GuardLogix: Dual Zone Gate Protection with E-stop and SensaGuard Switch

Safety Rating: PLe, Cat. 4 to EN ISO 13849.1 2008



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Introduction	This application example explains how to wire, configure, and program a Compact GuardLogix [®] controller and POINT Guard I/O TM module to monitor a two-zone safety system. Each zone consists of a safety gate which, once opened, removes power from a redundant pair of 100S contactors. This is duplicated in the second zone. Both zones are also protected by a global E-stop that shuts down both zones safely when it is actuated. This example uses a Compact GuardLogix controller, but is applicable to any GuardLogix controller.
	Features and Benefits
	 Standard and safety applications run in a single controller. Standard and safety I/O modules can use the same Ethernet adapter and network(s). Safety status and diagnostics can be easily read by the standard application or by other devices over an Ethernet or ControlNet network. The application can be expanded and incorporated into your application by adding the additional I/O required.
Important User Information	Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication <u>SGI-1.1</u> available from your local Rockwell Automation [®] sales office or online at <u>http://www.rockwellautomation.com/literature</u>) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.
	In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.
	The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.
	No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.
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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

\mathbf{v}	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.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
\mathbf{v}	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.
	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.

General Safety Information

IMPORTANT	This application example is for advanced users and assumes that you are trained and experienced in safety system requirements.
\mathbf{v}	ATTENTION: A risk assessment should be performed to make sure all task and hazard combinations have been identified and addressed. The risk assessment may require additional circuitry to reduce the risk to a tolerable level. Safety circuits must take into consideration safety distance calculations which are not part of the scope of this document.

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

Description

This application monitors two zones. Each zone is protected by a SensaGuardTM safety switch. If either gate is opened, the output contactors are de-energized, shutting down any associated machinery for that zone. The reset is manual. Both zones are also protected by a global E-stop switch. If the E-stop is actