] is ON(1). Units: Position Units **Tip:** If Unwind is configured for a non-zero value, the Home Position must be between 0 and the Unwind Position.
Feedback Position	DINT	tag	Position counts input Units: Counts **Tip:** Enter the Primary Feedback Position tag member of the motion safety instance providing position.
Feedback Velocity	REAL	tag	Velocity input Units: Feedback Units/Second, where Feedback Units are revolutions. **Tip:** Enter the Primary Feedback Velocity tag member of the motion safety instance providing velocity.
Feedback Valid	BOOL	tag	Feedback Valid input indicates that the Feedback Position and Feedback Velocity are valid for use. OFF(0): Not Valid ON(1): Valid **Tip:** Enter the Feedback Valid tag member of the motion safety instance providing feedback.
Connection Faulted	BOOL	tag	This input indicates the connection status to and from the drive safety instance. OFF(0): OK ON(1): Fault **Tip:** Enter the Connection Faulted tag member of the motion safety instance used with this SFX instruction.
Home Trigger	BOOL	tag	A ON(1) to OFF(0) transition of this input sets the Actual Position output to the Home Position input value and sets the Safe Feedback Homed output to ON(1) state. Setting Home Trigger ON(1) clears Safe Feedback Homed and Output SFH outputs OFF(0).
Reset[1]	BOOL	tag	This input clears an instruction fault provided the fault condition is not present. An OFF(0) to ON(1) transition of Reset clears, the Fault Present [FP], Fault Type and Diagnostic Code. The Fault Code is set to No Faults.

[1] ISO 13849-1 stipulates instruction reset function must occur on falling edge signals. To comply with ISO 13849-1 requirements, add the logic immediately before this instruction. Rename 'Reset Signal' tag in this example to the reset signal tag name. Then use the OSF instruction Output Bit tag as the instruction's reset source.



This table explains instruction outputs. The outputs are external tags (safety output modules) or internal tags for used in other logic routines.

Operand	Data Type	Description
Output 1 [O1]	BOOL	ON(1): Indicates the instruction is executing and not faulted. OFF (0): • The rung in condition is false. • The instruction is faulted.
Fault Present [FP]	BOOL	ON(1): A fault is present in the instruction. OFF(0): The instruction is operating normally.
Safe Feedback Homed [SFH]	BOOL	Instruction output that indicates the instruction has successfully defined the home position. SFH will be in the same state as Safe Feedback Homed operand. OFF(0): Not Homed (Incremental Position Only) ON(1): Homed (Absolute Position Valid)
Actual Position	REAL	Instruction output that represents the position in Position Units. Units: Position Units If the instruction is faulted the Actual Position will no longer be updated and will display as 0. When the instruction rung-in-condition initially becomes TRUE the Actual position will begin to update from the initial value of zero. If Unwind is > 0 then Actual Position will wrap around to 0 when the Actual Position reaches Unwind / Position Scaling for increasing position. The Actual Position will wrap from 0 to Unwind / Position Scaling for decreasing position.
Actual Cycles	DINT	When unwind is > 0 the feedback is configured as a rotary application. In a rotary application each time the position exceeds the unwind value, or rollover point, the Actual Cycles is incremented. When rotation is in the negative direction and the position decreases past zero, the position wraps around to the unwind value and Actual Cycles is decremented.
Actual Speed	REAL	Instruction output that represents the speed of the motor from the safe feedback object converted to user defined units for speed. Units: Position Units / Second OR Position Units / Minute If the instruction is faulted the Actual Speed will no longer be calculated and will display as 0.
Fault Type	SINT	Indicates the type of fault. See the Fault Codes and Corrective Actions section for specific codes and actions.
Diagnostic Code	SINT	Indicates information about the cause of a fault. See the Diagnostic Codes and Corrective Actions section for specific codes and actions.

This table explains instruction outputs that are written to the user-specified tag.

Operand	Data Type	Format	Description
Safe Feedback Homed	BOOL	tag	This output indicates that the SFX instruction has successfully defined the home position. OFF(0): Not homed (SFX used for incremental position only) ON(1): Homed (Home Position set) Safe Feedback Homed transitions to OFF (0) when: • SFX faults • SFX rung in condition is False • Home Trigger is ON(1) **Tip:** Assign this tag to the Safe Feedback Homed member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Status RA tag updates automatically in the drive axis tag to enable coordination of the motion task with the safety task.
SFX Fault	BOOL	tag	This output indicates SFX Fault status. OFF(0): Not Faulted ON(1): Faulted - See Faults and Corrective Actions **Tip:** Assign this tag to the SFX Fault member of the safety output tag structure corresponding to the motion safety instance of the drive module. The corresponding Axis Safety Faults RA tag updates automatically in the drive axis tag structure to enable coordination of the motion task with the safety task.

IMPORTANT Do not write to any instruction output tag under any circumstances.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

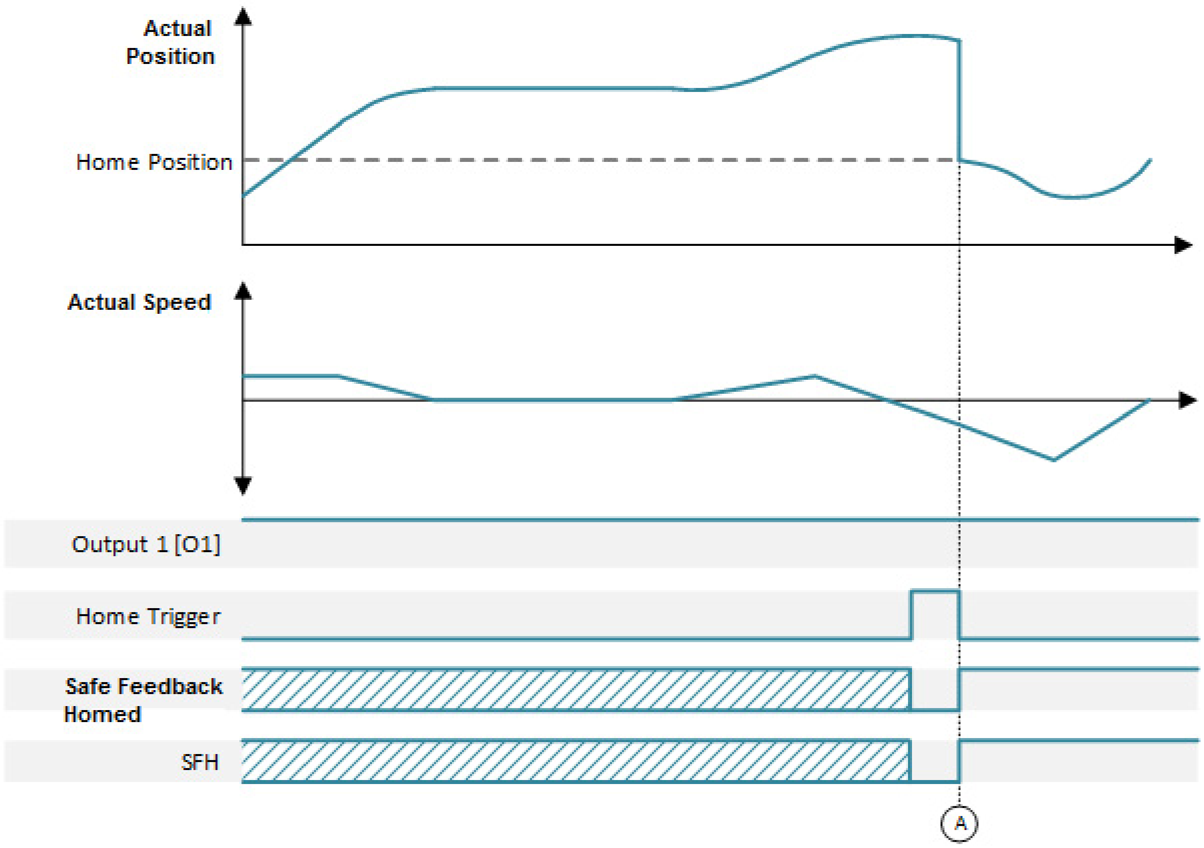
Execution

Ladder Diagram

Condition/State	Action Taken
Prescan	The .O1, .SFH, .SFHomed and .SFXFault outputs are cleared to OFF(0). The Diagnostic Code output is set to OFF (0) The Fault Type output is set to ON (1). ActualPosition, ActualCycles, ActualSpeed, PositionScalingOut, and UnwindOut are set to a value of 0.
Rung-condition-in is false	The .O1, .SFH and .SFHomed outputs are cleared to false. If an instruction fault is present when rung went false the fault condition will be maintained and Diagnostic Code displayed.
Rung-condition-in is true	The instruction executes.
Postscan	Not used

Home Operation

The SFX instruction requires a home input to set a home position for absolute position operation. At (A), the Home Trigger input transitioned from ON(1) to OFF(0) and initiates the setting of the Actual Position output to the Home Position input value. With a successful Home Operation, SF Home and Output SFH, are set to ON(1). Also shown, SF Home and Output SFH are set to OFF(0) whenever Home Trigger is ON(1). Since the Actual Position is simply updated with the home position with the trigger, it is recommended that the axis be stopped when homing.



Pass-Through Tags

A Safe Motion Monitoring Drive has one or more motion axes that are controlled by a motion task. The Safe Motion Monitoring Drive also has one or more motion safety instances that support safety functions used in a safety task of a safety controller. Some of the tags associated with a drives motion safety instance are pass-through tags. The following table shows the pass-through tags and the corresponding axis tags for the SFX instruction:

SFX Instruction Output	Pass-Through Tags for Motion Safety Instance	Safe Motion Monitoring Drive Action	Axis Tag
Safe Feedback Homed	module[1]:SO.SFHome[instance[2]]	updates tag	axis[3].SafeFeedbackHomedStatus
SFX Fault	module[1]:SO.SFXFault[instance[2]]	updates tag	axis[3].SFXFault

[1]module is the name for the drive module in Logix Designer I/O Configuration tree

[2]instance is 1 or 2 for dual axis drives otherwise null

[3]axis is the axis name in the Logix Designer Motion Group and is associated with module

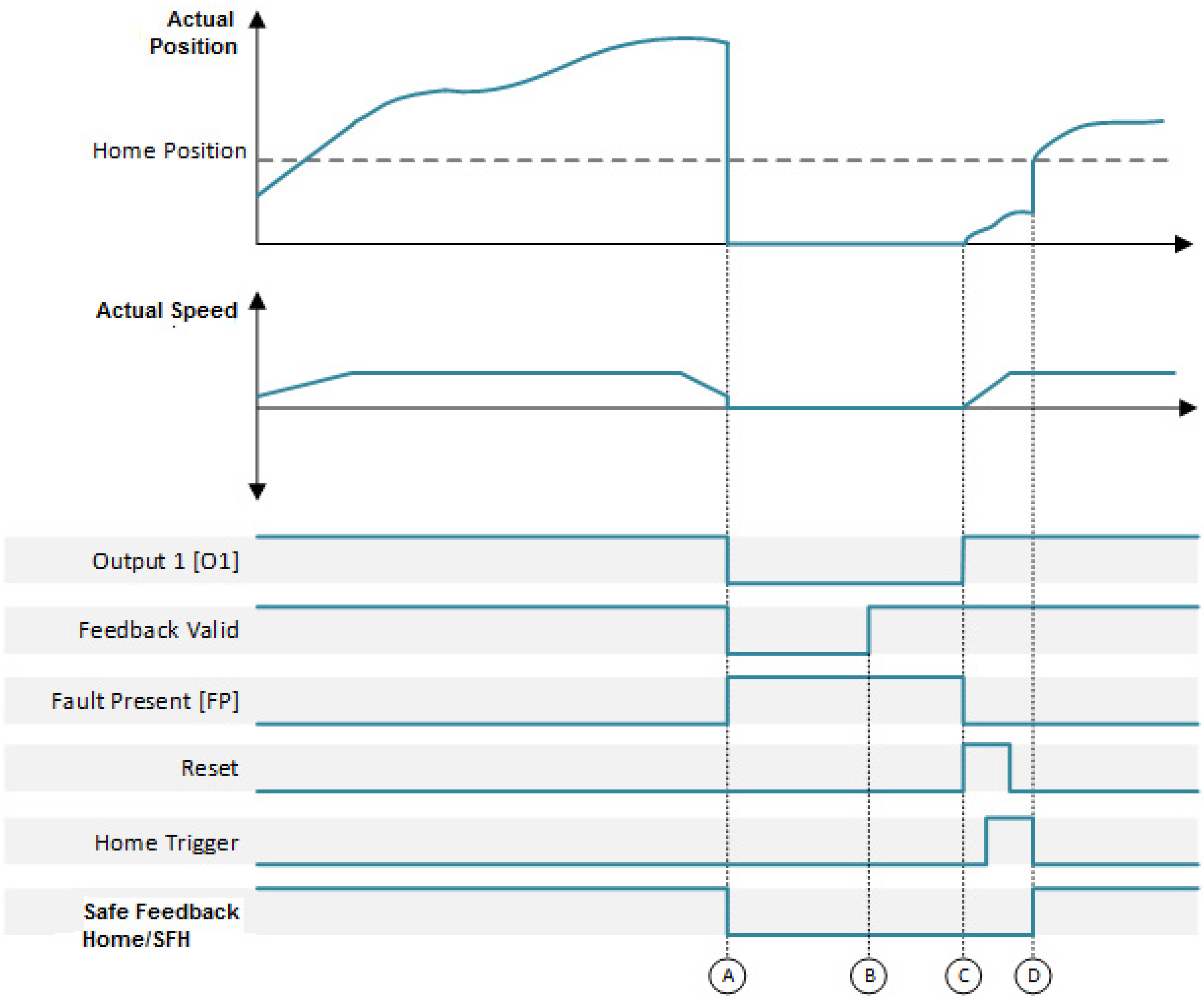
When assigning the Safe Feedback Homed and SFX Fault instruction outputs to the motion safety instance pass-through tags, the corresponding Axis Safety Status RA and Axis Safety Faults RA tags automatically update in the motion controller. The motion control task of motion controller reads the Axis Safety Status and the Axis Safety Faults tags to coordinate operation between the safety task and motion task.

Feedback Valid Fault

A SFX instruction will fault if the Primary Feedback Valid tag from the drive Safety Input Assembly turns OFF(0) while the instruction is executing. When this happens Output 1 [O1] turns OFF(0), Fault Present [FP] output turns ON(1), Safe Feedback Homed/SFH outputs turn OFF(0) and both Actual Position and Actual Speed are set to 0 at (A).

When Feedback Valid turns ON(1) (fault condition no longer present) at (B), a Reset is required to clear the fault, turn Output 1 [O1] ON(1) and begin calculating the position and speed at (C).

A Home Trigger input ON(1) to OFF(0) transition is required to reset home position at (D).



Fault Codes and Corrective Actions

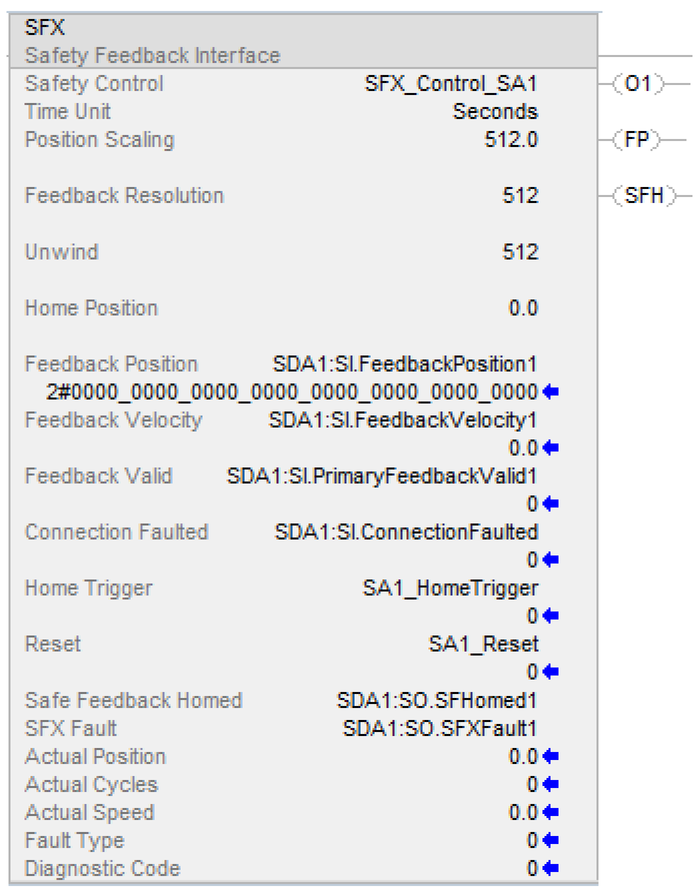
Fault Code	Description	Corrective Action
1	No Fault	None.
2	Invalid Configuration Fault	• Check the input values and correct inconsistencies or illegal values. Check the diagnostic code for more information • Reset the fault.
100	Feedback Invalid Fault	• The drive supplying the feedback has detected a fault, or the safety feedback has not been configured. Configure the feedback or correct the fault. • Reset the fault
101	Connection Fault	• Check the wiring. Check the network status of the modules. • Reset the fault.
102	Positive Arithmetic Overflow	The position exceeds the limits of linear system. Reduce the range of motion.

Fault Code	Description	Corrective Action
103	Negative Arithmetic Overflow	The position exceeds the limits of linear system. Reduce the range of motion.
104	Home Position Arithmetic Overflow	The Home Position exceeds the allowable range of a linear system. Check the program for correct Home Position value and Position Scaling value.
105	Actual Speed (position units/time unit) calculation has exceeded the limit of a REAL data type.	Verify Position Scaling and Feedback Resolution input values are correct.

Diagnostic Codes and Corrective Actions

Diagnostic Code	Description	Corrective Action
0	No diagnostic information available.	None
20	Feedback Resolution value not valid.	The resolution must be greater than 0.
21	Position Scaling value not valid.	Check the position scaling value.
22	Unwind value not valid.	Check the unwind value.
23	Home Position value was not valid when the Home Trigger transitioned from OFF(0) to ON(1).	If using unwind, verify Home Position value is greater than or equal to 0.0 and less than the Unwind value.

Example



See also

Drive Safety Instructions on page 361

Index Through Arrays on page 540

RSLogix 5000 Software, Version 14 and Later, Safety Application Instructions

This chapter provides general information about how to use the safety applications within a safety system that has a controller and I/O modules.

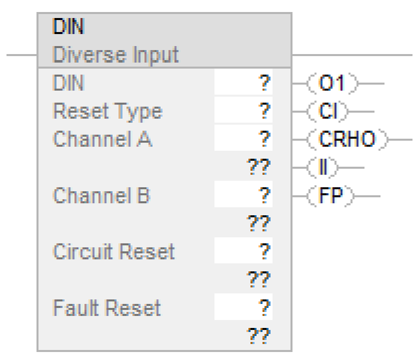
Diverse Input (DIN)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

Use the Diverse Input (DIN) instruction to emulate the input functionality of a safety relay in a software programmable environment.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Make sure that your safety input modules are configured as Single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat.4) safety functions.

This table explains the instruction inputs.

Parameter	Data Type	Description	Values
DIN	DIVERSE_INPUT	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.	-
Reset Type	BOOL	The reset type determines whether the instruction is using Manual or Automatic reset for Output 1.	Manual = 1 or Automatic = 0
Channel A[1]	BOOL	Channel A Input (Normally Open)	Safe = 0, Active = 1
Channel B[1]	BOOL	Channel B Input (Normally Closed)	Safe = 1, Active = 0
Circuit Reset	BOOL	Circuit Reset Input Manual Reset - Sets Output 1 after Channel A and Channel B are in the Active state, and the Circuit Reset input transitions from zero to one. Automatic Reset - Visible, but not used.	Initial = 0 Reset = 1
Fault Reset	BOOL	After fault conditions are corrected for the instruction, the fault outputs for the instruction are cleared when this input transitions from off to on.	Initial = 0 Reset = 1

[1] If this input is from a Guard I/O input module, make sure that the input is configured as a single, not Equivalent or Complementary.

This table explains the instruction outputs.

Parameter	Data Type	Description	Values
Output 1	BOOL	Output 1 is set to the Active state when input conditions are met.	Safe = 0, Active = 1
Cycle Inputs	BOOL	Cycle Inputs prompts for action. Before Output 1 is turned on, Channel A and Channel B inputs must be cycled through their Safe States at the same time before the circuit can be reset. This prompt is cleared when Channel A and Channel B transition to the Safe state.	Initial = 0 Prompt = 1
Circuit Reset Held On	BOOL	Manual Reset - The Circuit Reset Held On prompt is set when both input channels transition to the Active states, and the Circuit Reset input is already on. The Circuit Reset Held On prompt is cleared when the Circuit Reset input is turned off. Automatic Reset - Visible, but not used.	Initial = 0 Prompt = 1

Parameter	Data Type	Description	Values
Inputs Inconsistent	BOOL	This fault is set when Channel A and Channel B inputs are in inconsistent states (one Safe and one Active) for a period of time greater than the Inconsistent Time Period (listed below). This fault is cleared when Channel A and Channel B inputs return to consistent states (both Safe or both Active) and the Fault Reset input transitions from off to on. Inconsistent Time Period: 500 ms	Initial = 0 Fault = 1
Fault Present	BOOL	This is set whenever a fault is present in the instruction. Output 1 cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from off to on.	Initial = 0 Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Operation

This instruction monitors the states of two input channels and turns on Output 1 when the following conditions are met:

When using Manual Reset: both inputs are in the Active state and the Circuit Reset input is transitioned from a zero to a one.

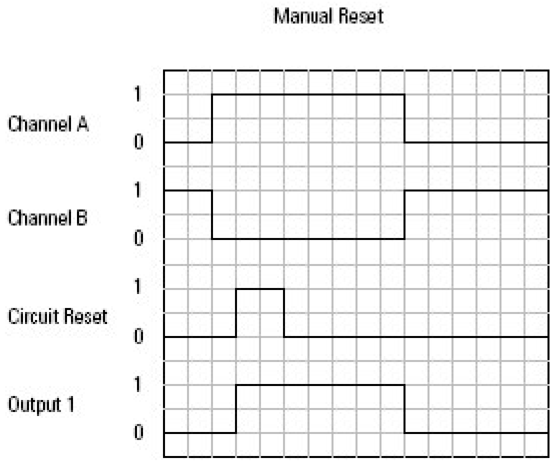
When using Automatic Reset: both inputs are in the Active state for 50 ms.

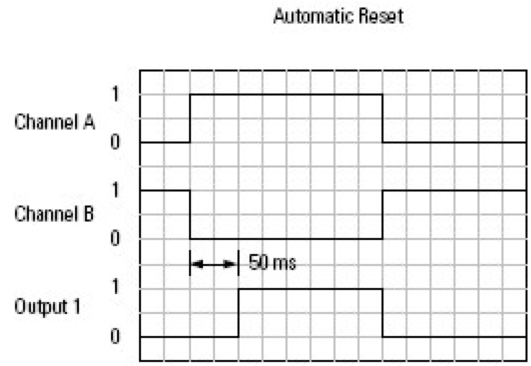
This instruction turns Output 1 off when either one or both of the input channels returns to the Safe state.

The Diverse Input (DIN) instruction has one input channel that is normally open and one that is normally closed. This means that a zero on the normally open channel and a one on the normally closed channel represent the Safe state, and vice-versa for the Active state.

See Safety Instructions for more information about how to condition input data associated with the normally closed channel.

These normal operation state changes are shown in the following timing diagrams:



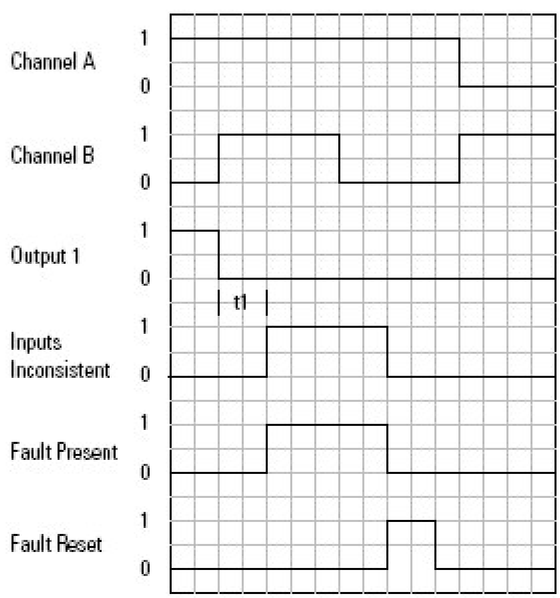


Operation with Inconsistent Inputs

This instruction generates a fault if the input channels are in inconsistent states (i.e., one Safe and one Active) for more than the specified period of time. The inconsistent time period is 500 ms.

This fault condition is enunciated via the Inputs Inconsistent and the Fault Present outputs. Output 1 cannot enter the Active state while the Fault Present output is active. The fault indication is cleared when the offending condition is remedied and the Fault Reset input is transitioned from zero to one.

These state changes are shown in the following timing diagram:

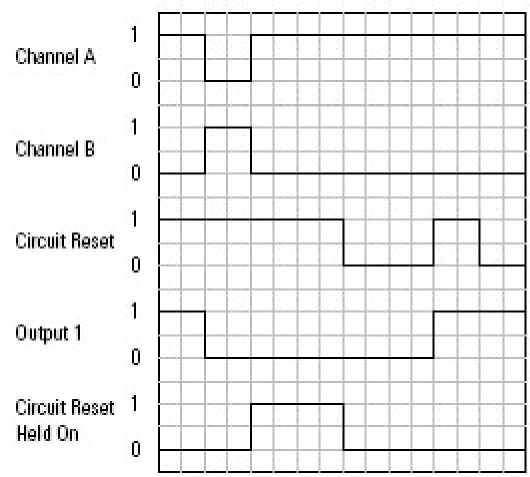


t1 = Inputs Inconsistent Time Period

Operation with Circuit Reset Held On - Manual Reset Only

This instruction also sets the Circuit Reset Held On output prompt if the Circuit Reset input is set (1) when the input channels transition to the Active state.

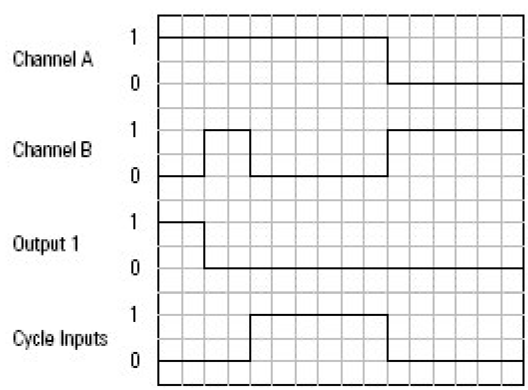
These state changes are shown in the following timing diagram.



Cycle Inputs Operation

If, while Output 1 is active, one of the input channels transitions from the Active state to the Safe state and back to the Active state before the other input channel transitions to the Safe state, the Cycle Inputs output prompt is set, and Output 1 cannot enter the Active state again until both input channels cycle through their Safe states.

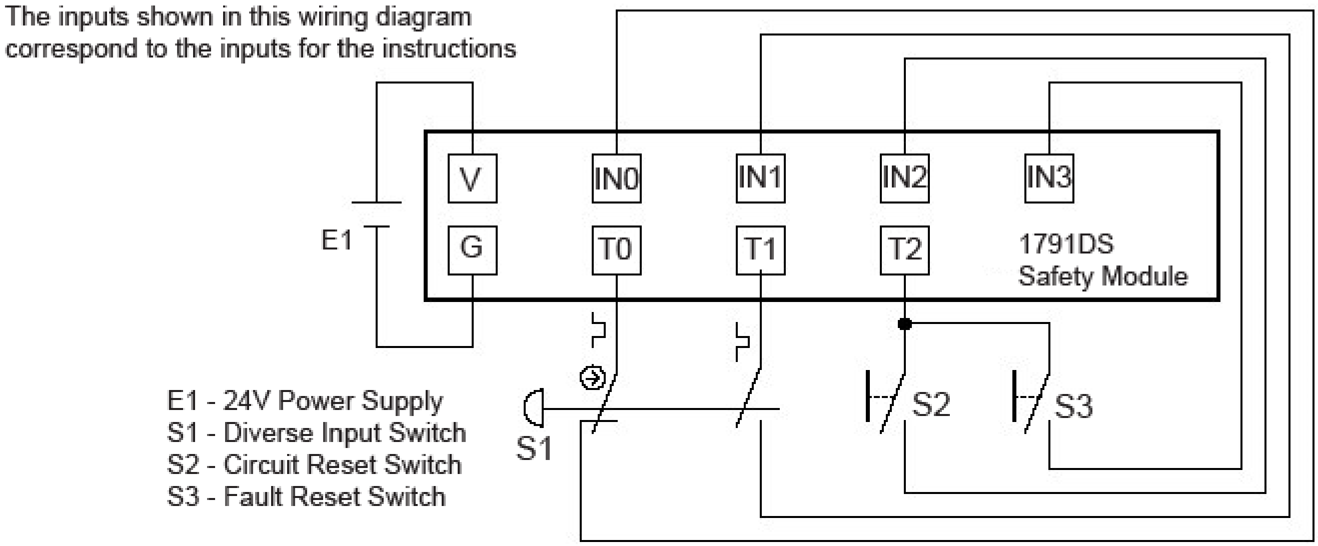
These state changes are shown in the following timing diagram:



Relationship of I/O Wiring to Instruction Parameters

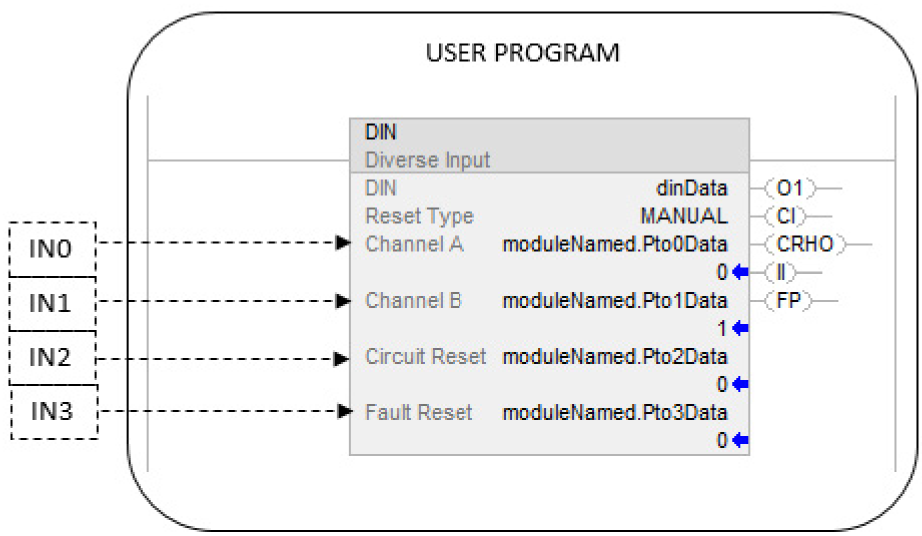
Diverse Input with Manual Reset Wiring and Programming

The following wiring diagram is one example of how to wire a 2-channel switch having diverse inputs to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.



S1 as shown in the Active state. INO - Normally Open, IN1 - Normally Closed.

The following programming example shows how the Diverse Input instruction with Manual Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. Logix Designer programming software is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None
3 (IN3)	Single	Safety	None

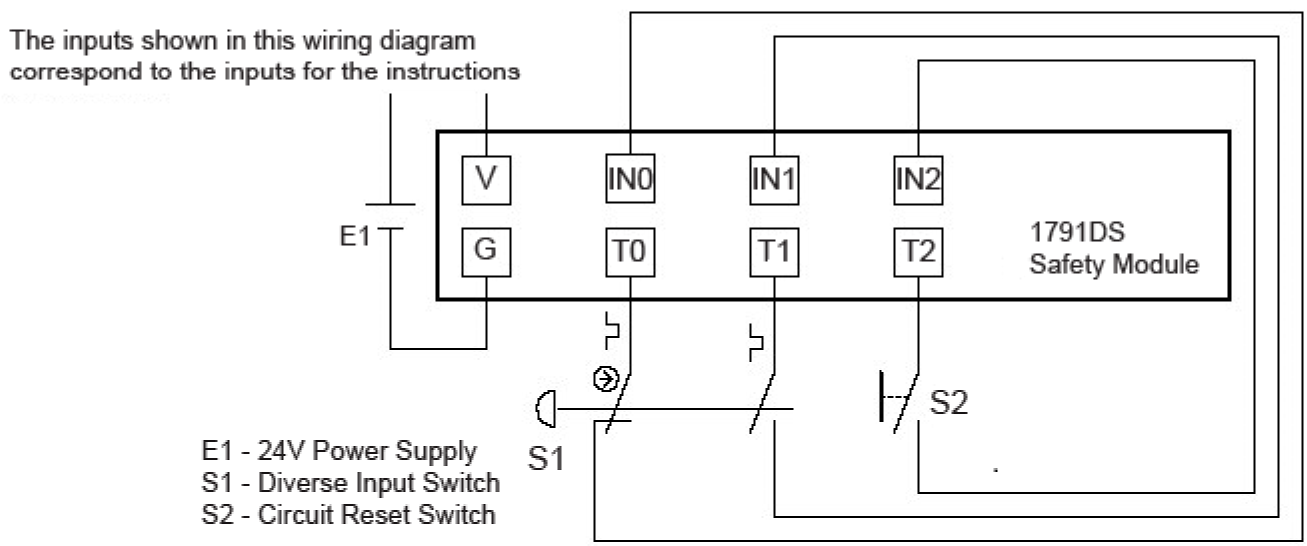
Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Diverse Input with Automatic Reset Wiring and Programming

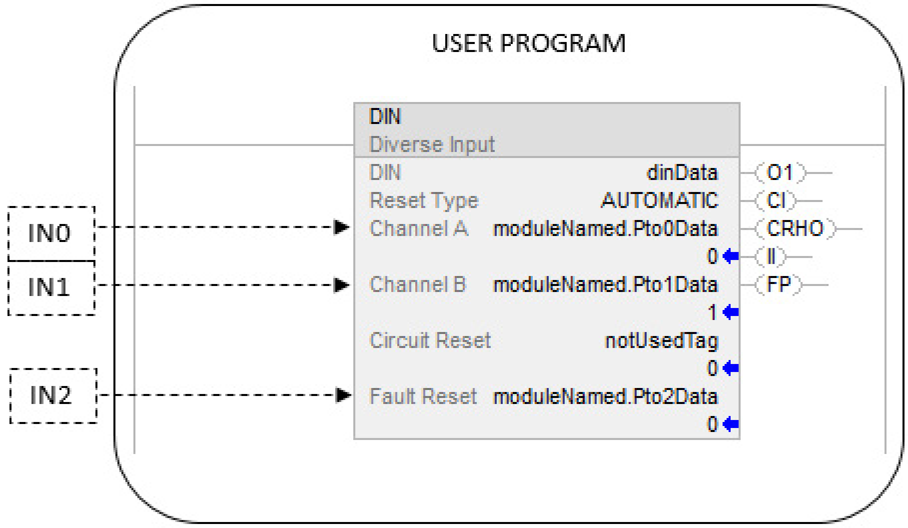
The following wiring diagram is one example of how to wire a 2-channel switch having diverse inputs to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.

ATTENTION: Various safety standards (EN 60204, ISO 13849-1) requires that when using the Automatic Circuit Reset feature, other measures must be implemented to make sure that an unexpected or unintended startup will not occur in the system or application.



S1 as shown in the Active state. INO - Normally Open, IN1 - Normally Closed.

The following programming example shows how the Diverse Input instruction with Automatic Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. Logix Designer programming software is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None

Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply

False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .O1, .CI, .CRHO, .II, and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

See also

Execution Times for Safety Application Instructions on page 526

Index Through Arrays on page 540

Status and Safety input and output for safety instructions on page 21

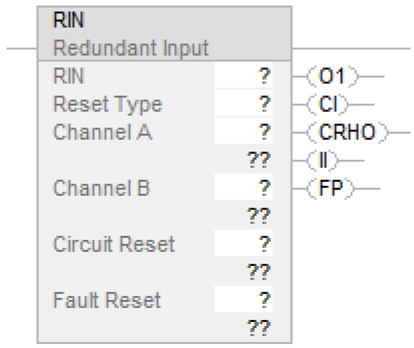
Redundant Input (RIN)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

Use the Redundant Input (RIN) instruction to emulate the input functionality of a safety relay in a software programmable environment.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Make sure that your safety input modules are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

This table explains the instructions inputs.

Parameter	Data Type	Description	Safe, Active, and Initial Values
RIN	REDUNDANT_INPUT	This parameter is a backing tag. As such, it maintains important execution information for each usage of this instruction. Do not attempt to reuse this backing tag or write to any of its members anywhere else in your program	-
Reset Type	Boolean	The reset type determines whether the instruction is using Manual or Automatic reset for Output 1.	Manual (1) or Automatic (0)
Channel A[1]	Boolean	Channel A Input (Normally Open)	Safe = 0 Active = 1
Channel B[1]	Boolean	Channel B Input (Normally Open)	Safe = 0 Active = 1

Parameter	Data Type	Description	Safe, Active, and Initial Values
Circuit Reset	Boolean	Circuit Reset Input Manual Reset - Sets Output 1 after Channel A and Channel B are in the Active state, and the Circuit Reset input transitions from zero to one. Automatic Reset - Visible, but not used.	Initial = 0 Reset = 1
Fault Reset	Boolean	After fault conditions are corrected for the instruction, the fault outputs for the instruction are cleared when this input transitions from off to on.	Initial = 0 Reset = 1

[1] If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

This table explains the instructions outputs.

Parameter	Data Type	Description	Safe, Active, and Initial Values
Output 1	Boolean	Output 1 is set to the Active state when input conditions are met.	Safe = 0, Active = 1
Cycle Inputs	Boolean	Cycle Inputs prompts for action. Before Output 1 is turned on, Channel A and Channel B inputs must be cycled through their Safe States at the same time before the circuit can be reset. This prompt is cleared when Channel A and Channel B transition to the Safe state.	Initial = 0 Prompt = 1
Circuit Reset Held On	Boolean	Manual Reset - The Circuit Reset Held On prompt is set when both input channels transition to the Active states, and the Circuit Reset input is already on. The Circuit Reset Held On prompt is cleared when the Circuit Reset input is turned off. Automatic Reset - Visible, but not used.	Initial = 0 Prompt = 1
Inputs Inconsistent	Boolean	This fault is set when Channel A and Channel B inputs are in inconsistent states (one Safe and one Active) for a period of time greater than the Inconsistent Time Period (listed below). This fault is cleared when Channel A and Channel B inputs return to consistent states (both Safe or both Active) and the Fault Reset input transitions from off to on. Inconsistent Time Period: 500 ms	Initial = 0 Fault = 1
Fault Present	Boolean	This value is set whenever a fault is present in the instruction. Output 1 cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from off to on.	Initial = 0 Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Operation

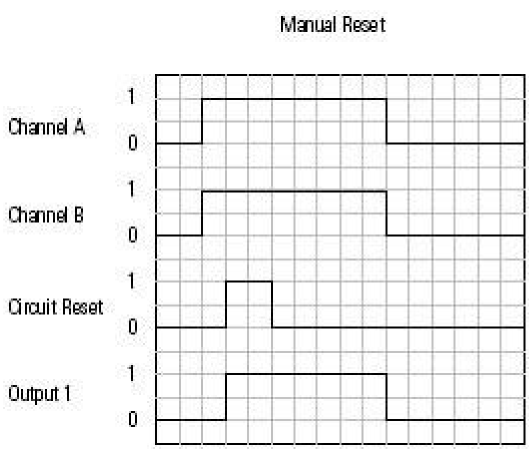
This instruction monitors the states of two input channels and turns on Output 1 when the following conditions are met:

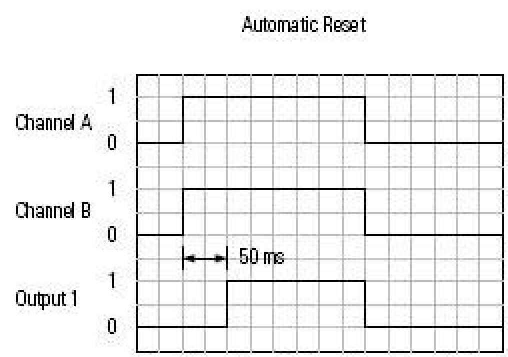
- When using Manual Reset: both inputs are in the Active state and the Circuit Reset input is transitioned from a zero to a one.
- When using Automatic Reset: both inputs are in the Active state for 50 ms.

This instruction turns Output 1 off when either one or both of the input channels returns to the Safe state.

Both input channels for the Redundant Input (RIN) instruction are normally open. This means zeros on both channels represent the Safe state, and ones on both channels represent the Active state.

These normal operation state changes are shown in the following timing diagrams:



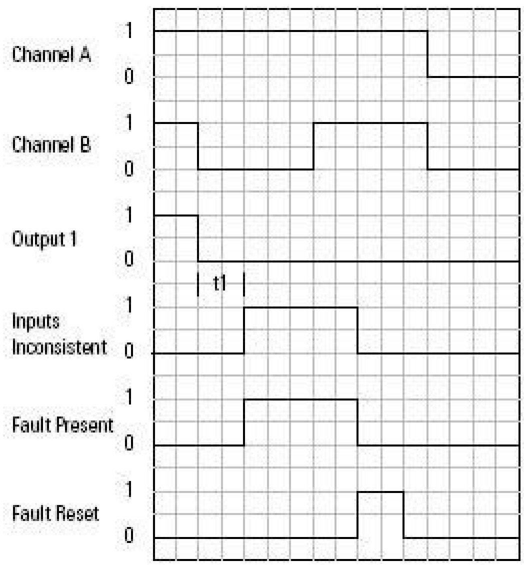


Operation with Inconsistent Inputs

This instruction generates a fault if the input channels are in inconsistent states (i.e., one Safe and one Active) for more than the specified period of time. The inconsistent time period is 500 ms.

This fault condition is enunciated via the Inputs Inconsistent and the Fault Present outputs. Output 1 cannot enter the Active state while the Fault Present output is active. The fault indication is cleared when the offending condition is remedied and the Fault Reset input is transitioned from zero to one.

These state changes are shown in the following timing diagram:

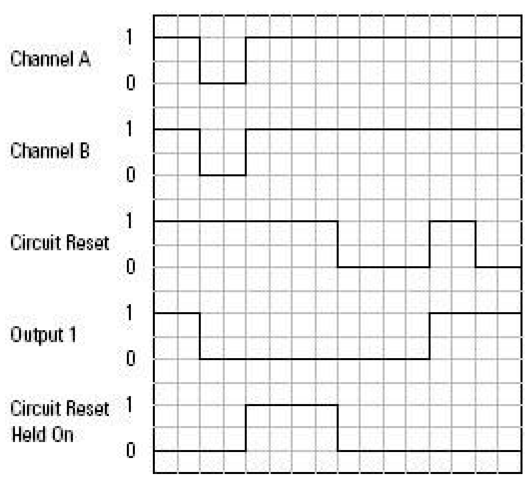


t1 = Inputs Inconsistent Time Period

Operation with Circuit Reset Held On - Manual Reset Only

This instruction also sets the Circuit Reset Held On output prompt if the Circuit Reset input is set (1) when the input channels transition to the Active state.

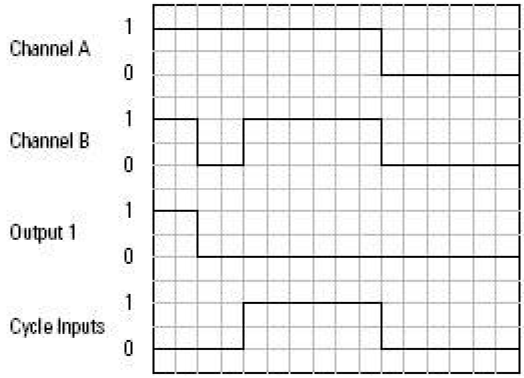
These state changes are shown in the following timing diagram.



Cycle Inputs Operation

If, while Output 1 is active, one of the input channels transitions from the Active state to the Safe state and back to the Active state before the other input channel transitions to the Safe state, the Cycle Inputs output prompt is set, and Output 1 cannot enter the Active state again until both input channels cycle through their Safe states.

These state changes are shown in the following timing diagram:



False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

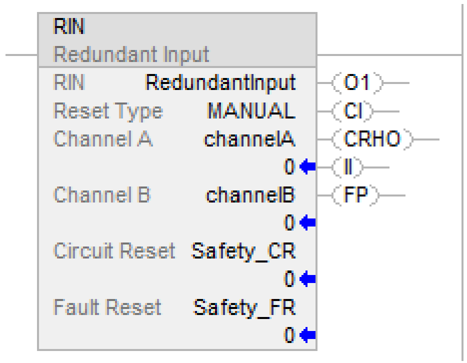
Major/Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

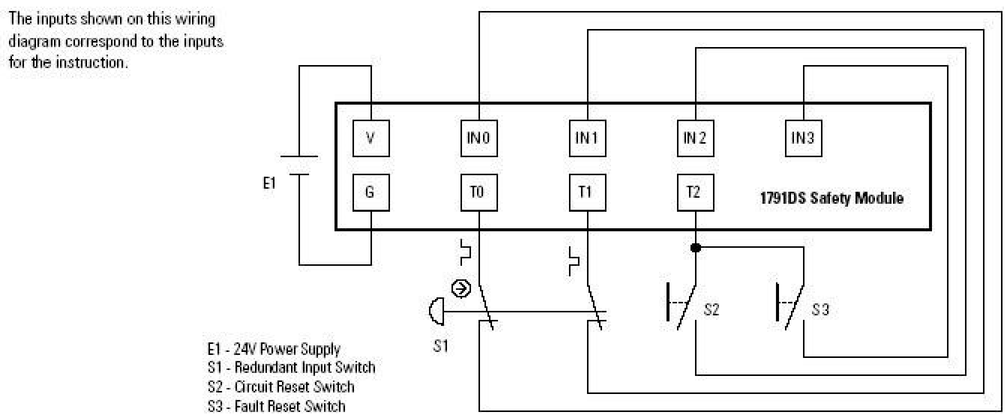
Condition/State	Action Taken
Prescan	The .O1, .CI, .CRHO, .II, and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

Example



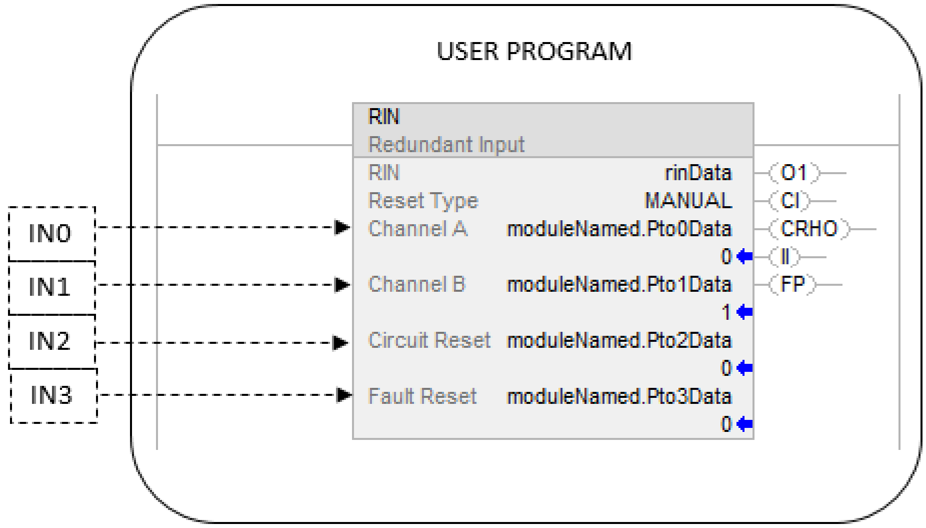
Manual Reset Wiring Example

The following wiring diagram is one example of how to wire a 2-channel switch having two normally open contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.



Manual Reset Programming Example

The following programming example shows how the Redundant Input instruction with Manual Reset can be applied to the previous wiring diagram.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None
3 (IN3)	Single	Safety	None

Test Output

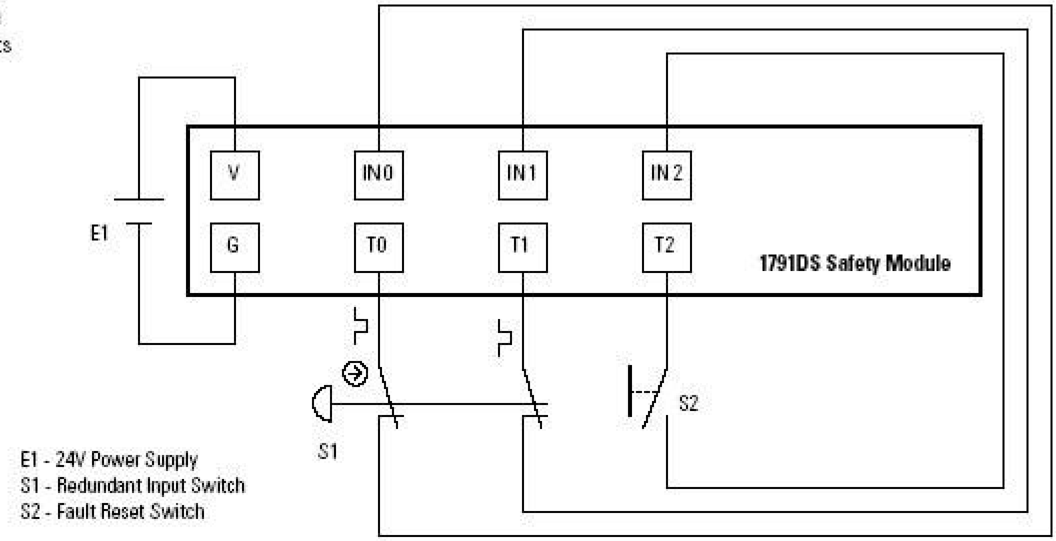
Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Automatic Reset Wiring

The following wiring diagram is one example of how to wire a 2-channel switch having normally open contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.

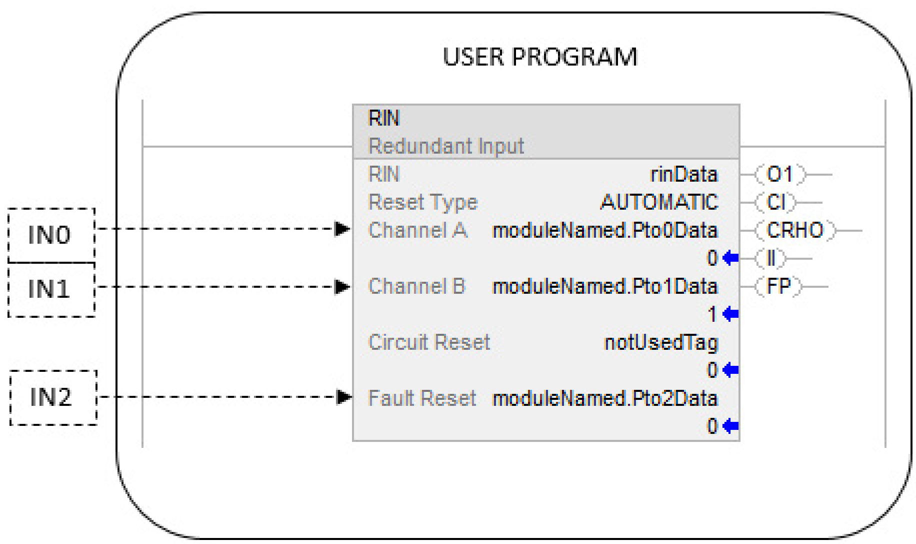
IMPORTANT	Various safety standards (EN 60204, ISO 13849-1) requires that when using the Automatic Circuit Reset feature, other measures must be implemented to make sure that an unexpected or unintended startup will not occur in the system or application.

The inputs shown on this wiring diagram correspond to the inputs for the instruction.



Automatic Reset Programming Example

The following programming example shows how the Redundant Input instruction with Automatic Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)

Input Point	Type	Point Mode	Test Source
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None

Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply

See also

Execution Times for Safety Application Instructions on page 526

Index Through Arrays on page 540

Status and Safety input and output for safety instructions on page 21

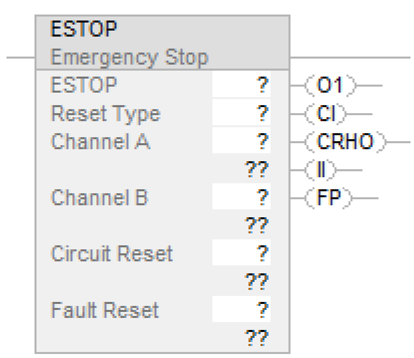
Emergency Stop (ESTOP)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The purpose of the Emergency Stop (ESTOP) instruction is to emulate the input functionality of a safety relay in a software programmable environment.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Make sure that your safety input modules are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

This table explains the instruction inputs.

Operand	Data Type	Description	Safe, Active, and Initial Values
ESTOP	EMERGENCY_STOP	This operand is a backing tag. As such, it maintains important execution information for each usage of this instruction. Do not attempt to reuse this backing tag or write to any of its members anywhere else in your program.	-
Reset Type	BOOL	The reset type determines whether the instruction is using Manual or Automatic reset for Output 1.	Manual (1) or Automatic (0)
Channel A[1]	BOOL	Channel A Input (Normally Open)	Safe = 0, Active = 1
Channel B[1]	BOOL	Channel B Input (Normally Open)	Safe = 0, Active = 1
Circuit Reset	BOOL	Circuit Reset Input Manual Reset - Sets Output 1 after Channel A and Channel B transition from Safe state to the Active state, and the Circuit Reset input transitions from zero to one. Automatic Reset - Visible, but not used.	Initial = 0 Reset = 1
Fault Reset	BOOL	After fault conditions are corrected for the instruction, the fault outputs for the instruction are cleared when this input transitions from off to on.	Initial = 0 Reset = 1

[1] If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

This table explains the instruction outputs.

Operand	Data Type	Description	Safe, Active, and Initial Values
Output 1	BOOL	Output 1 is set to the Active state when input conditions are met.	Safe = 0 Active = 1

Operand	Data Type	Description	Safe, Active, and Initial Values
Cycle Inputs	BOOL	Cycle Inputs prompts for action. Before Output 1 is turned on, Channel A and Channel B inputs must be cycled through their Safe States simultaneously before the circuit can be reset. This prompt is cleared when Channel A and Channel B transition to the Safe state.	Initial = 0 Prompt = 1
Circuit Reset Held On	BOOL	Manual Reset - The Circuit Reset Held On prompt is set when both input channels transition to the Active states, and the Circuit Reset input is already on. The Circuit Reset Held On prompt is cleared when the Circuit Reset input is turned off. Automatic Reset - Visible, but not used.	Initial = 0 Prompt = 1
Inputs Inconsistent	BOOL	This fault is set when Channel A and Channel B inputs are in inconsistent states (one Safe and one Active) for a period of time greater than the Inconsistent Time Period (listed below). This fault is cleared when Channel A and Channel B inputs return to consistent states (both Safe or both Active) and the Fault Reset input transitions from off to on. Inconsistent Time Period: 500 ms	Initial = 0 Fault = 1
Fault Present	BOOL	The value is set whenever a fault is present in the instruction. Output 1 cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from off to on.	Initial = 0 Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Operation

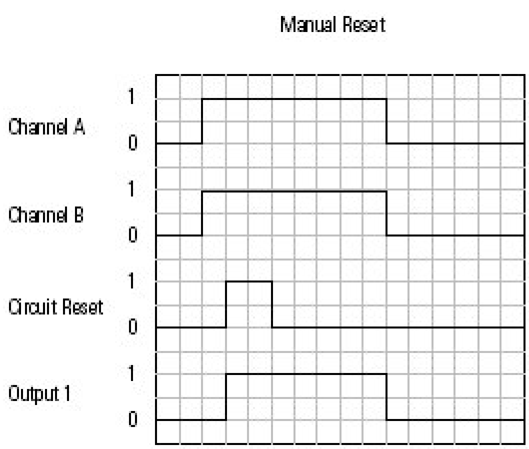
This instruction monitors the states of two input channels and turns on Output 1 when the following conditions are met:

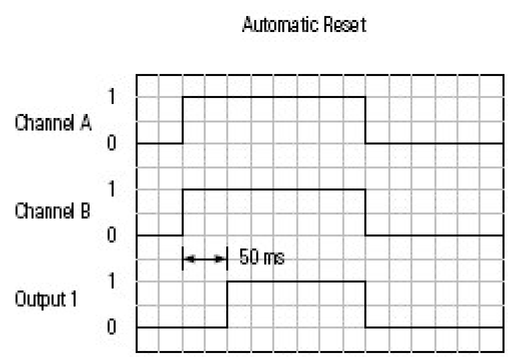
- When using Manual Reset: both inputs are in the Active state and the Circuit Reset input is transitioned from a zero to a one.
- When using Automatic Reset: both inputs are in the Active state for 50 ms.

This instruction turns Output 1 off when either one or both of the input channels returns to the Safe state.

Both input channels for the Emergency Stop (ESTOP) instruction are normally open. Zeros on both channels represent the Safe state, and ones on both channels represent the Active state.

These normal operation state changes are shown in the following timing diagrams.



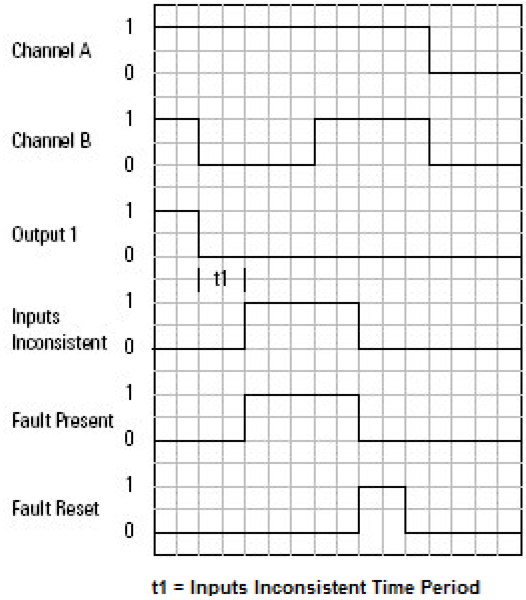


Operation with Inconsistent Inputs

This instruction generates a fault if the input channels are in inconsistent states (one Safe and one Active) for more than the specified period of time. The inconsistent time period is 500 ms (t1).

This fault condition is enunciated via the Inputs Inconsistent and the Fault Present outputs. Output 1 cannot enter the Active state while the Fault Present output is active. The fault indication is cleared when the offending condition is remedied and the Fault Reset input is transitioned from zero to one.

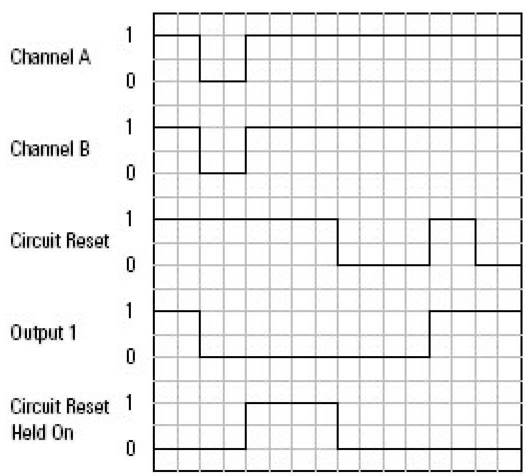
These state changes are shown in the following timing diagram.



Operation with Circuit Reset Held On - Manual Reset Only

This instruction also sets the Circuit Reset Held On output prompt if the Circuit Reset input is set (1) when the input channels transition to the Active state.

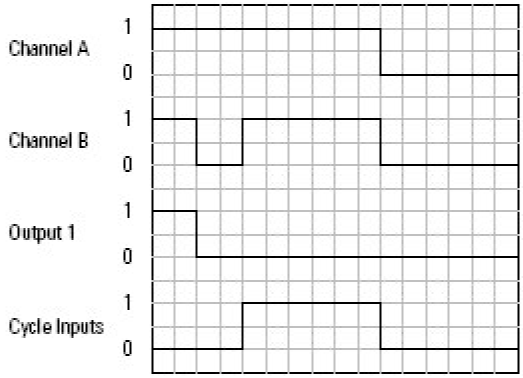
These state changes are shown in the following timing diagram.



Cycle Inputs Operation

If, while Output 1 is active, one of the input channels transitions from the Active state to the Safe state and back to the Active state before the other input channel transitions to the Safe state, the Cycle Inputs output prompt is set. Output 1 cannot enter the Active state again until both input channels cycle through their Safe states.

These state changes are shown in the following timing diagram:



False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

Execution

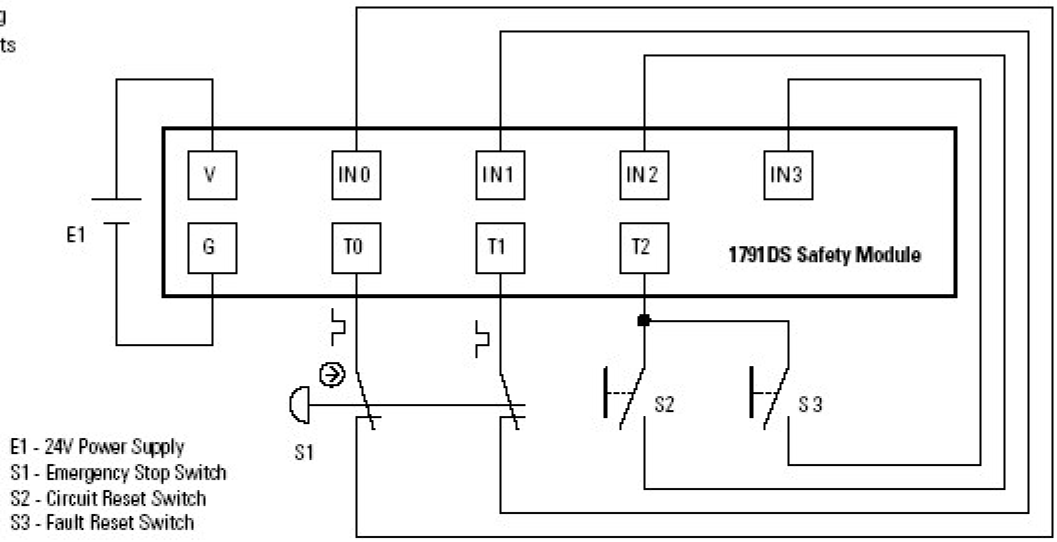
Condition/State	Action Taken
Prescan	The .O1, .CI, .CRHO, .II, and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

Example

Emergency Stop with Manual Reset Wiring

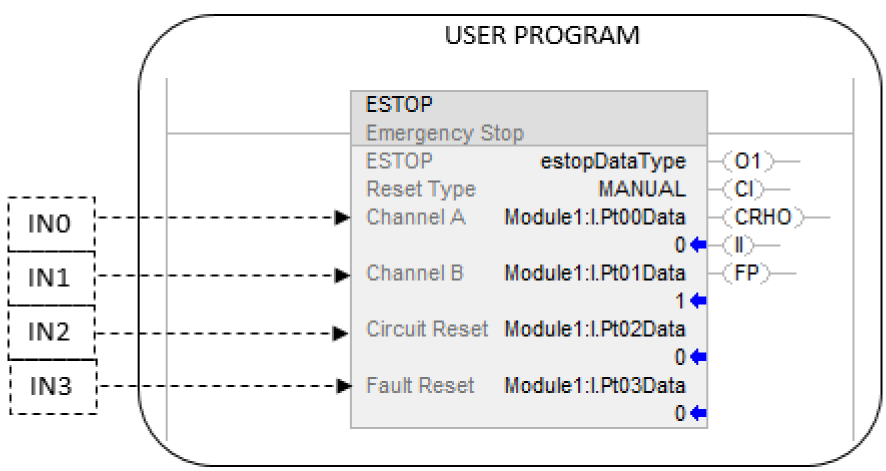
The following wiring diagram is one example of how to wire a 2-channel Emergency Stop switch having two normally open contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.

The inputs shown on this wiring diagram correspond to the inputs for the instruction.



Manual Reset Programming Example

The following programming example shows how the Emergency Stop instruction with Manual Reset can be applied to the previous wiring diagram.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer application is used to configure the following I/O module operands for pulse testing.

Input Configuration			
Input Point	**Type**	**Point Mode**	**Test Source**

Input Configuration			
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None
3 (IN3)	Single	Safety	None

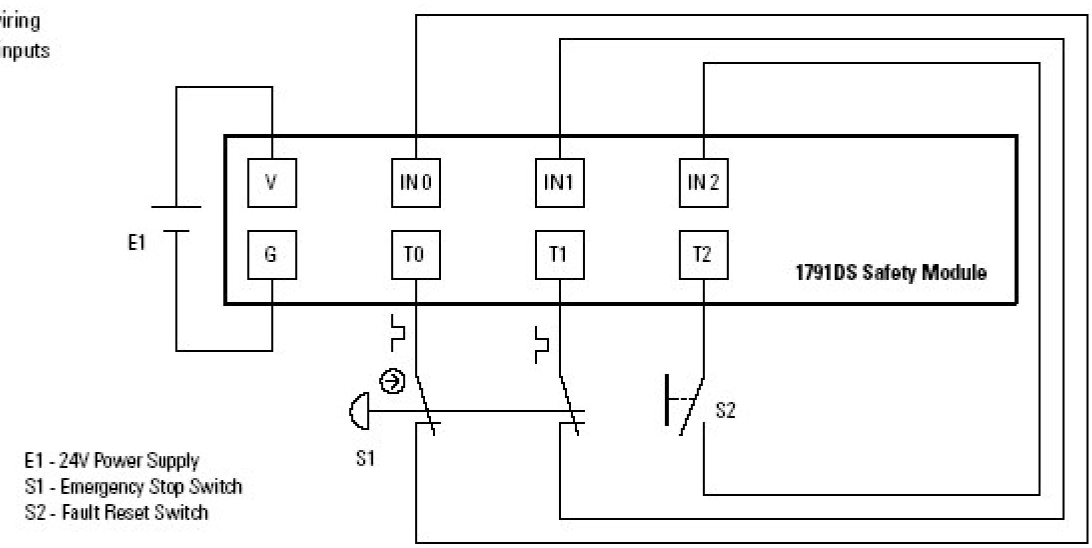
Test Output	
Test Output Point	**Point Mode**
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Automatic Reset Wiring and Programming

The following wiring diagram is one example of how to wire a 2-channel Emergency Stop switch having normally open contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.

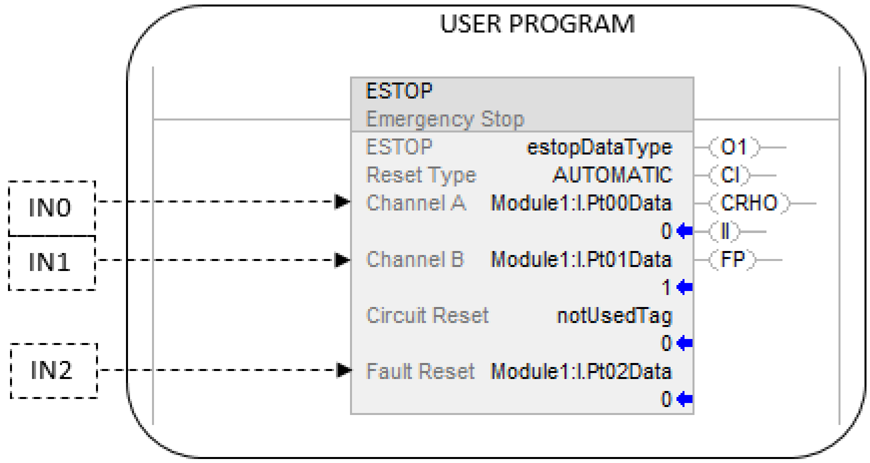
ATTENTION: Various safety standards (EN 60204, ISO 13849-1) require that when using the Automatic Circuit Reset feature, other measures must be implemented to make sure that an unexpected (or unintended) startup does not occur in the system or application.

The inputs shown on this wiring diagram correspond to the inputs for the instruction.



Automatic Reset Programming Example

The following programming example shows how the Emergency Stop instruction with Automatic Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer application is used to configure the following I/O module operands for pulse testing.

Input Configuration			
Input Point	**Type**	**Point Mode**	**Test Source**
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None

Test Output	
Test Output Point	**Point Mode**
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply

See also

Execution Times for Safety Application Instructions on page 526

Index Through Arrays on page 540

Status and Safety input and output for safety instructions on page 21

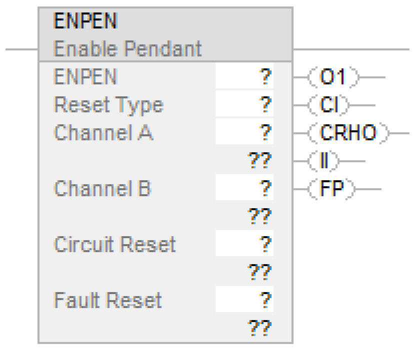
Enable Pendant (ENPEN)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The purpose of the Enable Pendant (ENPEN) instruction is to emulate the input functionality of a safety relay in a software programmable environment.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Make sure that your safety input modules are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

This table explains the instruction inputs.

Parameter	Data Type	Description	Values
ENPEN	ENABLE_PENDANT	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.	-
Reset Type	BOOL	The reset type determines whether the instruction is using Manual or Automatic reset for Output 1.	Manual = 1 or Automatic = 0

Parameter	Data Type	Description	Values
Channel A[1]	BOOL	Channel A Input (Normally Open)	Safe = 0, Active = 1
Channel B[1]	BOOL	Channel B Input (Normally Open)	Safe = 0, Active = 1
Circuit Reset	BOOL	Circuit Reset Input Manual Reset - Sets Output 1 after Channel A and Channel B transition from the Safe state to the Active state, and the Circuit Reset input transitions from zero to one. Automatic Reset - Visible, but not used.	Initial = 0 Reset = 1
Fault Reset	BOOL	After fault conditions are corrected for the instruction, the fault outputs for the instruction are cleared when this input transitions from off to on.	Initial = 0 Reset = 1

[1] If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

This table explains the instruction outputs.

Parameter	Data Type	Description	Values
Output 1	BOOL	Output 1 is set to the Active state when input conditions are met.	Safe = 0 Active = 1
Cycle Inputs	BOOL	Cycle Inputs prompts for action. Before Output 1 is turned on, Channel A and Channel B inputs must be cycled through their Safe States simultaneously before the circuit can be reset. This prompt is cleared when Channel A and Channel B transition to the Safe state.	Initial = 0 Prompt = 1
Circuit Reset Held On	BOOL	Manual Reset - The Circuit Reset Held On prompt is set when both input channels transition to the Active states, and the Circuit Reset input is already on. The Circuit Reset Held On prompt is cleared when the Circuit Reset input is turned off. Automatic Reset - Visible, but not used.	Initial = 0 Prompt = 1
Inputs Inconsistent	BOOL	This fault is set when Channel A and Channel B inputs are in inconsistent states (one Safe and one Active) for a period of time greater than the Inconsistent Time Period (listed below). This fault is cleared when Channel A and Channel B inputs return to consistent states (both Safe or both Active) and the Fault Reset input transitions from off to on. Inconsistent Time Period: 500 ms	Initial = 0 Fault = 1
Fault Present	BOOL	The value is set whenever a fault is present in the instruction. Output 1 cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from off to on.	Initial = 0 Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Operation

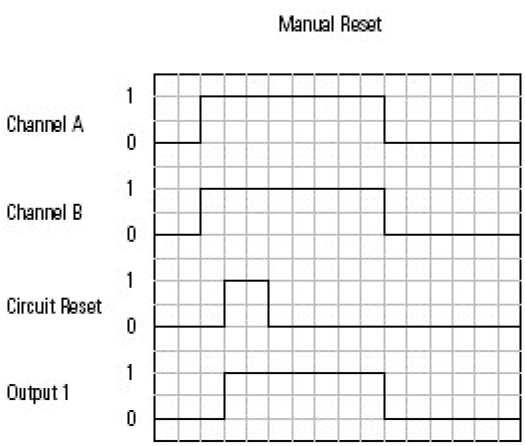
This instruction monitors the states of two input channels and turns on Output 1 when the following conditions are met:

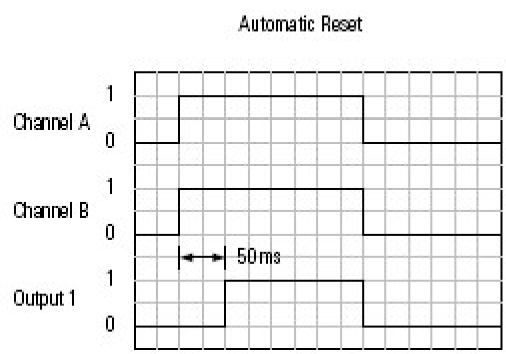
- When using Manual Reset: both inputs are in the Active state and the Circuit Reset input is transitioned from a zero to a one.
- When using Automatic Reset: both inputs are in the Active state for 50 ms.

This instruction turns Output 1 off when either one or both of the input channels returns to the Safe state.

Both input channels for the Enable Pendant (ENPEN) instruction are normally open. Zeros on both channels represent the Safe state, and ones on both channels represent the Active state.

These normal operation state changes are shown in the following timing diagrams:



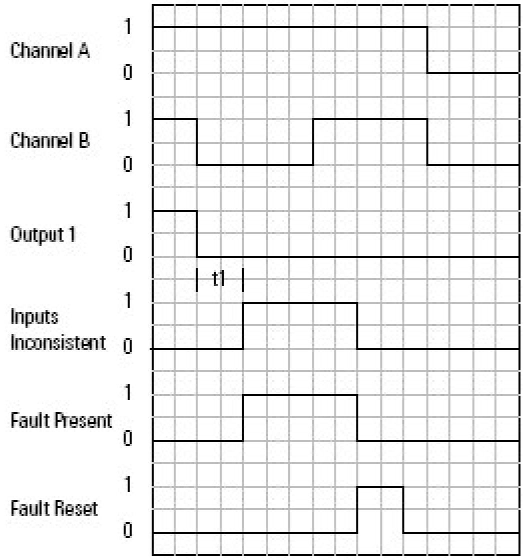


Operation with Inconsistent Inputs

This instruction generates a fault if the input channels are in inconsistent states (one Safe and one Active) for more than the specified period of time. The inconsistent time period is 500 ms (t1).

This fault condition is enunciated via the Inputs Inconsistent and the Fault Present outputs. Output 1 cannot enter the Active state while the Fault Present output is active. The fault indication is cleared when the offending condition is remedied and the Fault Reset input is transitioned from zero to one.

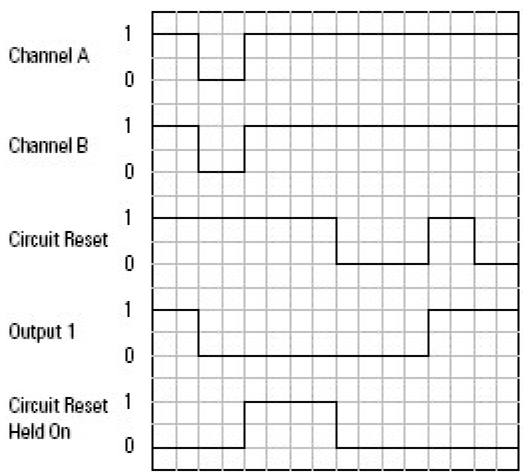
These state changes are shown in the following timing diagram:



Operation with Circuit Reset Held On - Manual Reset Only

This instruction also sets the Circuit Reset Held On output prompt if the Circuit Reset input is set (1) when the input channels transition to the Active state.

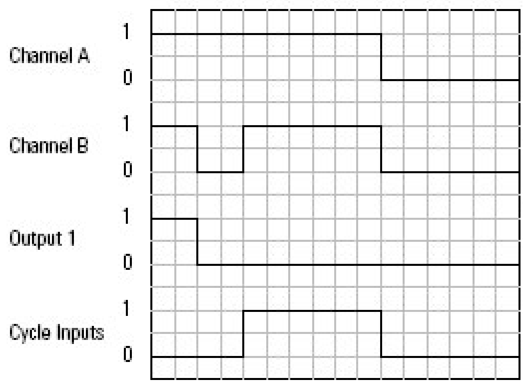
These state changes are shown in the following timing diagram.



Cycle Inputs Operation

If, while Output 1 is active, one of the input channels transitions from the Active state to the Safe state and back to the Active state before the other input channel transitions to the Safe state, the Cycle Inputs output prompt is set. Output 1 cannot enter the Active state again until both input channels cycle through their Safe states.

These state changes are shown in the following timing diagram:



False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See Index Through Arrays for array-indexing faults.

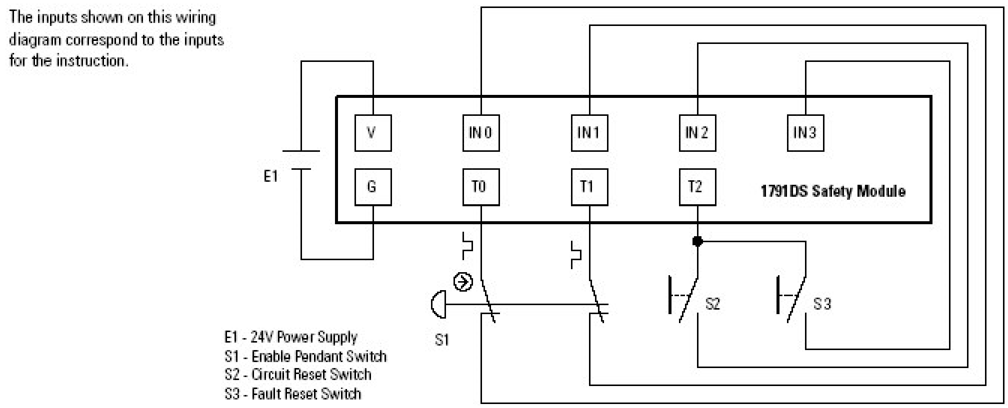
Execution

Condition/State	Action Taken
Prescan	The .O1, .CI, .CRHO, .II, and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

Example

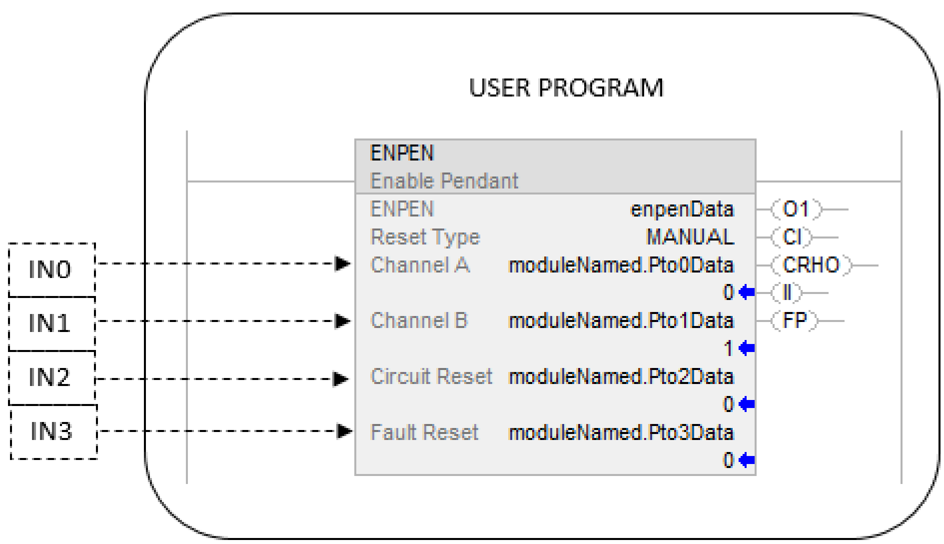
Manual Reset Wiring

The following wiring diagram is one example of how to wire a 2-channel switch having two normally open contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.



Manual Reset Programming Example

The following programming example shows how the Enable Pendant instruction with Manual Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None
3 (IN3)	Single	Safety	None

Test Output

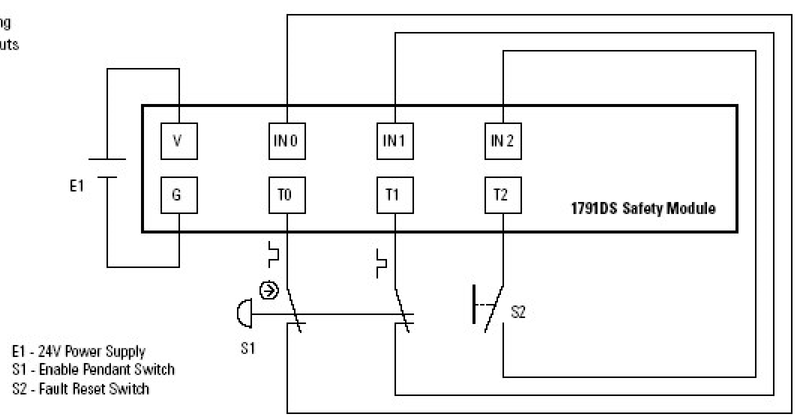
Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Automatic Reset Wiring and Programming

The following wiring diagram is one example of how to wire a 2-channel switch having normally open contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.

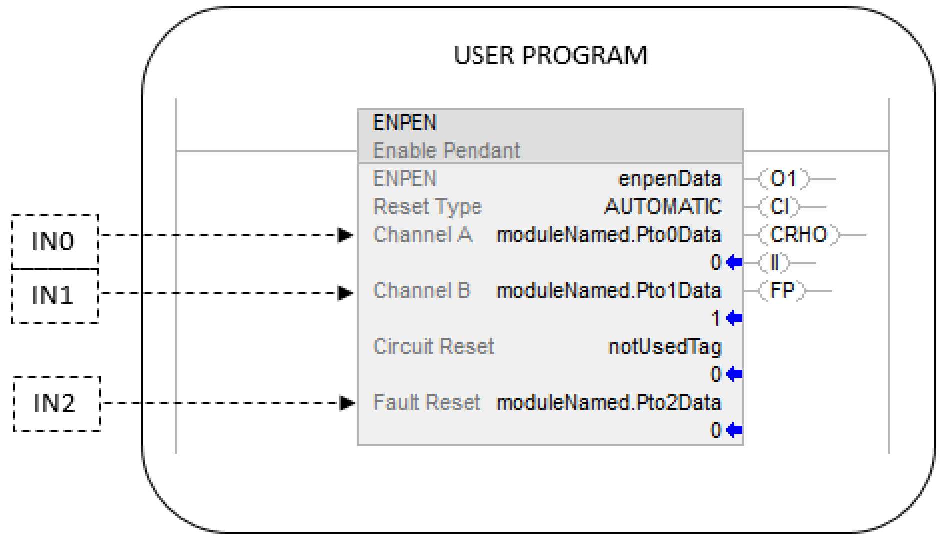
ATTENTION: Various safety standards (EN 60204, ISO 13849-1) require that when using the Automatic Circuit Reset feature, other measures must be implemented to make sure that an unexpected (or unintended) startup does not occur in the system or application.

The inputs shown on this wiring diagram correspond to the inputs for the instruction.



Automatic Reset Programming Example

The following programming example shows how the Enable Pendant instruction with Automatic Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None

Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply

See also

Index Through Arrays on page 540

Status and Safety input and output for safety instructions on page 21

Light Curtain (LC)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

Use the Light Curtain (LC) instruction to provide a manual and an automatic circuit reset interface from a programmable controller to a light curtain.

Many Light Curtains pulse test their two outputs; OSSD1 and OSSD2. If these outputs are wired directly into Safety controller inputs, the pulse test needs to be filtered. Otherwise, the Safety controller may mistake the low (0) pulse test for a light curtain blockage.

Most light curtains provide controllers or relays that essentially filter out the pulse test and provide two dry contacts for OSSD1 and OSSD2. If you use these devices, then OSSD1 and OSSD2 can be wired directly to the Safety controller.

If you are NOT using the light curtain controller or relay, then the Safety controller must provide the pulse test filtering. There are two ways for the Safety controller to filter this signal. The first is hardware- based digital input filters on the Safety input modules. For more information on Safety I/O modules, refer to the *DeviceNet Safety I/O User Manual*, publication 1791DS-UM001, *Guard I/O EtherNet/IP Safety Modules User Manual*, publication 1791ES-UM001, and *Point Guard I/O Safety Modules User Manual*, publication 1734-UM013. The second is a software- based filter in the Light Curtain instruction. For more information on this filter, refer to the section entitled Input Filter Time below.

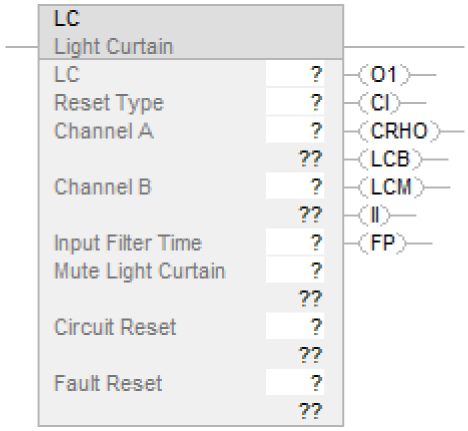
Of these two methods, the hardware filter is preferred. If the digital input filters the low (0) signals for longer than the low (0) pulse test width, then the hardware filter filters out the pulse test. For example, if the Light Curtain signals pulse low (0) for 100 μ s during a pulse test, then the hardware must filter out low (0)signals that are 100 μ s or longer. Note that the Safety DeviceNet I/O modules have a configurable filter of 0 to 126 ms.

If the hardware filter cannot filter the pulse test, or you choose not to use the hardware filter, then the filtering must be done in the Safety controller ladder logic. Software based filters look at the input once every program cycle. Theoretically, every time the Safety controller looks at OSSD1, it may be low (0) if the pulse test is occurring at that exact time. In other words, you may have to make your software filter long enough to scan OSSD1 multiple times before the filter times out, and OSSD1 is set logically low (0).

Setting the software filter time higher than the Safety controller's Safety task period ensures that the input must be low (0) for three consecutive scans before the software filter times out. For example, if the Safety controller's Safety task period is 5 ms, a software filter time of 10 ms requires three low (0) scans. If the filter time is 15 ms, four low (0) scans are required. The downside of using a longer hardware or software filter is that this filter time must be directly added to the calculation of the light curtain safety reaction time.

Available Languages

Ladder Diagram



Function Block

Not available for this instruction.

Structured Text

Not available for this instruction.

Operands

IMPORTANT Make sure that your safety input modules are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or Ple (Cat. 4) safety functions.

This table explains the instruction inputs.

Parameter	Data Type	Description	Values
LC	LIGHT_CURTAIN	This parameter is a backing tag. As such, it maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag or write to any of its members anywhere else in your program	—
Reset Type	BOOL	The reset type determines whether the instruction is using Manual or Automatic reset for Output 1.	Manual = 1 or Automatic = 0
Channel A[1]	BOOL	Channel A Input	Safe = 0, Active = 1
Channel B[1]	BOOL	Channel B Input	Safe = 0, Active = 1
Input Filter Time	DINT	This parameters selects the time, from 0…250 ms, used for filtering of the output pulse testing by the light curtain.	Initial = 0 ms Maximum = 250 ms

Parameter	Data Type	Description	Values
Mute Light Curtain	BOOL	Permits muting of the light curtain when it is not being used.	Initial = 0 Mute Light Curtain = 1
Circuit Reset	BOOL	Circuit Reset Input Manual Reset - Sets Output 1 after Channel A and Channel B transition from the Safe state to the Active state, and the Circuit Reset input transitions from zero to one. Automatic Reset - Visible, but not used.	Initial = 0, Reset = 1
Fault Reset	BOOL	After fault conditions are corrected for the instruction, the fault outputs for the instruction are cleared when this input transitions from off to on.	Initial = 0, Reset = 1

[1] If this input is from a Guard I/O input module, make sure that the input is configured as single, not Equivalent or Complementary.

This table explains the instruction outputs.

Parameter	Data Type	Description	Values
Output 1	BOOL	Output 1 is set to the Active state when input conditions are met.	Safe = 0, Active = 1
Cycle Inputs	BOOL	Cycle Inputs prompts for action. Before Output 1 is turned on, Channel A and Channel B inputs must be cycled through their Safe States at the same time before the circuit can be reset. This prompt is cleared when Channel A and Channel B transition to the Safe state.	Initial = 0, Prompt = 1
Circuit Reset Held On	BOOL	Manual Reset - The Circuit Reset Held On prompt is set when both input channels transition to the Active states, and the Circuit Reset input is already on. The Circuit Reset Held On prompt is cleared when the Circuit Reset input is turned off. Automatic Reset - Visible, but not used.	Initial = 0, Prompt = 1
Light Curtain Blocked	BOOL	This value indicates that the light curtain is blocked or has lost power.	Initial = 0, Blocked = 1
Light Curtain Muted	BOOL	This value indicates that the light curtain is muted (that is, not being used).	Initial = 0, Muted = 1
Inputs Inconsistent	BOOL	This fault is set when Channel A and Channel B inputs are in inconsistent states (one Safe and one Active) for a period of time greater than the Inconsistent Time Period (listed below). This fault is cleared when Channel A and Channel B inputs return to consistent states (both Safe or both Active) and the Fault Reset input transitions from off to on. Inconsistent Time Period: 500 ms	Initial = 0, Fault = 1

Parameter	Data Type	Description	Values
Fault Present	BOOL	This value is set whenever a fault is present in the instruction. Output 1 cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from off to on.	Initial = 0, Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

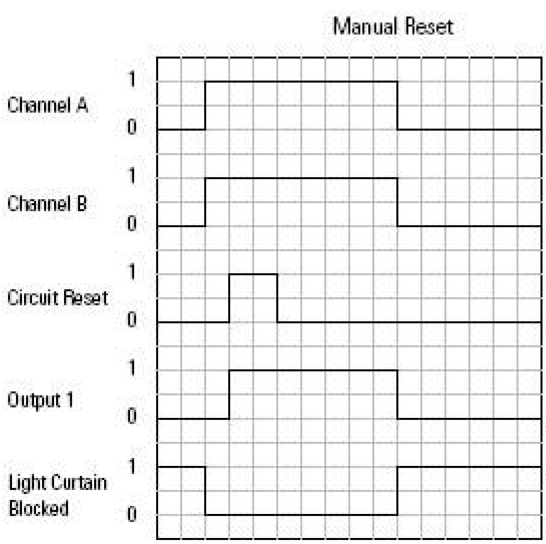
Normal Operation

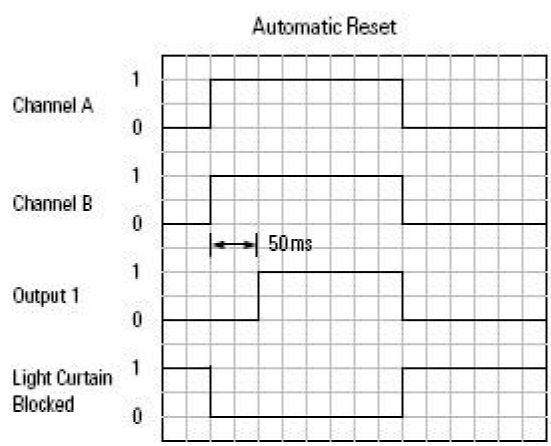
This instruction monitors the states of two input channels and turns on Output 1 when the following conditions are met.

- When using Manual Reset: both inputs are in the Active state and the Circuit Reset input is transitioned from a zero to a one.
- When using Automatic Reset: both inputs are in the Active state for 50 ms.

This instruction turns Output 1 off when either one or both of the input channels returns to the Safe state.

These normal operation state changes are shown in the following timing diagrams.



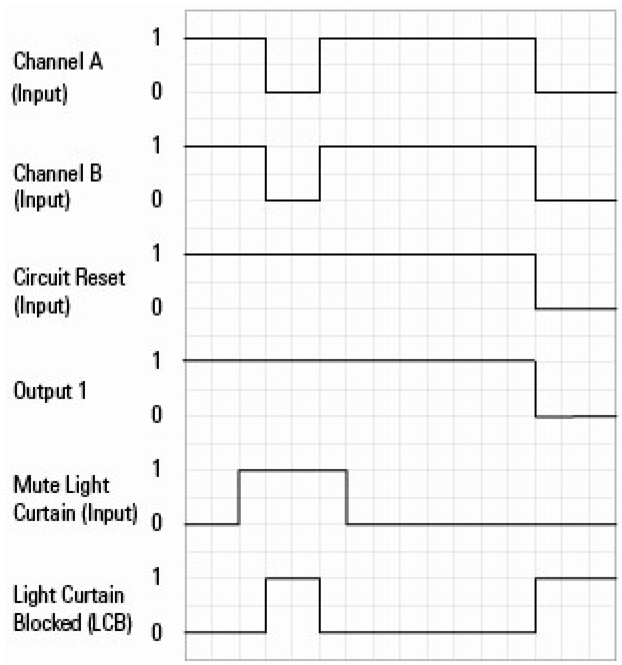


Muting Operation

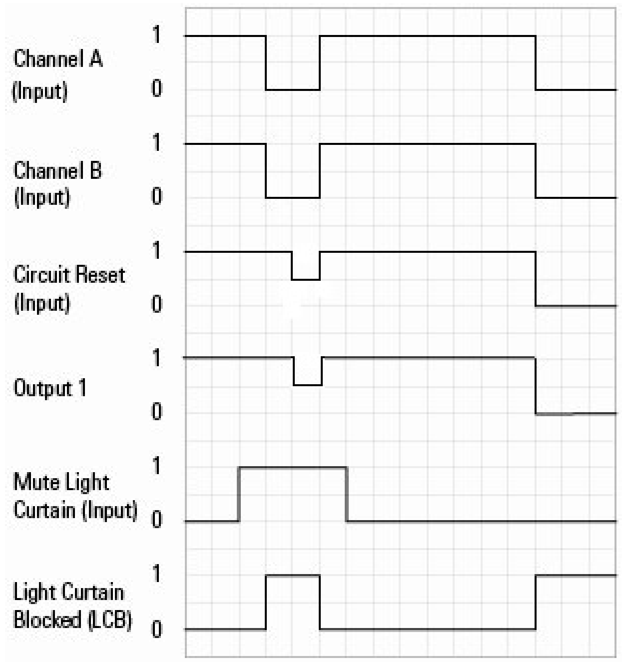
The one exception to the above Output 1 control is Light Curtain Muting that, when enabled, permits the inputs to leave the Active state and output 1 to remain on. The Light Curtain Muted output represents the value of the Mute Light Curtain input and indicates that the light curtain is not being used.

This instruction also has a Light Curtain Blocked output that indicates when the input channels are NOT in the Active state (ones).

These state changes are shown in the following timing diagrams.



If the Mute Light Curtain input is not set properly, or the light curtain is blocked after the muting period is finished, the behavior of this instruction reverts back to the behavior defined earlier when no muting is present.

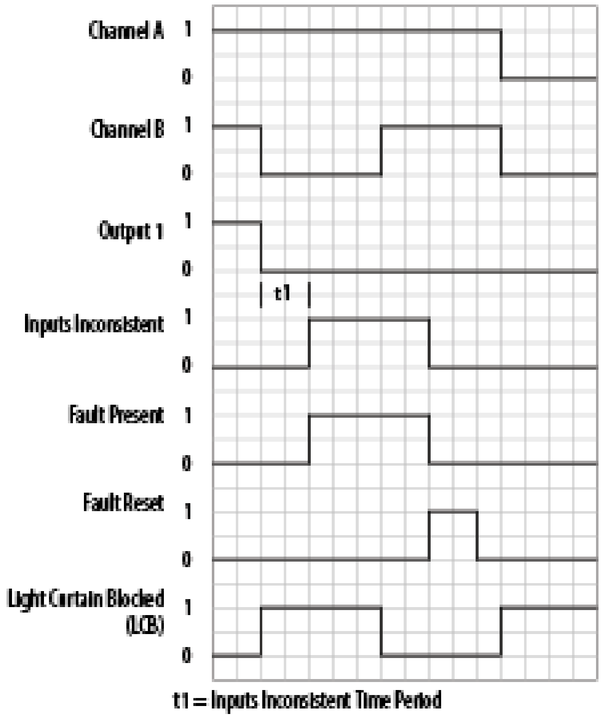


Operation with Inconsistent Inputs

This instruction generates a fault if the input channels are in inconsistent states (that is, one Safe and one Active) for more than 500 ms.

This fault condition is enunciated via the Inputs Inconsistent and the Fault Present outputs. Output 1 cannot enter the Active state while the Fault Present output is active. The fault indication is cleared when the offending condition is remedied and the Fault Reset input is transitioned from zero to one.

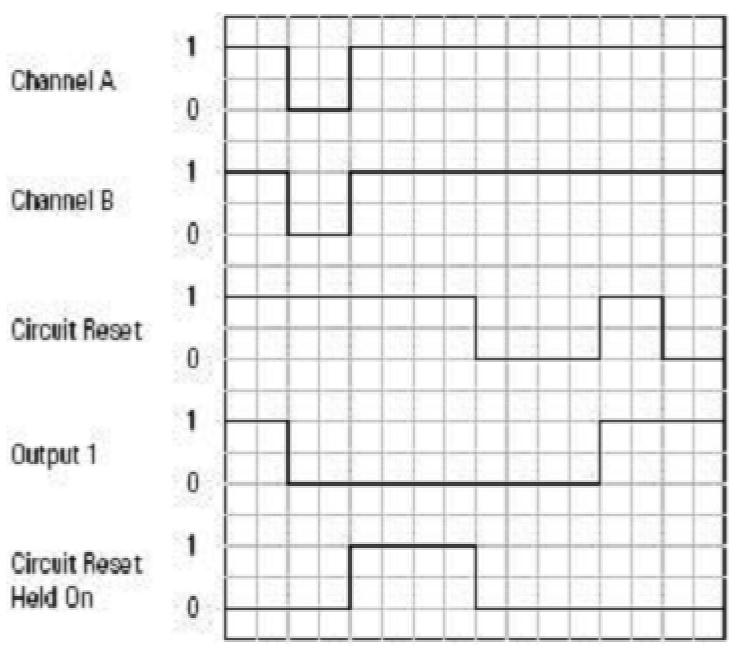
These state changes are shown in the following timing diagram.



Operation with Circuit Reset Held On - Manual Reset Only

This instruction also sets the Circuit Reset Held On output prompt if the Circuit Reset input is set (1) when the input channels transition to the Active state.

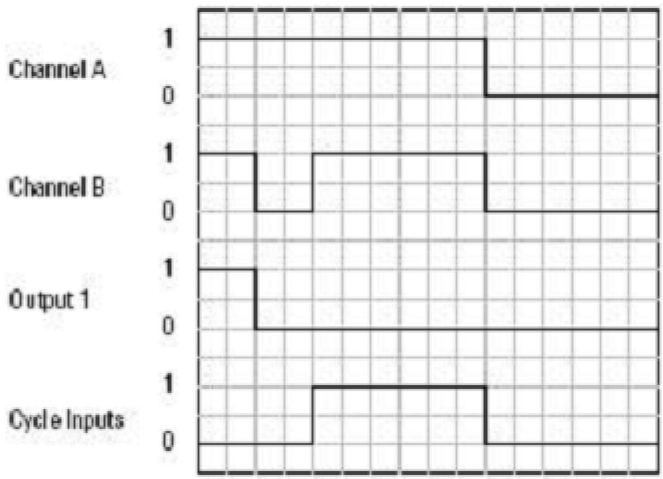
These state changes are shown in the following timing diagram.



Cycle Inputs Operation

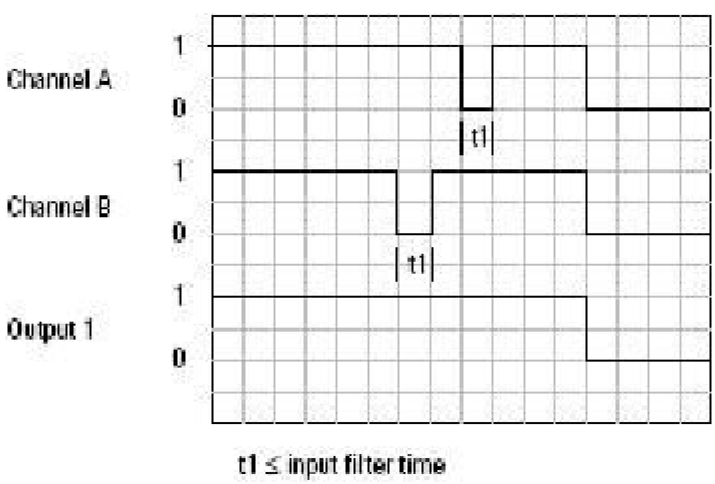
If, while Output 1 is active, one of the input channels transitions from the Active state to the Safe state and back to the Active state before the other input channel transitions to the Safe state, the instruction sets the Cycle Inputs outputs prompt. Output 1 cannot enter the Active state again until both input channels cycle through their Safe states.

These state changes are shown in the following timing diagram.



Input Filter Time

When an input filter time is specified, then, for that length of time, an input channel is allowed to go to the Safe state while the other channel is in the Active state without Output 1 going to its Safe state. However, Output 1 goes to the Safe state when both input channels are in the Safe state at the same time.



False Rung State Behavior

When the instruction is executed on a false rung, the behavior is the same as the true rung state, except all outputs, including prompts and fault indicators, are zero.

When the rung state becomes true, the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

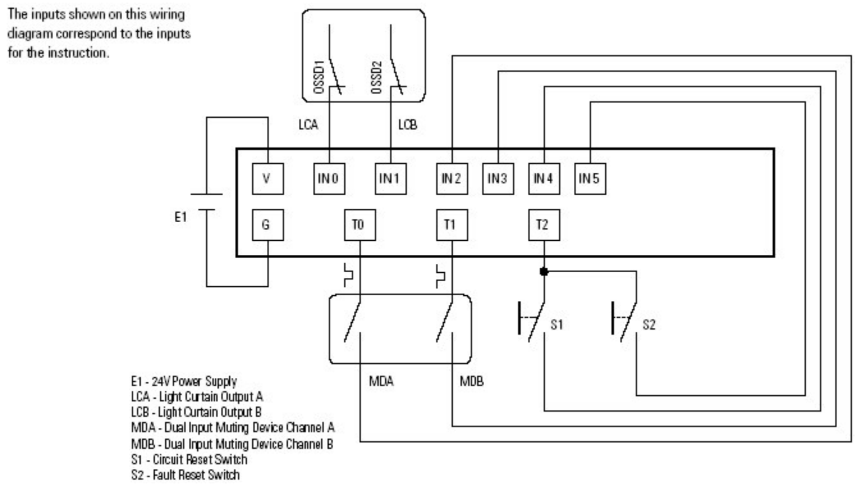
Execution

Condition/State	Action Taken
Prescan	The .O1, .CI, .CRHO, .LCB, .LCM, .II, and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

Example

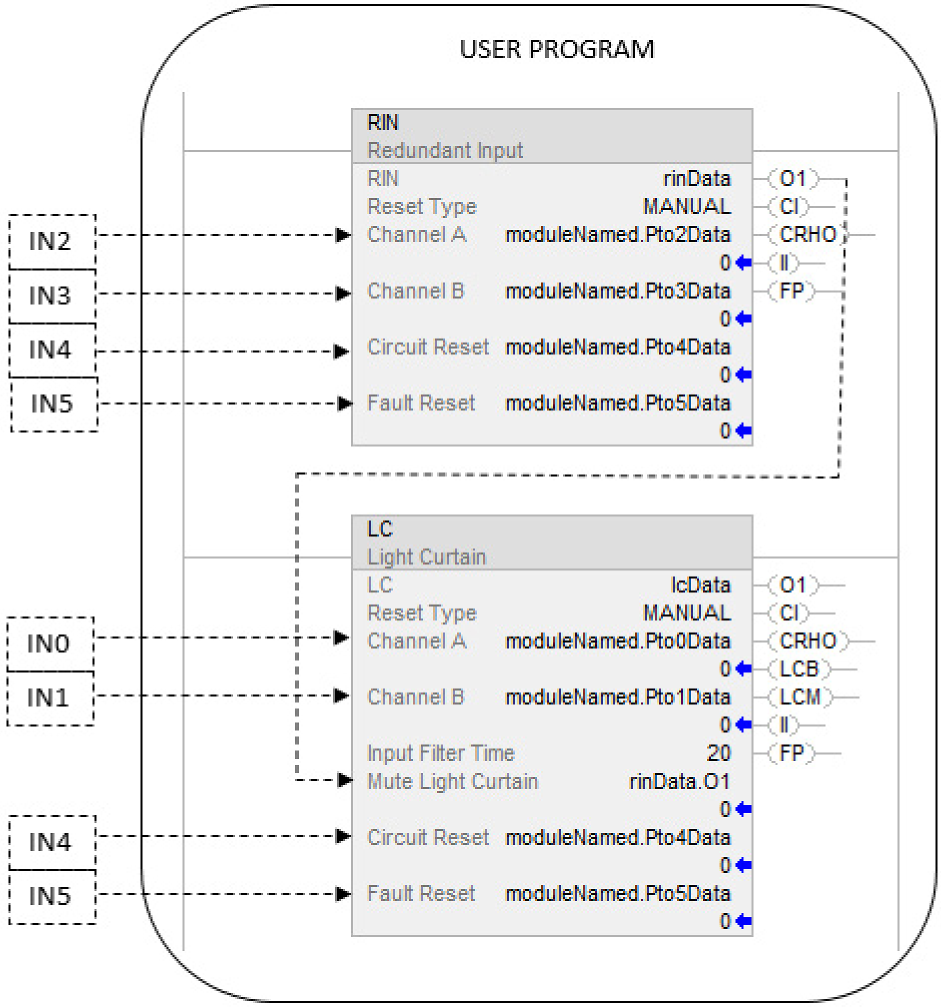
Manual Reset Wiring

The following wiring diagram is one example of how to wire a light curtain's two normally open outputs and two inputs required for muting to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.



Manual Reset Programming

The following programming example shows how the Light Curtain instruction with Manual Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety	None
1 (IN1)	Single	Safety	None
2 (IN2)	Single	Safety Pulse Test	*0 (T0)*
3 (IN3)	Single	Safety Pulse Test	*1 (T1)*
4 (IN4)	Single	Safety	None
5 (IN5)	Single	Safety	None

Test Output

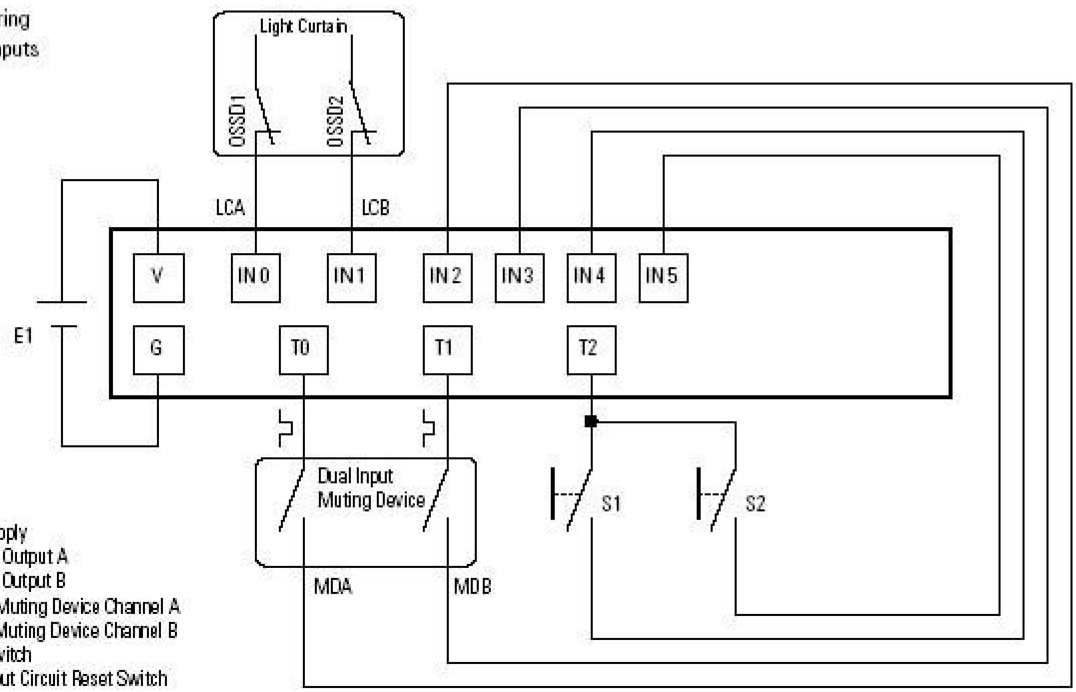
Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Automatic Reset Wiring

The following wiring diagram is one example of how to wire a light curtain's two normally open outputs and two inputs required for muting to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.

ATTENTION: Various safety standards (EN 60204, ISO 13849-1) require that when using the Automatic Circuit Reset feature, other measures must be implemented to make sure that an unexpected (or unintended) startup will not occur in the system or application.

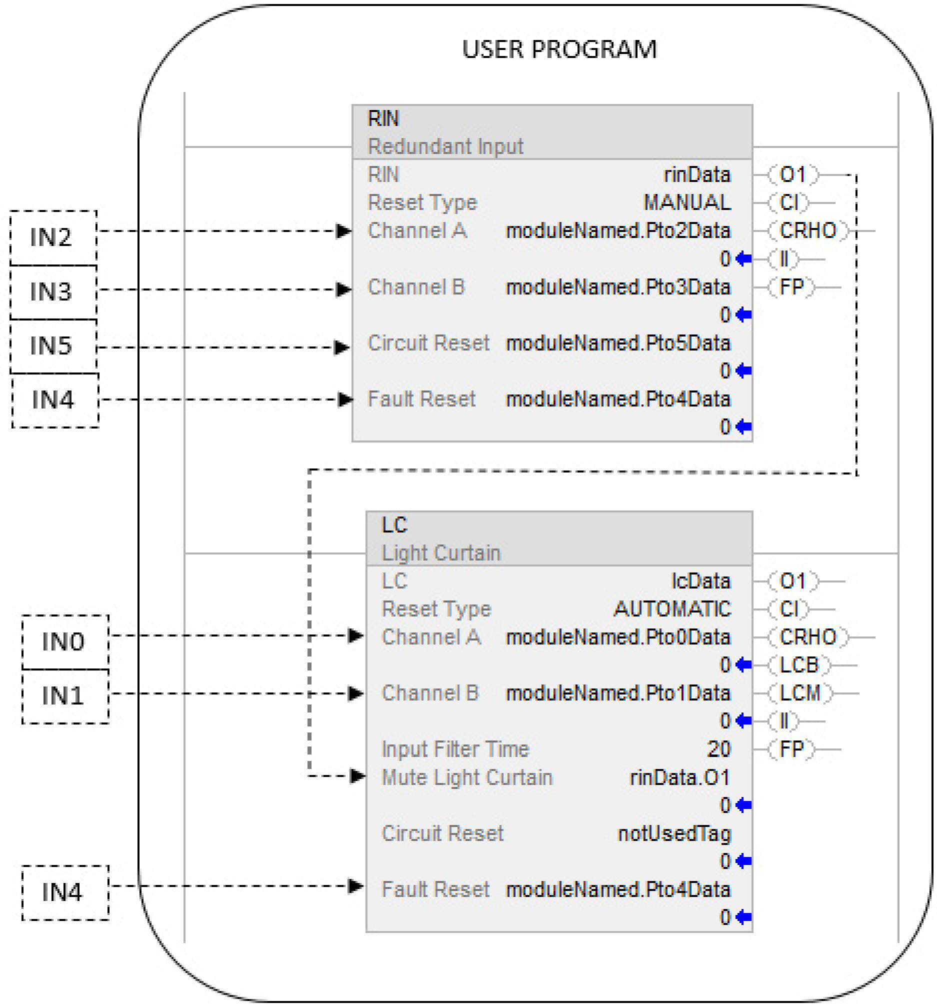
The inputs shown on this wiring diagram correspond to the inputs for the instruction.



E1 - 24V Power Supply
LCA - Light Curtain Output A
LCB - Light Curtain Output B
MDA - Dual Input Muting Device Channel A
MDB - Dual Input Muting Device Channel B
S1 - Fault Reset Switch
S2 - Redundant Input Circuit Reset Switch

Automatic Reset Programming

The following programming example shows how the Light Curtain instruction with Automatic Reset can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

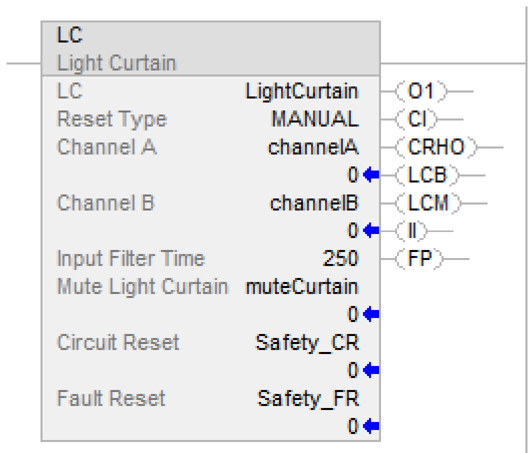
Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety	None
1 (IN1)	Single	Safety	None
2 (IN2)	Single	Safety Pulse Test	0 (T0)
3 (IN3)	Single	Safety Pulse Test	1 (T1)
4 (IN4)	Single	Safety	None
5 (IN5)	Single	Safety	None

Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Example



See also

Instruction Execution Time on page 526

Index Through Arrays on page 540

Status and Safety input and output for safety instructions on page 21

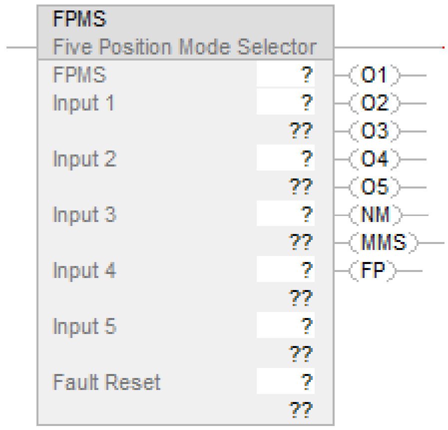
Five Position Mode Selector (FPMS)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

The basic purpose of the Five Position Mode Selector (FPMS) instruction is to provide an interface from a programmable controller to a three-to-five position selector switch.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

This table explains the instruction inputs.

Parameter	Data Type	Description	Safe, Active, and Initial Values
FPMS	FIVE_POS_MODE_SELECTOR	This parameter is a backing tag. As such, it maintains important execution information for each usage of this instruction. Do not attempt to reuse this backing tag or write to any of its members anywhere else in your program.	-
Input 1	BOOL	Mode 1 Selected Input	Safe = 0 Active = 1
Input 2	BOOL	Mode 2 Selected Input	Safe = 0 Active = 1
Input 3	BOOL	Mode 3 Selected Input	Safe = 0 Active = 1
Input 4	BOOL	Mode 4 Selected Input	Safe = 0 Active = 1
Input 5	BOOL	Mode 5 Selected Input	Safe = 0 Active = 1

Parameter	Data Type	Description	Safe, Active, and Initial Values
Fault Reset	BOOL	After fault conditions are corrected for the instruction, the Fault Present output for the instruction is cleared when this input transitions from OFF to ON.	Initial = 0 Reset = 1

This table explains the instruction outputs.

Parameter	Data Type	Description	Safe, Active, and Initial Values
Output 1	BOOL	Output associated with Input 1	Safe = 0 Active = 1
Output 2	BOOL	Output associated with Input 2	Safe = 0 Active = 1
Output 3	BOOL	Output associated with Input 3	Safe = 0, Active = 1
Output 4	BOOL	Output associated with Input 4	Safe = 0 Active = 1
Output 5	BOOL	Output associated with Input 5	Safe = 0 Active = 1
No Mode	BOOL	No Mode Selected Fault	Initial = 0 Fault = 1
Multiple Modes Selected	BOOL	More than One Mode Selected Fault	Initial = 0 Fault = 1
Fault Present	BOOL	This value is set whenever a fault is present in the instruction. An output cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from OFF to ON.	Initial = 0 Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Operation

Normal Operation

The Five-Position Mode Selector Instruction has five outputs that are associated with five inputs. Its main job is to enable one of the five outputs when its associated input goes active.

It has a fault for more than one input active, and another for no inputs active. These faults occur when the associated inputs conditions exist for more than 250 ms. During this 250 ms, if one of the fault conditions is detected, the outputs temporarily remain in their last state. If the fault condition is still present after the 250 ms, the Fault Present bit is set to one and the instruction's outputs are set to zero.

Faults may be cleared by the rising edge of the Fault Reset signal, but only after the input fault condition has been cleared.

False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

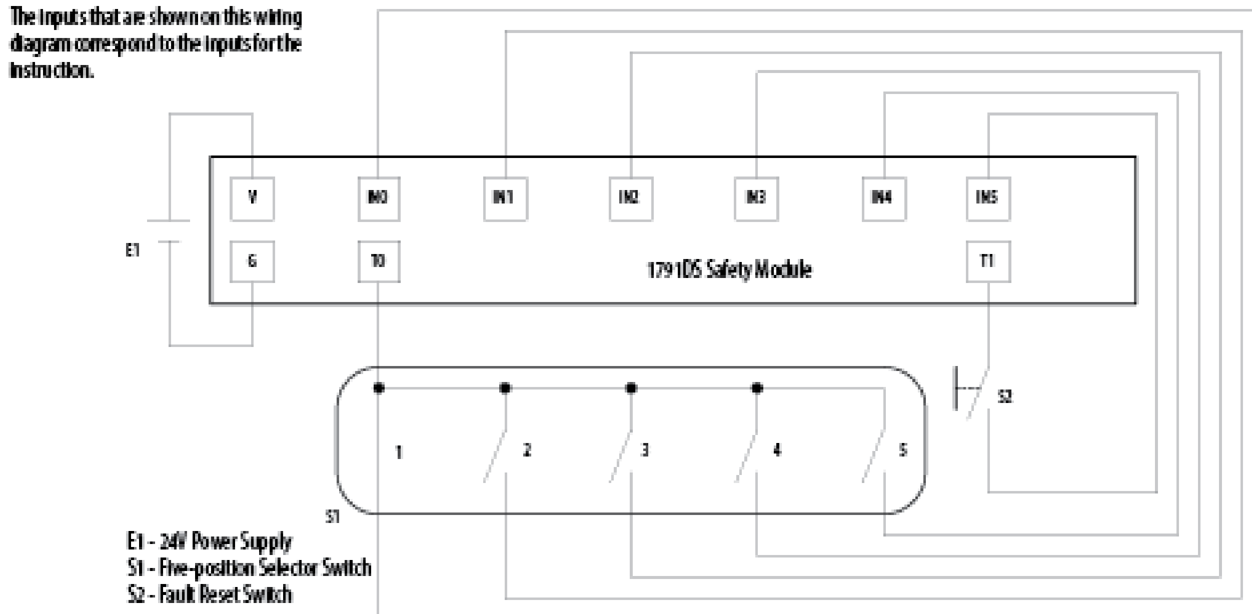
Execution

Condition/State	Action Taken
Prescan	The .01, .02, .03, .04, .05, .NM, .NMS and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

Example

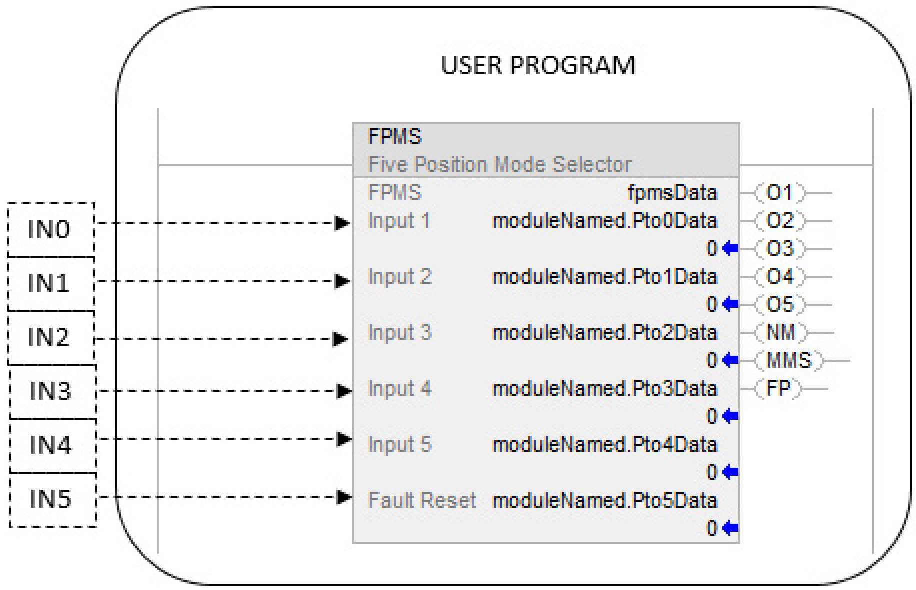
Wiring Example

The following wiring diagram is one example of how to wire a five-position selector switch to a 1791DS safety I/O module to comply with ISO 13849-1 Category 4.



Programming Example

The following programming example shows how the Five Position Mode Selector (FPMS) instruction can be applied to the wiring diagram shown in the following diagram.



Logix Designer programming software is used to configure the following I/O module parameters.

Input Configuration

Point	Type	Point Mode
0 (IN0)	Single	Safety
1 (IN1)	Single	Safety
2 (IN2)	Single	Safety
3 (IN3)	Single	Safety
4 (IN4)	Single	Safety
5 (IN5)	Single	Safety

Output

Point	Point Made
0	Power Supply
1	Power Supply
2	Not Used
3	Not Used

See also

Execution Times for Safety Application Instructions on page 526

Index Through Arrays on page 540

Common Attributes on page 529

Status and Safety input and output for safety instructions on page 21

Redundant Output (ROUT)

This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

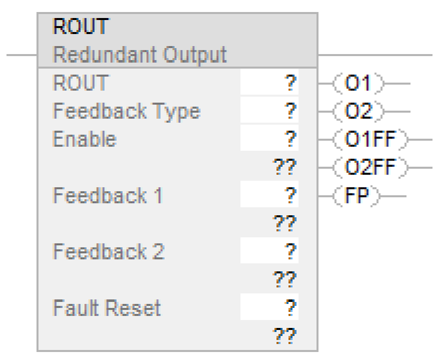
Use the Redundant Output with Continuous Feedback Monitoring (ROUT) instruction to emulate the output functionality of a safety relay in a software programmable environment.

The Redundant Output with Continuous Feedback Monitoring Instruction can be used in two ways:

- Redundant Output with Negative Feedback (RONF)
- Redundant Output with Positive Feedback (ROPF)

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

This table explains the instruction inputs.

Operand	Data Type	Description	Values
ROUT	REDUNDANT_OUTPUT	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.	-
Feedback Type	BOOL	The feedback type determines whether the instruction is using negative or positive feedback	Negative = 0 (RONF) or Positive = 1 (ROPF)
Enable	BOOL	Input to Enable the Redundant Outputs	Safe = 0 Active = 1
Feedback 1	BOOL	Feedback from a device either directly or indirectly controlled by Output 1.	RONF: Off = 1 On = 0 ROPF: Off = 0 On = 1
Feedback 2	BOOL	Feedback from a device either directly or indirectly controlled by Output 2.	RONF: Off = 1 On = 0 ROPF: Off = 0 On = 1
Fault Reset	BOOL	After fault conditions are corrected for the instruction, the Fault Present output for the instruction is cleared when this input transitions from off to on.	Initial = 0 Reset = 1

This table explains the instruction outputs.

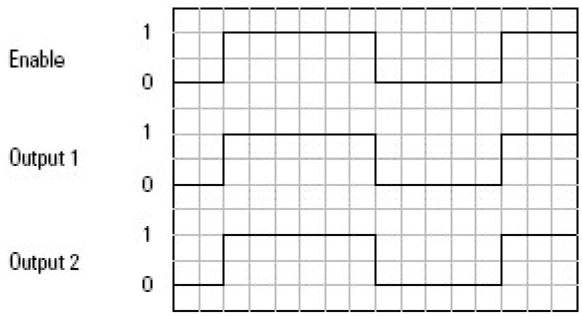
Operand	Data Type	Description	Safe, Active, and Initial Values
Output 1	BOOL	Output 1 of the redundant outputs	Safe = 0 Active = 1
Output 2	BOOL	Output 2 of the redundant outputs	Safe = 0 Active = 1
Output 1 Feedback Failure	BOOL	Output 1 Feedback is not indicating the correct state of Output 1 within 250 ms.	Initial = 0 Fault = 1
Output 2 Feedback Failure	BOOL	Output 2 Feedback is not indicating the correct state of Output 2 within 250 ms.	Initial = 0 Fault = 1
Fault Present	BOOL	This is set whenever a fault is present in the instruction. Outputs cannot enter the Active state when Fault Present is set. Fault Present is cleared when all faults are cleared and the Fault Reset input transitions from off to on.	Initial = 0 Fault = 1

IMPORTANT Do not write to any instruction output tag under any circumstance.

Operation

Normal Operation

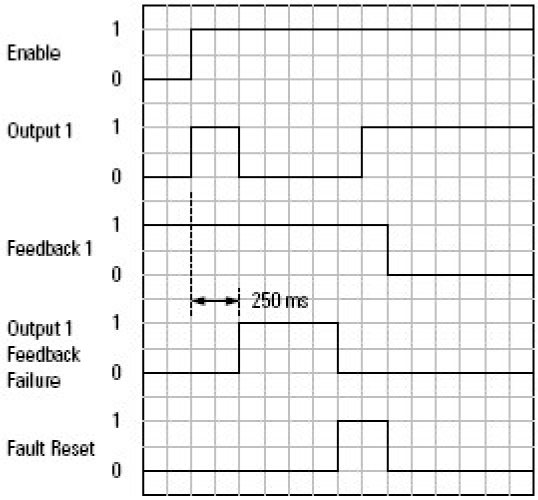
This instruction monitors a single logical input and activates two field outputs when the logical input goes Active.

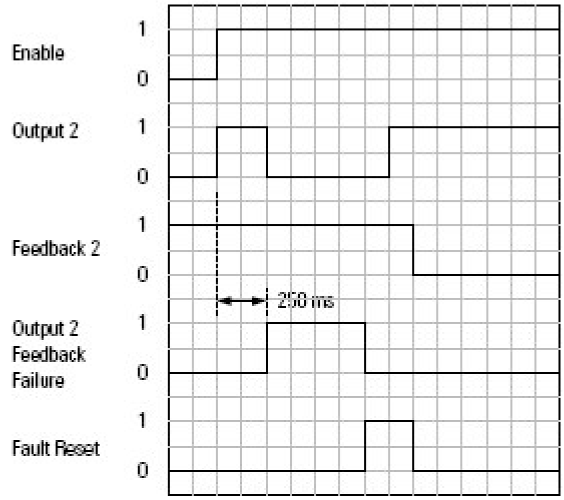


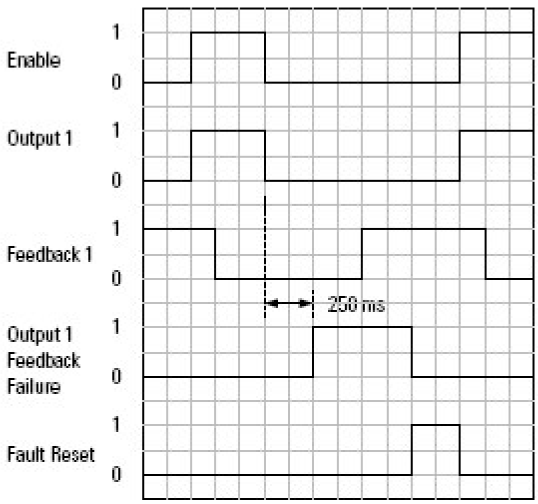
It also monitors a feedback channel for each field output and generates a fault if both channels do not, within a time limit, indicate the desired state of the associated outputs.

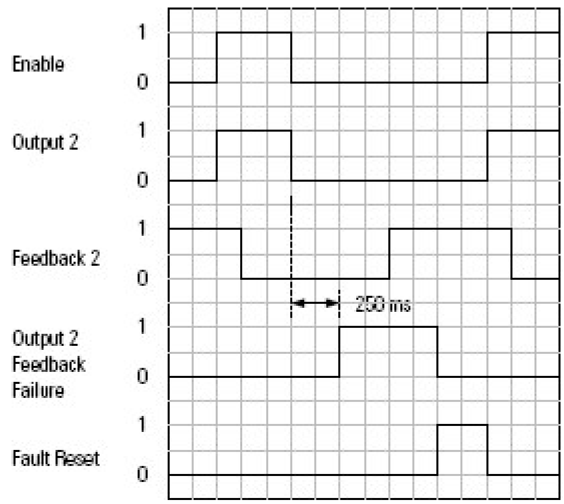
Instruction operation is illustrated in the following timing diagrams:

Negative Feedback

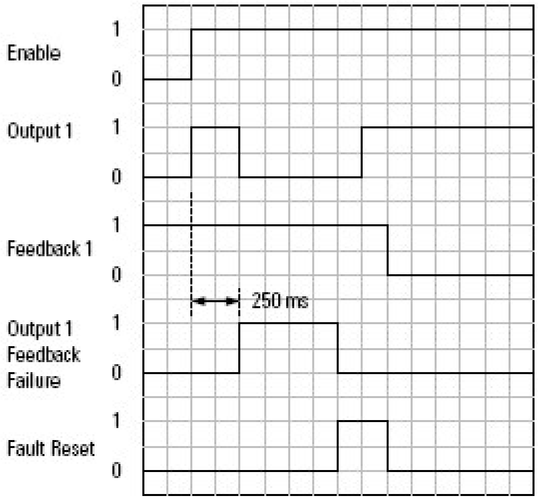


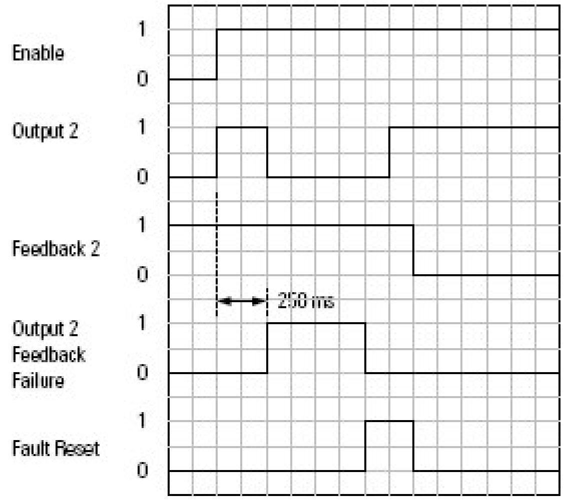


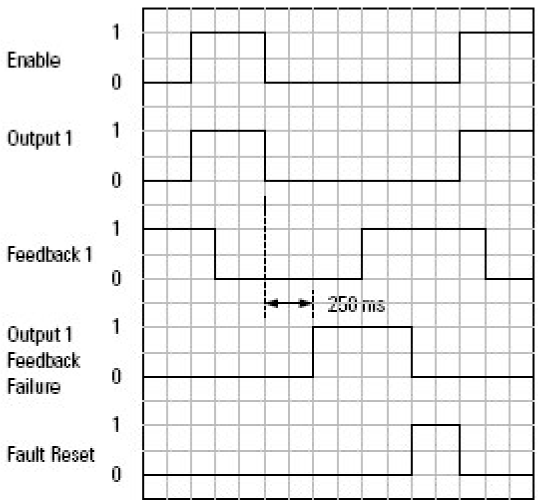


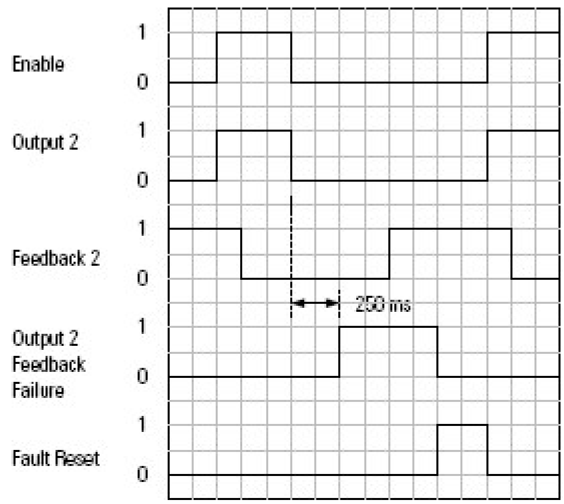


Positive Feedback









False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

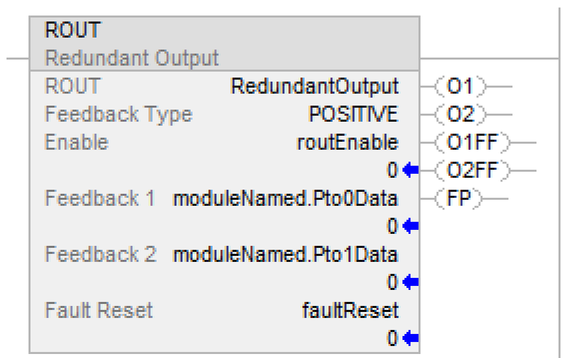
Major/Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

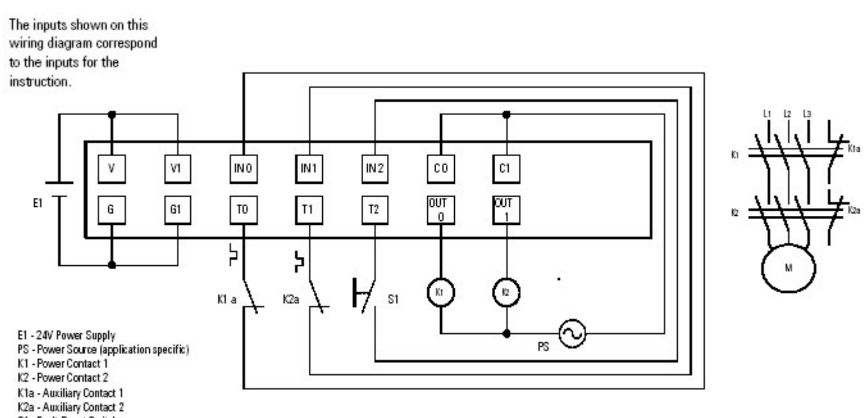
Condition/State	Action Taken
Prescan	The .O1, .O2, .O1FF, .O2FF and .FP are cleared to false.
Rung condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	The instruction executes as described in the False Rung State Behavior section.

Example



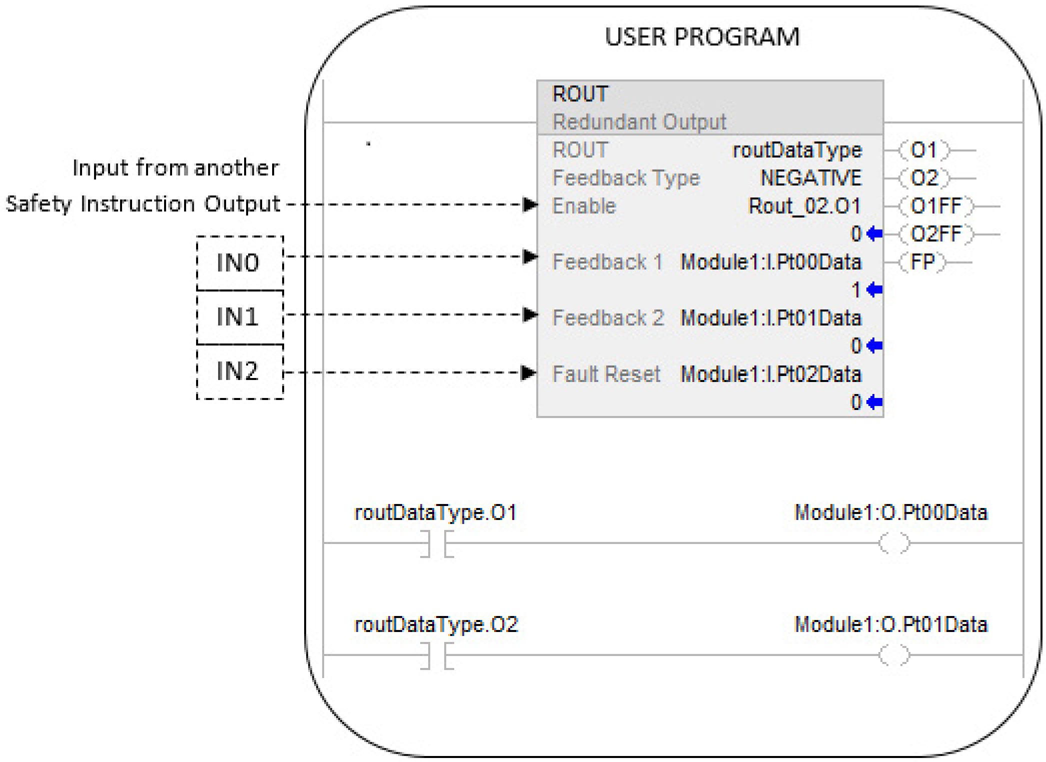
Negative Feedback Wiring

The following wiring diagram illustrates how to wire two contactors, and normally open auxiliary contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.



Negative Feedback Programming

The following programming example shows how the Redundant Output instruction with negative feedback can be applied to the wiring diagram shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None

Test Output

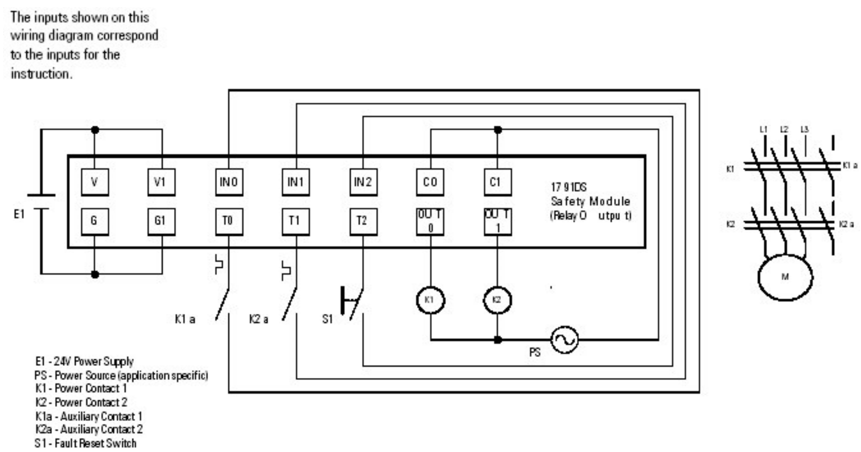
Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Output Configuration

Point	Type	Point Mode
0 (OUT0)	Single	Safety
1 (OUT1)	Single	Safety

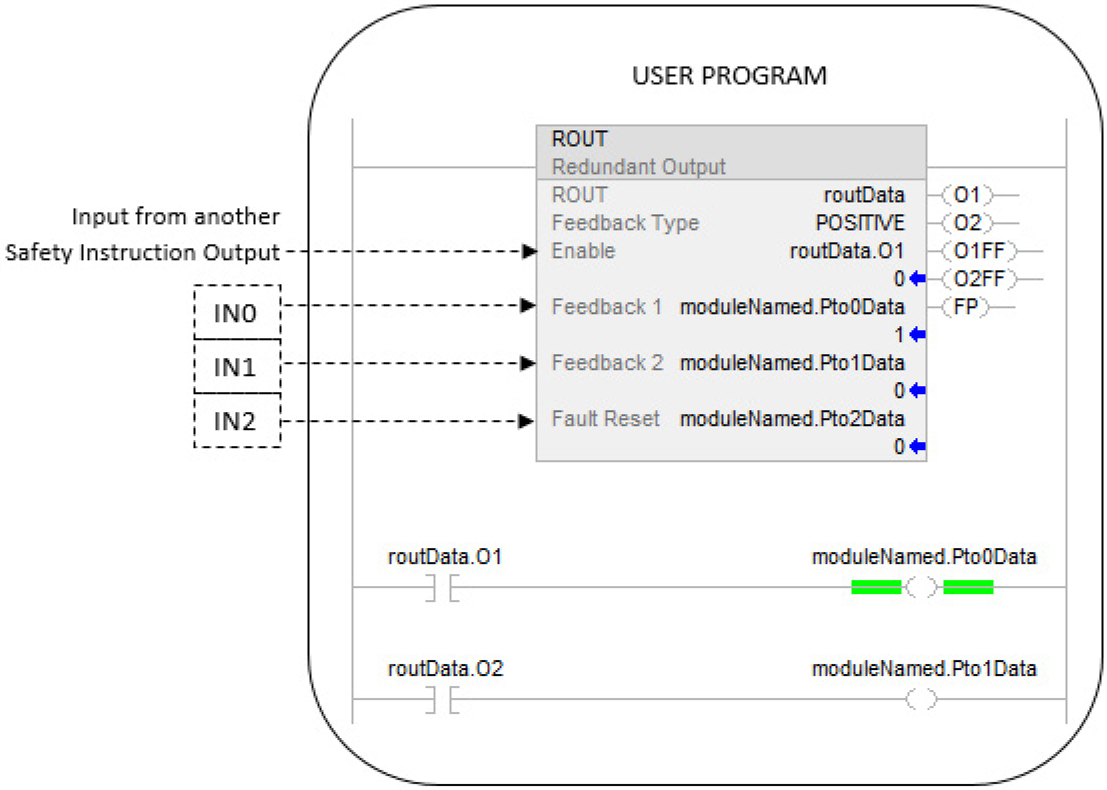
Positive Feedback Wiring

The following wiring diagram illustrates how to wire two contactors and normally open auxiliary contacts to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4.



Positive Feedback Programming

The following programming example shows how the Redundant Output instruction with positive feedback can be applied to the previous wiring diagram.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety	None

Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Power Supply
3 (T3)	Not Used

Output Configuration

Output Configuration		
Point	**Type**	**Point Mode**
0 (OUT0)	Single	Safety
1 (OUT1)	Single	Safety

See also

Execution Times for Safety Application Instructions on page 526

Index Through Arrays on page 540

Common Attributes on page 529

Status and Safety input and output for safety instructions on page 21

Two Hand Run Station (THRS)

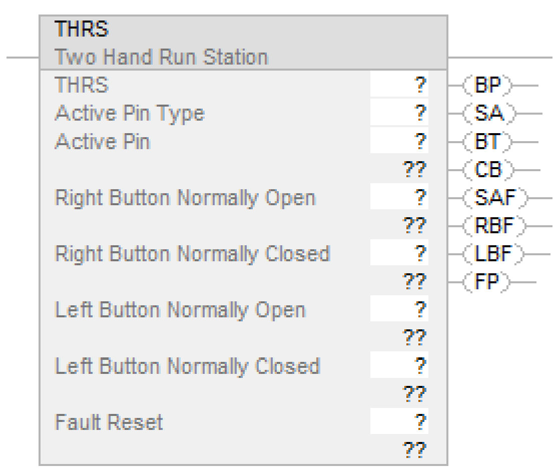
This instruction applies to the Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, and GuardLogix 5580 controllers.

Use the Two Hand Run Station (THRS) instruction to provide a method to incorporate two diverse input buttons used as a single operation start button into a software programmable environment.

A run station can also be inserted or removed from controlling the process by using an Active Pin input in this instruction. The Two Hand Run Station with Active Pin Instruction takes the four inputs (two from each button) and turns them into one signal for the rest of the application.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

This instruction is not available in structured text.

Operands

IMPORTANT Make sure that your safety input modules are configured as single, not Equivalent or Complementary. These instructions provide all dual channel functionality necessary for PLd (Cat. 3) or PLe (Cat. 4) safety functions.

The following table explains instruction inputs.

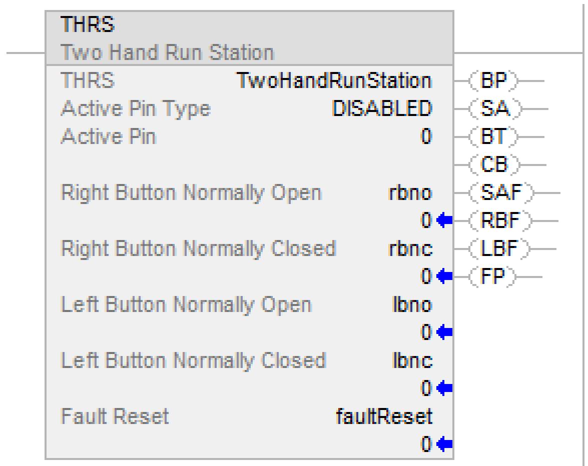
Operand	Data Type	Description	Values
THRS	TWO_HAND_RUN_STATION	This parameter is a backing tag that maintains important execution information for each usage of this instruction. **ATTENTION:** To avoid unexpected operation do not reuse this backing tag and its members. Do not write to any of the tag members anywhere else in the program.	—
Active Pin Type	BOOL	The Active Pin type determines whether or not the input and outputs specific to the Active Pin are processed. ENABLED or DISABLED	Enabled = 1 or Disabled = 0
Active Pin	BOOL	Active Pin for run station Active Pin Enabled - When set, the Buttons Pressed output can enter the Active state. When clear, the Buttons Pressed output remains off. Active Pin Disabled - Visible, but not used.	Initial = 0 Set = 1
Right Button Normally Open	BOOL	Right Button N.O. Contact Input	Safe = 0 Active = 1
Right Button Normally Closed	BOOL	Right Button N.C. Contact Input	Safe = 1 Active = 0
Left Button Normally Open	BOOL	Left Button N.O. Contact Input	Safe = 0 Active = 1
Left Button Normally Closed	BOOL	Left Button N.C. Contact Input	Safe = 1 Active = 0
Fault Reset	BOOL	Fault Reset Input Active Pin Enabled - When transitioned from off to on, and the fault cause has been cleared, the Right Button Fault, Left Button Fault and Station Active Fault outputs are cleared. Active Pin Disabled - When transitioned from off to on, and the fault cause has been cleared, the Right Button Fault and Left Button Fault outputs are cleared.	Initial = 0 Reset =1

The following table provides the outputs to the instruction. In many applications, the output tags may represent the state of actual field devices. They may also be internal tags used to represent machine state information for use with other instructions.

Operand	Data Type	Description	Values
Buttons Pressed	BOOL	Output is enabled when the run station buttons are pressed and no faults are present.	Safe = 0 Active = 1
Station Active	BOOL	Output is enabled when the run station is active. Active Pin Enabled - Set indicates that the station is active. Cleared indicates that the station is inactive. Active Pin Disabled - Visible, but not used, always zero.	Initial = 0 Active = 1
Button Tiedown	BOOL	Indicates that both buttons were not pressed within 500 ms of each other. Cleared when both buttons are released.	Initial = 0 Active = 1
Cycle Buttons	BOOL	Set when the Button Tiedown indicator is set. Cleared when the Button Tiedown indicator is cleared.	Initial = 0 Active = 1
Station Active Fault	BOOL	Active Pin Enabled - Fault is set when the station is inactive. Active Pin Disabled - Visible, but not used, always zero.	Initial = 0 Active = 1
Right Button Fault	BOOL	There is a right button fault. Set when the Right Button Normally Closed and the Right Button Normally Open inputs are not both energized or not both de-energized within 250 ms.	Initial = 0 Active = 1
Left Button Fault	BOOL	There is a left button fault. Set when the Left Button Normally Closed and the Left Button Normally Open inputs are not both energized or not both de-energized within 250 ms.	Initial = 0 Active = 1
Fault Present	BOOL	One or more of the faults are present. Active Pin Enabled - Set when the Station Active Fault, Right Button Fault or Left Button Fault outputs are set. Cleared when the Station Active Fault, Right Button Fault and Left Button Fault outputs are cleared. Active Pin Disabled - Set when the Station Right Button Fault or Left Button Fault outputs are set. Cleared when the Right Button Fault and Left Button Fault outputs are cleared.	Initial = 0 Active = 1

IMPORTANT Do not write to any instruction output tag under any circumstances.

Example

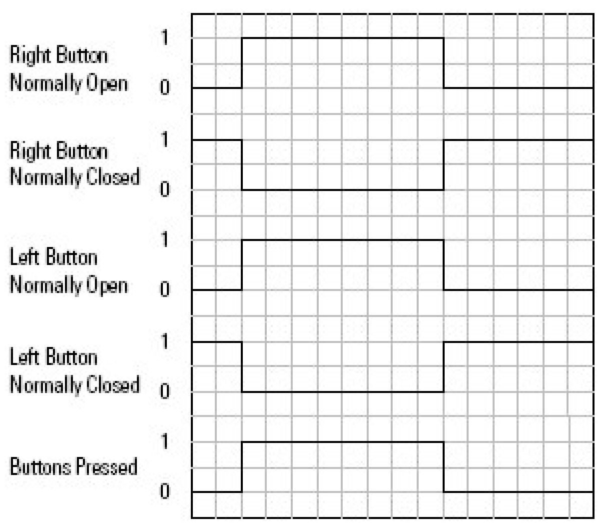


Operation

Normal Operation

This instruction takes the four inputs (two from each button) and turns them into one signal for the rest of the application.

These normal operation state changes are shown in the following timing diagram:

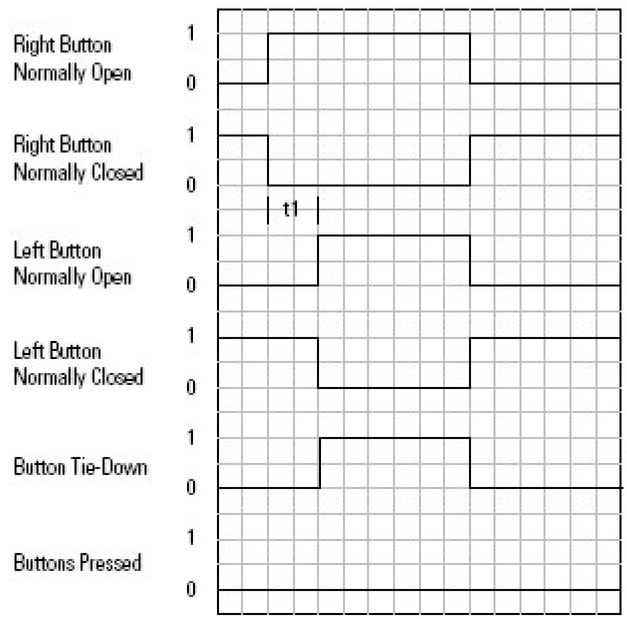


See the *De-energize to Trip* section in the *Safety Instructions* topic for information about how to condition the input data associated with the normally closed channel.

Button Tie-Down Operation

The Two-Hand Run Station instruction also monitors the four inputs to make sure none of them fail or are intentionally defeated. If the buttons are not pressed within 500 ms (t1) of each other, this instruction generates a Button Tie-Down condition and prevents the Buttons Pressed output from entering the Active state.

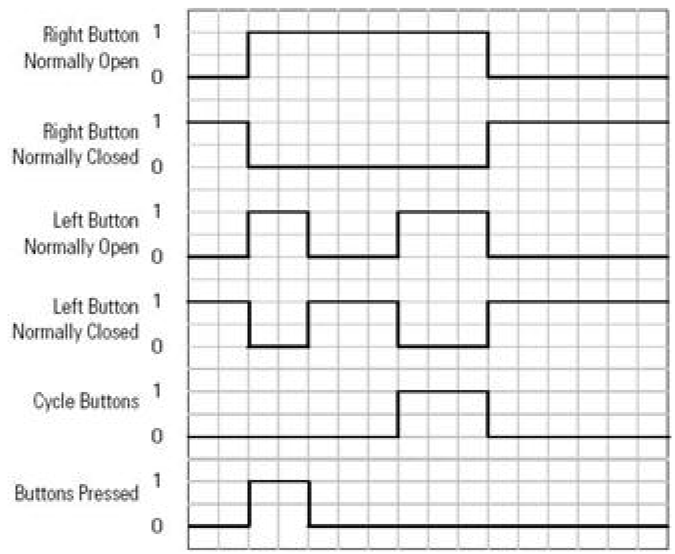
These state changes are shown in the following timing diagram:



Cycle Buttons Operation

If, while Buttons Pressed is active, one of the buttons transitions from the Active state to the Safe state and back to the Active state before the other button transitions to the Safe state, this instruction sets the Cycle Buttons output prompt, and prevents the Buttons Pressed output from entering the Active state again until both buttons cycle through their Safe states.

These state changes are shown in the following timing diagram.



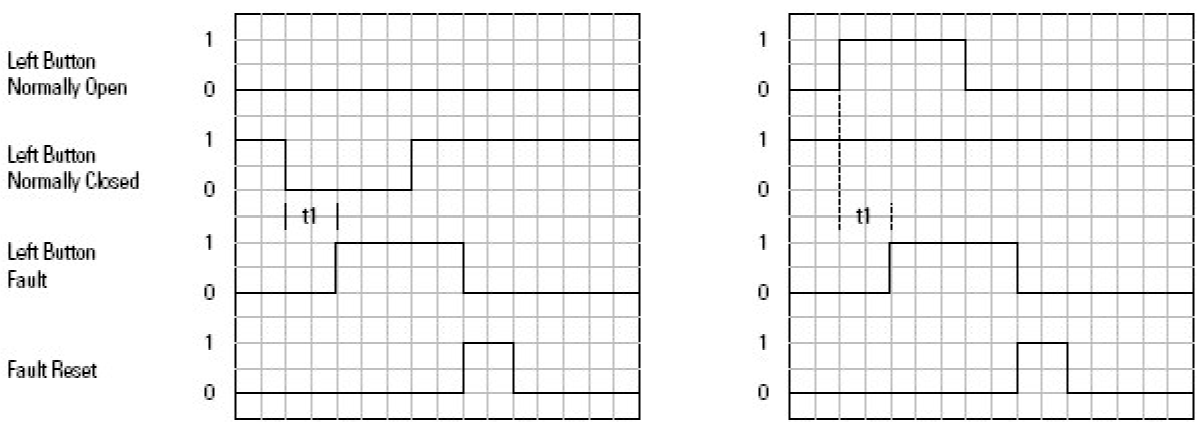
Button Fault Operation

This instruction also monitors the individual inputs from each button. If the two contacts for one of the buttons are in opposite safe states for more than 250 ms (t1), the appropriate fault is set (Left Button Fault or Right Button Fault). The Fault Present output is also set.

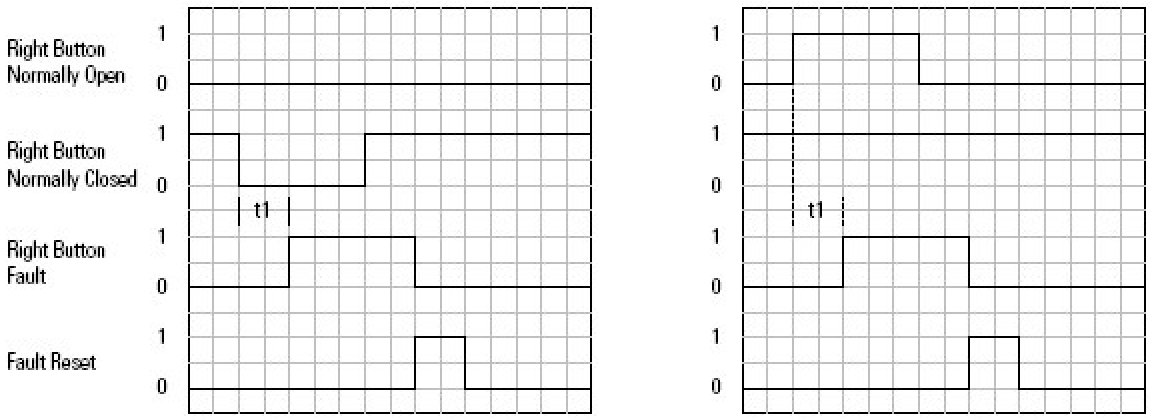
The Buttons Pressed output is set to the Safe state whenever one of these faults exists.

These state changes are shown in the following timing diagrams:

Left Button Fault



Right Button Fault



False Rung State Behavior

When the instruction is executed on a false rung the behavior is exactly the same as true rung state except all outputs, including prompts and fault indicators, will be zero. When the rung state becomes true the outputs will be set as determined by the instruction logic.

Affects Math Status Flags

No

Major / Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

Condition/State	Action Taken
Prescan	The .BP, .SA, .BT, .CB, .SAF, .RBF, .LBF and .FP are cleared to false.
Rung-condition-in is false	The instruction executes as described in the False Rung State Behavior section.
Rung-condition-in is true	The instruction executes as described in the Normal Operation section.
Postscan	Same as Rung condition-in is false.

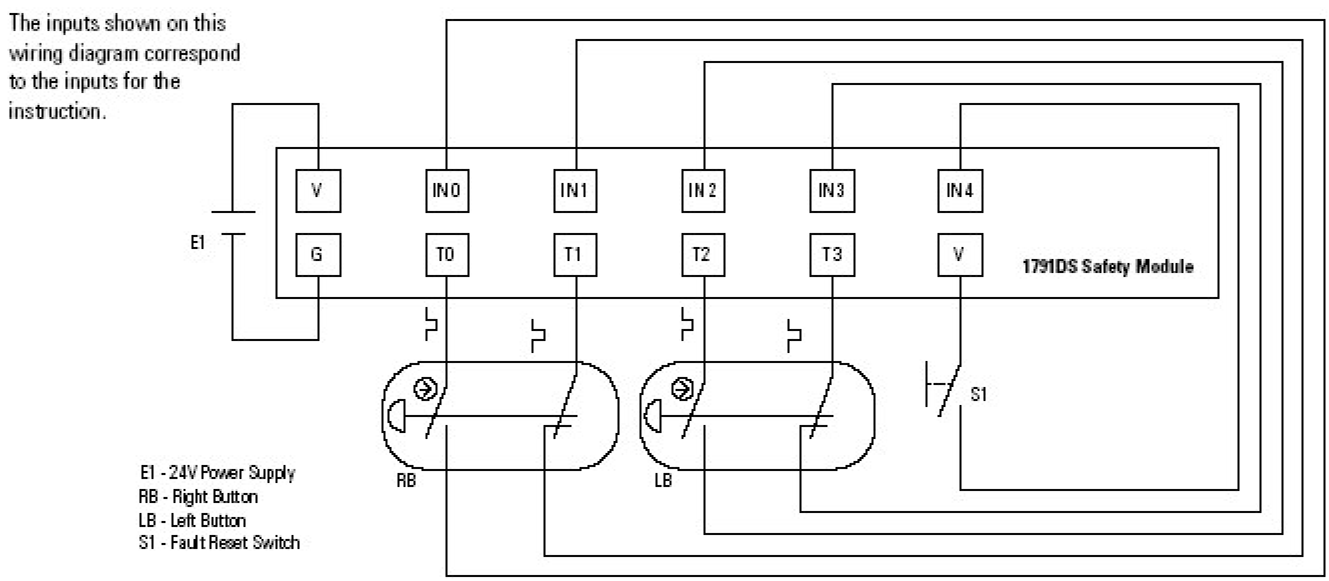
Example

Relationship of I/O Wiring to Instruction Parameters

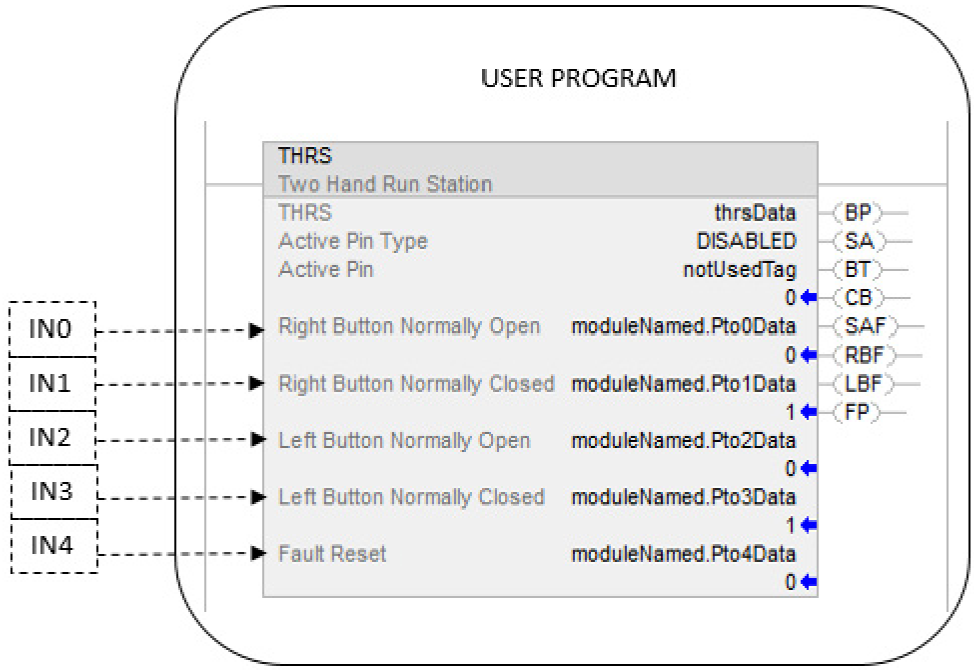
Two Hand Run Station with Active Pin Disabled Wiring and Programming

IMPORTANT The Two-Hand Run Station is wired properly when the four run button inputs are in the safe state when the run buttons are released.

The following wiring diagram is one example of how to wire right and left buttons to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4. Each button has 2 diverse input channels.



The following programming example shows how the Two-Hand Run Station without Active Pin instruction can be applied to the previous wiring diagram.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety Pulse Test	2 (T2)
3 (IN3)	Single	Safety Pulse Test	3 (T3)
4 (IN4)	Single	Safety	None

Test Output

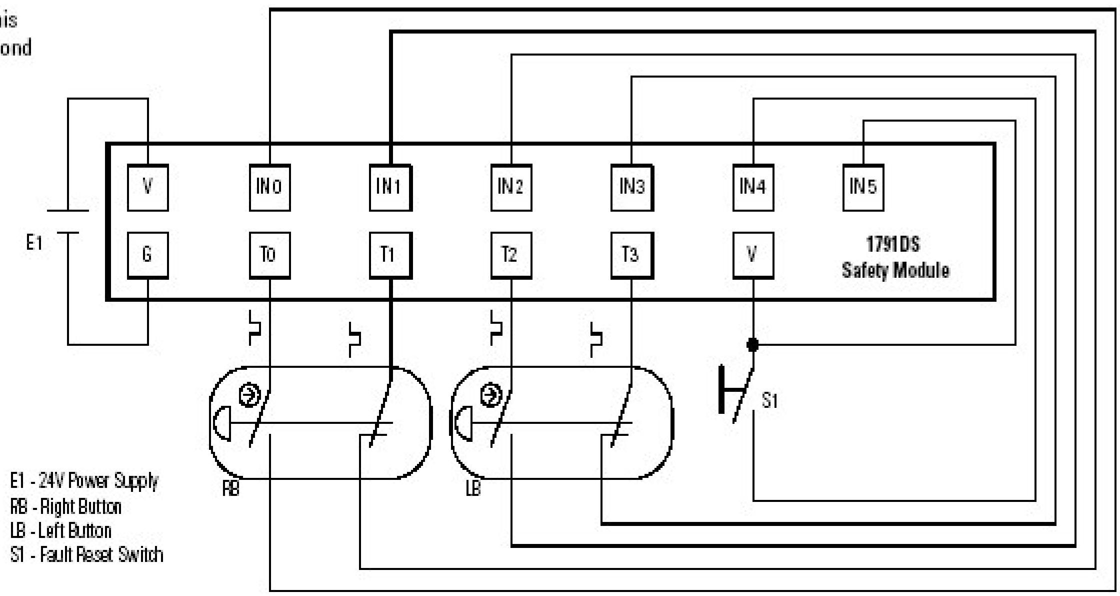
Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Pulse Test
3 (T3)	Pulse Test

Two Hand Run Station with Active Pin Enabled Wiring and Programming

IMPORTANT The Two-Hand Run Station is wired properly when the four run button inputs are in the safe state when the run buttons are released.

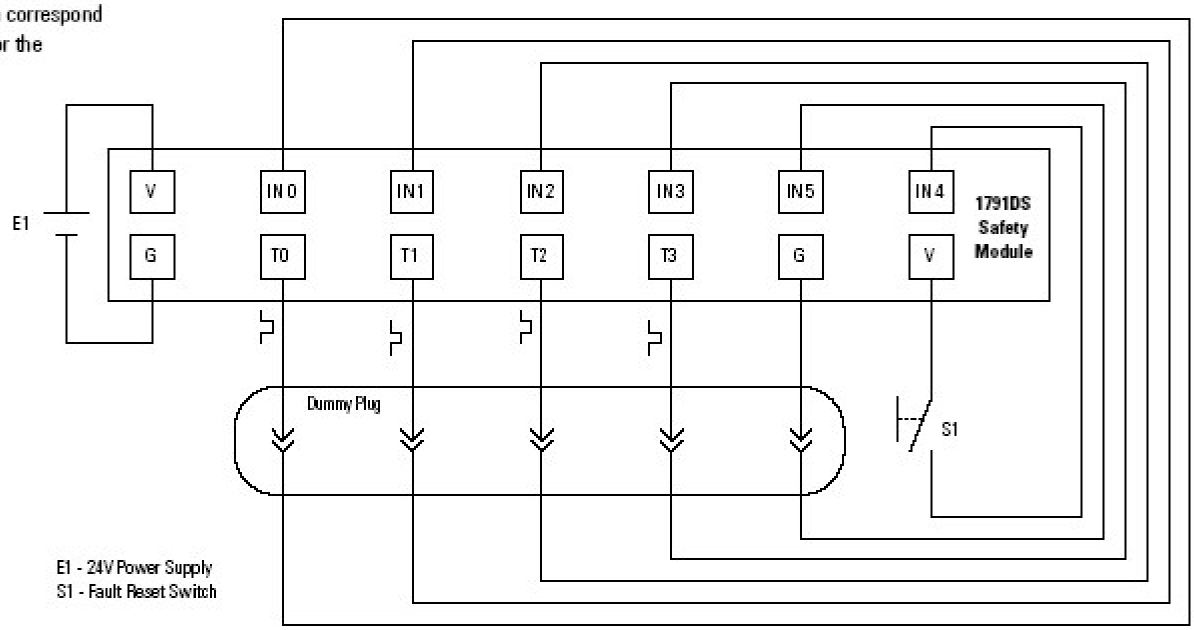
The following wiring diagram is one example of how to wire right and left buttons to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4. Each button has 2 diverse input channels.

The inputs shown on this wiring diagram correspond to the inputs for the instruction.

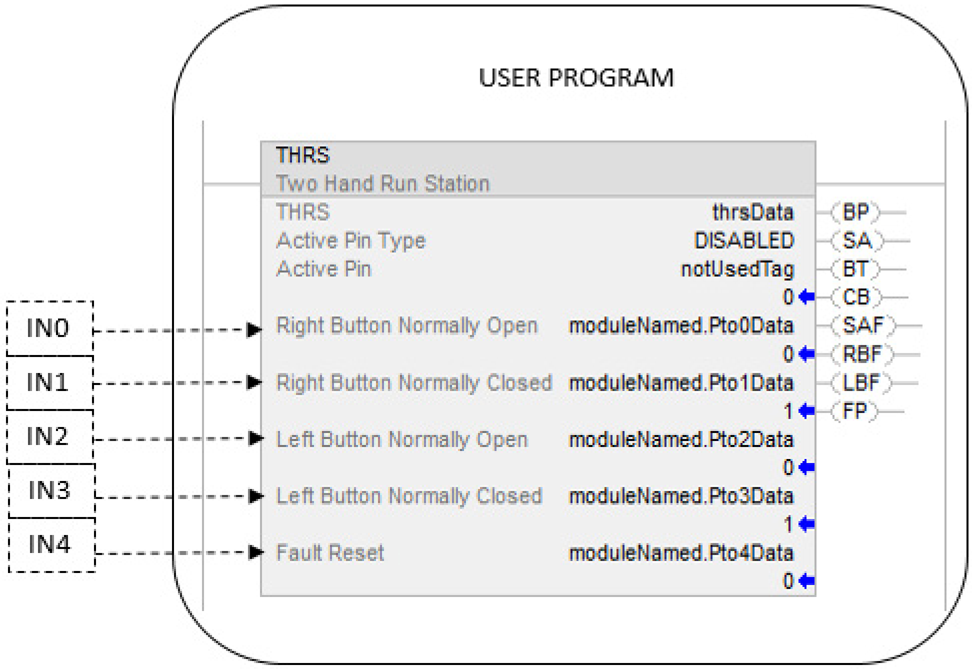


The following wiring diagram is one example of how to wire a Dummy Plug to a 1791DS Safety I/O module to comply with ISO 13849-1 Category 4. Each button has 2 diverse input channels.

The inputs shown on this wiring diagram correspond to the inputs for the instruction.



The following programming examples show how the Two-Hand Run Station with Active Pin instruction can be applied to the wiring diagrams shown above.



ISO 13849-1 Category 4 requires that inputs be independently pulse tested. The Logix Designer programming application is used to configure the following I/O module parameters for pulse testing.

Input Configuration

Input Point	Type	Point Mode	Test Source
0 (IN0)	Single	Safety Pulse Test	0 (T0)
1 (IN1)	Single	Safety Pulse Test	1 (T1)
2 (IN2)	Single	Safety Pulse Test	2 (T2)
3 (IN3)	Single	Safety Pulse Test	3 (T3)
4 (IN4)	Single	Safety	None
5 (IN5)	Single	Safety	None

Test Output

Test Output Point	Point Mode
0 (T0)	Pulse Test
1 (T1)	Pulse Test
2 (T2)	Pulse Test
3 (T3)	Pulse Test

See also

Execution Times for Safety Application Instructions on page 526

Index Through Arrays on page 540

Common Attributes on page 529

Execution Times for Safety Application Instructions

The list is the average execution times for the GuardLogix Safety Application Instructions. Logix Designer application instructions were measured while enabled and operating on an enabled ladder logic rung.

Version 17 and later, Safety Application Instructions

Mnemonic	Name		Execution Time		
			with 1756-L6S controllers	with 1756-L7S controllers	with 1769-L3S controllers
CROUT	Configurable Redundant Output	Negative Feedback	12 µs	9 µs	14 µs
		Positive Feedback	14 µs	9 µs	9 µs
DCS	Dual Channel Input - Stop		24 µs	13 µs	14 µs
DCST	Dual Channel Input - Stop With Test		26 µs	13 µs	14 µs
DCSTL	Dual Channel Input - Stop With Test and Lock		36 µs	18 µs	20 µs
DCSTM	Dual Channel Input - Stop With Test and Mute		28 µs	15 µs	16 µs
DCM	Dual Channel Input - Monitor		14 µs	8 µs	8 µs
DCSRT	Dual Channel Input - Start		20 µs	10 µs	11 µs
DCA	Dual Channel Analog Input		36 µs	16 µs	18 µs
DCAF	Dual Channel Analog Input (Floating Point)		-----	16 µs	15 µs
SMAT	Safety Mat		16 µs	10 µs	10 µs
THRSe	Two-Hand Run Station – Enhanced		44 µs	19 µs	33 µs
TSAM	Two Sensor Asymmetrical Muting		30 µs	19 µs	19 µs
TSSM	Two Sensor Symmetrical Muting		30 µs	16 µs	18 µs
FSBM	Four Sensor Bidirectional Muting		34 µs	18 µs	19 µs

Version 17 and later, Metal Form Safety Application Instructions

Mnemonic	Name	Execution Time		
		with 1756-L6S controllers	with 1756-L7S controllers	with 1769-L3S controllers
CBCM	Clutch Brake Continuous Mode	28 µs	15 µs	17 µs
CBIM	Clutch Brake Inch Mode	18 µs	11 µs	12 µs
CBSSM	Clutch Brake Single Stoke Mode	20 µs	13 µs	13 µs
CPM	Crankshaft Position Monitor	24 µs	14 µs	15 µs
CSM	Camshaft Monitor	24 µs	15 µs	15 µs

EPMS	Eight-position Mode Selector	24 µs	14 µs	16 µs
AVC	Auxiliary Valve Control	20 µs	10 µs	14 µs
MVC	Main Valve Control	12 µs	9 µs	8 µs
MMVC	Maintenance Manual Valve Control	20 µs	14 µs	13 µs

Version 14 and later, Safety Application Instructions

Mnemonic	Name		Execution Time		
			with 1756-L6S controllers	with 1756-L7S controllers	with 1769-L3S controllers
ENPEN	Enable Pendant	Auto Reset	8 µs	6 µs	6 µs
		Manual Reset	10 µs	6 µs	6 µs
ESTOP	E-stop		10 µs	7 µs	7 µs
RIN	Redundant Input		10 µs	7 µs	7 µs
ROUT	Redundant Output	Negative Feedback	10 µs	6 µs	6 µs
		Positive Feedback	14 µs	9 µs	9 µs
DIN	Diverse Input Auto Reset		12 µs	8 µs	9 µs
	Diverse Input Manual Reset		16 µs	8 µs	8 µs
FPMS	5-Position Mode Selector		12 µs	9 µs	9 µs
THRS	Two Handed Run Station	Active Pin Enabled	16 µs	10 µs	12 µs
		Active Pin Disabled	14 µs	10 µs	11 µs
LC	Light Curtain		14 µs	9 µs	9 µs

Common Attributes for Safety Instructions

Follow the guidelines in this chapter for the common attributes for the Safety Instructions.

Common Attributes

For more information on attributes that are common to the Logix 5000™ instructions, click any of the topics below.

Math Status Flags on page 529

Immediate Values on page 539

Data Conversions on page 531

Elementary data types on page 534

Floating Point Values on page 537

Index Through Arrays on page 540

Bit Addressing on page 541

Math Status Flags

Follow the guidelines in this topic for Math Status Flags.

Description

Controllers	Description
CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, Compact GuardLogix 5380, and GuardLogix 5580 controllers	A set of Math Status Flags for accessing directly with instructions. These flags are only updated in ladder diagram routines, and are not tags, and flag aliases are not applicable.
CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers	A set of Math Status Flags for accessing directly with instructions. These flags are updated in all routine types, but are not tags, and flag aliases are not applicable.

Status Flags

Status Flag	Description (For CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, Compact GuardLogix 5380, and GuardLogix 5580 controllers)	Description (For CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers)
S:FS First scan flag	The first scan flag is set by the controller: • The first time a program is scanned after the controller goes to Run mode • The first time a program is scanned after the program is uninhibited • When a routine is called from an SFC Action and the step that owns that Action is first scanned. Use the first scan flag to initialize data for use in later scans. It is also referred to as the first pass bit.	The first scan flag is set by the controller: • The first time a program is scanned after the controller goes to Run mode • The first time a program is scanned after the program is uninhibited • When a routine is called from an SFC Action and the Step that owns that Action is first scanned. Use this flag to initialize data for use in later scans. It is also referred to as the first pass bit.
S:N Negative flag	The controller sets the negative flag when the result of a math or logical operation is a negative value. Use this flag as a quick test for a negative value.	The controller sets the negative flag when the result of a math or logical operation is a negative value. Use this flag as a quick test for a negative value. Using S:N is more efficient than using the CMP instruction.
S:Z Zero flag	The zero flag is set by the controller when the result of a math or logical operation is zero. Use this flag as a quick test for a zero value. The zero flag clears at the start of executing an instruction capable of setting this flag.	The controller sets the zero flag when the result of a math or logical operation is zero. Use this flag as a quick test for a zero value.
S:V Overflow flag	The controller sets the overflow flag when: • The result of a math operation results in an overflow. For example, adding 1 to a SINT generates an overflow when the value goes from 127 through -128. • The destination tag is too small to hold the value. For example, if you try to store the value 123456 to a SINT or INT tag. Use the overflow flag to verify the result of an operation is still in range. If the data being stored is a string type, S:V is set if the string is too large to fit into the destination tag. **Tip:** If applicable, set S:V with an OTE or OTL instruction. Click **Controller Properties > Advanced tab > Report Overflow Faults** to enable or disable reporting overflow faults. If an overflow occurs while evaluating an array subscript, a minor fault is generated and a major fault is generated to indicate the index is out of range.	The controller sets the overflow flag when: • The result of a math operation results in an overflow. For example, adding 1 to a SINT generates an overflow when the value goes from 127...-128. • The destination tag is too small to hold the value. For example, if you try to store the value 123456 to a SINT or INT tag. Use the overflow flag to check that the result of an operation is still in range. A minor fault is generated anytime an overflow flag is set. **Tip:** If applicable,set S:V with an OTE or OTL instruction.
S:C Carry flag	The controller sets the carry flag when the result of a math operation resulted in the generation of a carry out of the most significant bit. Only the ADD and SUB instructions, and not the + and – operators, with integer values affect this flag.	The controller sets the carry flag when the result of a math operation resulted in the generation of a carry out of the most significant bit.

Status Flag	Description (For CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, Compact GuardLogix 5380, and GuardLogix 5580 controllers)	Description (For CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers)
S:MINOR Minor fault flag	The controller sets the minor fault flag when there is at least one minor program fault. Use the minor fault tag to test if a minor fault occurred. This bit only triggers by programming faults, such as overflow. It is not triggered by a battery fault. The bit clears at the beginning of every scan. **Tip:** If applicable, explicitly set S:MINOR with an OTE or OTL instruction.	The controller sets the minor fault flag when there is at least one minor program fault. Use the minor fault flag to test if a minor fault occurred and take appropriate action. This bit is triggered only by programming faults, such as overflow. It is not triggered by a battery fault. The bit clears at the beginning of every scan. **Tip:** If applicable, explicitly set S:MINOR with an OTE or OTL instruction.
IMPORTANT	The math status flags are set based on the stored value. Instructions that normally do not affect math status flags might appear to affect math status flags if type conversion occurs from mixed data types for the instruction parameters. The type conversion process sets the math status flags.	

Expressions in Array Subscripts

Controllers	Description
CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, Compact GuardLogix 5380, and GuardLogix 5580 controllers	Expressions do not set status flags based on the results of math operations. If expressions overflow: • A minor fault generates if the controller is configured to generate minor faults. • A major fault (type 4, code 20) generates because the resulting value is out of range.
CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers	Expressions set status flags based on the results of math operations. If an array subscript is an expression, the expression and the instruction could generate minor faults.

Tip: If an array subscript is too large (out of range), a major fault (type 4, code 20) generates.

Data Conversions

Data conversions occur when mixing data types in programming.

When programming:	Conversions can occur when you:
Ladder Diagram Structured Text	Mix data types for the parameters within one Instruction or expression.
Function Block	Wire two parameters that have different data types

Instructions execute faster and require less memory if all the operands of the instruction use:

- The same data type.
- An intermediate data type:
  - All function block instructions support one data type operand only.

- If mixing data types or use tags that are not the optimal data type, the controller converts the data according to these rules:
  - Operands are converted according to the ranking of data types from SINT, USINT, INT, UINT, DINT, UDINT, LINT, ULINT, REAL, and LREAL with ranking from 1 (the lowest) to 10 (the highest).

Tip: To reduce the time and memory for converting data, use the same data type for all the operands of an instruction.

Convert SINT or INT to DINT or DINT to LINT

A SINT or INT input source tag gets promoted to a DINT value by a sign-extension for Source Tag. Instructions that convert SINT or INT values to DINT values use one of the following conversion methods.

This conversion method	Converts data by placing
Sign-extension	The value of the leftmost bit (the sign of the value) into each bit position to the left of the existing bits until there are 32 or 64 bits.
Zero-fill	Zeroes to the left of the existing bits until there are 32 or 64 bits.

Logical instructions use zero fill. All other instructions use sign-extension

The following example shows the results of converting a value using sign-extension and zero-fill.

This value	2#1111_1111_1111_1111	(-1)
Converts to this value by sign-extension	2#1111_1111_1111_1111_1111_1111_1111_1111	(-1)
Converts to this value by zero-fill	2#0000_0000_0000_0000_1111_1111_1111_1111	(65535)

If you use a SINT or INT tag and an immediate value in an instruction that converts data by sign-extension, use one of these methods to handle immediate values.

Specify any immediate value in the decimal radix.

If you enter the value in a radix other than decimal, specify all 32 bits of the immediate value. To do so, enter the value of the leftmost bit into each bit position to its left until there are 32 bits.

Create a tag for each operand and use the same data type throughout the instruction. To assign a constant value, either:

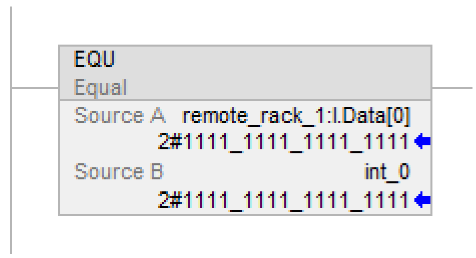
Enter it into one of the tags.

Add a MOV instruction that moves the value into one of the tags.

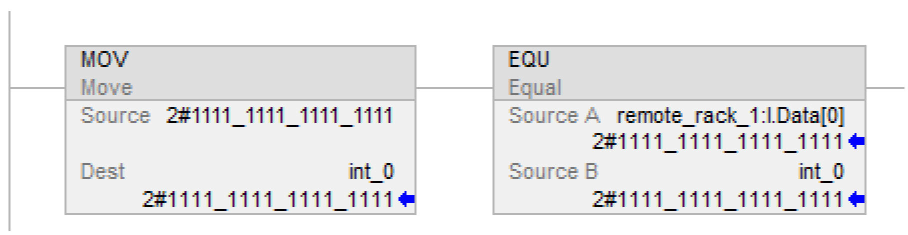
Use a MEQ instruction to check only the required bits.

The following examples show two ways to mix an immediate value with an INT tag. Both examples check the bits of a 1771 I/O module to determine if all the bits are on. Since the input data word of a 1771 I/O module is an INT tag, it is easiest to use a 16-bit constant value.

IMPORTANT	Mixing an INT tag with an immediate value Since remote_rack_1:I.Data[0] is an INT tag, the value to check it against is also entered as an INT tag.



IMPORTANT	Mixing an INT tag with an immediate value Since remote_rack_1:I.Data[0] is an INT tag, the value to check it against first moves into int_0, also an INT tag. The EQU instruction then compares both tags.



Convert Integer to REAL

The controller stores REAL values in IEEE single-precision, floating-point number format. It uses one bit for the sign of the value, 23 bits for the base value, and eight bits for the exponent (32 bits total). If you mix an integer tag (SINT, INT, or DINT) and a REAL tag as inputs in the same instruction, the controller converts the integer value to a REAL value before the instruction executes.

- A SINT or INT value always converts to the same REAL value.
- A DINT value may not convert to the same REAL value:
- A REAL value uses up to 24 bits for the base value (23 stored bits plus a 'hidden' bit).
- A DINT value uses up to 32 bits for the value (one for the sign and 31 for the value).

If the DINT value requires more than 24 significant bits, it might not convert to the same REAL value. If it will not, the controller stores the uppermost 24 bits rounded to the nearest even value.

Convert DINT to SINT or INT

To convert a DINT value to a SINT or INT value, the controller truncates the upper portion of the DINT and stores the lower bits that fit in the data type. If the value is too large the conversion generates an overflow.

	Convert a DINT to an INT and a SINT	
This DINT value	Converts to this smaller value	
16#0001_0081 (65,665)	INT:	16#0081 (129)
	SINT:	16#81 (-127)

Convert REAL to SINT, INT, or DINT

To convert a REAL value to an integer value, the controller rounds any fractional part and stores the bits that fit in the result data type. If the value is too large the conversion generates an overflow.

Numbers round as in the following examples.

Fractions < 0.5 round down to the nearest whole number.

Fractions > 0.5 round up to the nearest whole number.

Fractions = 0.5 round up or down to the nearest even number.

Important:	Conversion of REAL values to DINT values
This REAL value	**Converts to this DINT value**
-2.5 -3.5	-2 -4
-1.6	-2
-1.5	-2
-1.4	-1
1.4	1
1.5	2
1.6	2
2.5 3.5	2 4

Elementary data types

The controller supports the elementary data types defined in IEC 1131-3 defined data types. The elementary data types are:

Data type	Description	Range
BOOL	1-bit boolean	0 = cleared 1 = set
SINT	1-byte integer	-128 to 127
INT	2-byte integer	-32,768 to 32,767
DINT	4-byte integer	-2,147,483,648 to 2,147,483,647

Data type	Description	Range
REAL	4-byte floating-point number	-3.402823E^{38} to -1.1754944E^{-38} (negative values) and 0 and 1.1754944E^{-38} to 3.402823E^{38} (positive values)
LINT	8-byte integer **Note:** The LINT data type has limited use on CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers. They can be used only with copy (COP, CPS) instructions, the CST/WallClock Time attribute, time synchronization, and Add-On Instructions.	0 to 32,535,129,599,999,999
USINT	1-byte unsigned integer	0 to 255
UINT	2-byte unsigned integer	0 to 65,535
UDINT	4-byte unsigned integer	0 to 4,294,967,295
ULINT	8-byte unsigned integer	0 to 18,446,744,073,709,551,615
REAL	4-byte floating-point number	-3.4028235E38 to -1.1754944E-38 (negative values) and 0.0 and 1.1754944E-38 to 3.4028235E38 (positive values)
LREAL	8-byte floating-point number	-1.7976931348623157E308 to -2.2250738585072014E-308 (negative values) and 0.0 and 2.2250738585072014E-308 to 1.7976931348623157E308 (positive values)

These controllers support the following elementary data types:

Controllers	Data type
CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, Compact GuardLogix 5380, and GuardLogix 5580 controllers	SINT, INT, DINT, LINT, REAL USINT, UINT, UDINT, ULINT, LREAL
CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers	SINT, INT, DINT, LINT, REAL.

The controller handles all immediate values as DINT data types.

The REAL data type also stores ± infinity and ± NAN, but the software display differs based on the display format.

Data type conversions

When data types are mixed for operands within an instruction, some instructions automatically convert data to an optimal data type for that instruction. In some cases, the controller converts data to fit a new data type; in some cases, the controller just fits the data as best it can.

Conversion	Result		
larger integer to smaller integer	The controller truncates the upper portion of the larger integer and generates an overflow. For example:		
	Decimal		**Binary**
	DINT	65,665	0000_0000_0000_0001_0000_0000_1000_0001
	INT	129	0000_0000_1000_0001
	SINT	-127	1000_0001
SINT or INT to REAL	No data precision is lost		
DINT to REAL	Data precision could be lost. Both data types store data in 32 bits, but the REAL type uses some of its 32 bits to store the exponent value. If precision is lost, the controller takes it from the least-significant portion of the DINT.		
LREAL to LREAL	No data precision is lost.		
LREAL TO REAL	Data precision could be lost.		
LREAL/REAL to unsigned integer	Data precision could be lost. If the source value is too big to fit into destination the controller stores what it can and may produce an overflow.		
Signed Integer/Unsigned Integer to LREAL/REAL	If the integer value has more significant bits than can be stored in the destination, the lower bits will be truncated.		
Signed integer to unsigned integer	If the source value is too big to fit into destination, the controller stores what it can and may produce an overflow.		
Unsigned integer to signed integer	If the source value is too big to fit into destination, the controller stores what it can and may produce an overflow.		
REAL to integer	The controller rounds the fractional part and truncates the upper portion of the non-fractional part. If data is lost, the controller sets the overflow status flag. Rounding is to the nearest whole number: less than 0.5, round down; equal to 0.5, round to nearest even integer; greater than 0.5, round up For example:		
	REAL (source)	**DINT (result)**	
	1.6	2	
	-1.6	-2	
	1.5	2	
	-1.5	-2	
	1.4	1	
	-1.4	-1	
	2.5	2	
	-2.5	-2	

Do not convert data to or from the BOOL data type.

IMPORTANT	The math status flags are set based on the value being stored. Instructions that normally do not affect math status keywords might appear to do so if type conversion occurs because of mixed data types for the instruction parameters. The type conversion process sets the math status keywords.

Safety Data Types

The Logix Designer application prevents the modification of a User Defined or Add-On Defined type that would cause an invalid data type for User Defined or Add-On Defined types that are referenced directly or indirectly by a Safety tag. (This includes nested structures.)

Safety tags can be composed of the following data types:

- All elementary data types.
- Predefined types that are used for safety application instructions.
- User-defined data types or arrays that are composed of the previous two types.

Online edits of user-defined data type member names in safety tags

Online editing is allowed for member names of user-defined data types on CompactLogix 5380, Compact GuardLogix 5380, CompactLogix 5480, ControlLogix 5580, and GuardLogix 5580 controllers. However, online editing is disabled when a user-defined data type is used on a safety tag and the controller is in the Safety Secured state.

See also

Math Status Flags on page 529

Floating Point Values

This information applies to the CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, and GuardLogix 5580 controllers. Controller differences are noted where applicable.

Logix controllers handle floating point values according to the IEEE 754 standard for floating-point arithmetic. This standard defines how floating point numbers are stored and calculated. The IEEE 754 standard for floating point math was designed to provide speed and the ability to handle very large numbers in a reasonable amount of storage space.

A REAL tag stores a single-precision, normalized floating-point number.

An LREAL tag stores a double-precision, normalized floating-point number.

The controllers support these elementary data types:

Controllers	Data Type
CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, Compact GuardLogix 5380, and GuardLogix 5580 controllers	REAL, LREAL
CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, and GuardLogix 5570 controllers	REAL

Denormalized numbers and -0.0 are treated as 0.0

If a computation results in a NAN value, the sign bit could be positive or negative. In this situation, the software displays 1#.NAN with no sign.

Not all decimal values can be exactly represented in this standard format, which results in a loss of precision. For example, if you subtract 10 from 10.1, you expect the result to be 0.1. In a Logix controller, the result could very well be 0.10000038. In this example, the difference between 0.1 and 0.10000038 is .000038%, or practically zero. For most operations, this small inaccuracy is insignificant. To put things in perspective, if you were sending a floating point value to an analog output module, there would be no difference in the output voltage for a value being sent to the module that differs by .000038%.

Guidelines for Floating-point Math Operations

Follow these guidelines:

When performing certain floating-point math operations, there may be a loss of precision due to rounding error. Floating-point processors have their own internal precision that can impact resultant values.

Do not use floating point math for money values or for totalizer functions. Use INT or DINT values, scale the values up, and keep track of the decimal place (or use one INT or DINT value for dollars, and a second INT or DINT value for cents).

Do not compare floating-point numbers. Instead, check for values within a range. The LIM instruction is provided specifically for this purpose.

Totalizer Examples

The precision of the REAL data type affects totalization applications such that errors occur when adding very small numbers to very large numbers.

For example, add 1 to a number over a period of time. At some point the add will no longer affect the result because the running sum is much greater than 1, and there are not enough bits to store the entire result. The add stores as many upper bits as possible and discards the remaining lower bits.

To work around this, do math on small numbers until the results get large. Then, transfer them to another location for additional large-number math. For example:

- x is the small incremented variable.
- y is the large incremented variable.
- z is the total current count that can be used anywhere.
- x = x+1;
- if x = 100,000;
- {
- y = y + 100,000;
- x = 0;
- }
- z = y + x;

Or another example:

- x = x + some_tiny_number;
- if (x >= 100)
- {
- z = z + 100;
- x = x - 100; // there might be a tiny remainder
- }

Immediate values

When you enter an immediate value (constant) in decimal format (for example, -2, 3) the controller stores the value by using 32 bits. If you enter a value in a radix other than decimal, such as binary or hexadecimal, and do not specify all 32 bits, the controller places a zero in the bits that you do not specify (zero-fill).

IMPORTANT Zero-fill of immediate binary, octal or hexadecimal values less than 32 bits.

If you enter	The controller stores
-1	16#ffff ffff (-1)
16#ffff (-1)	16#0000 ffff (65535)
8#1234 (668)	16#0000 029c (668)
2#1010 (10)	16#0000 000a (10)

Integer Immediate Values

If you enter	The controller stores
Without any suffix	DINT
"U" or "u"	UDINT
"L" or "l"	LINT
"UL", "ul", "Ul", or "uL"	ULINT

Floating Point Immediate Values

If you enter	The controller stores
Without any suffix	REAL
"L" or "l"	LREAL

Index Through Arrays

To dynamically change the array element that your logic references, use tag or expression as the subscript to point to the element. This is similar to indirect addressing in PLC-5 logic. Use these operators in an expression to specify an array subscript:

Tip:
- Logix Designer allows subscripts that are extended data type tags only, and does not support subscript expressions that have extended data types.
- All available integer elementary data types can be used as a subscript index. Only use SINT, INT, and DINT tags with operators to create a subscript expression.

Operator	Description
+	add
-	subtract/negate
*	multiply
/	divide
AND	AND
FRD	BCD to integer
NOT	complement
OR	OR
TOD	integer to BCD
SQR	square root
XOR	exclusive OR

For example:

Definitions	Example	Description
my_list defined as DINT[10]	my_list[5]	This example references element 5 in the array. The reference is static because the subscript value remains constant.
my_list defined as DINT[10] position defined as DINT	MOV the value 5 into position my_list[position]	This example references element 5 in the array. The reference is dynamic because the logic can change the subscript by changing the value of position.
my_list defined as DINT[10] position defined as DINT offset defined as DINT	MOV the value 2 into position MOV the value 5 into offset my_list[position+offset]	This example references element 7 (2+5) in the array. The reference is dynamic because the logic can change the subscript by changing the value of position or offset.

Tip: When entering an array subscript, make sure it is within the boundaries of the specified array. Instructions that view arrays as a collection of elements generate a major fault (type 4, code 20) if a subscript exceeds its corresponding dimension.

Bit Addressing

Bit addressing is used access a particular bit within a larger container. Larger containers include any integer, structure or BOOL array. For example:

Definition	Example	Description
Variable0 defined as LINT has 64 bits	variable0.42	This example references the bit 42 of variable0.
variable1 defined as DINT has 32 bits	variable1.2	This example references the bit 2 of variable1.
variable2 defined as INT has 16 bits	variable2.15	This example references the bit 15 of variable2.
variable3 defined as SINT holds 8 bits	variable3.[4]	This example references bit 4 of variable3.
variable4 defined as COUNTER structure has 5 status bits	variable4.DN	This example references the DN bit of variable4.
MyVariable defined as BOOL[100] MyIndex defined as SINT	MyVariable[(MyIndex AND NOT 7) / 8].[MyIndex AND 7]	This example references a bit within a BOOL array.
MyArray defined as BOOL[20]	MyArray[3]	This example references the bit 3 of MyArray.
variable5 defined as ULINT holds 64 bits	variable5.53	This example references the bit 53 of variable5.

Use Bit Addressing anywhere a BOOL typed tag is allowed.

See also

Index Through Arrays on page 540

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Rockwell Automation support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	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 information on its website at rok.auto/pec.

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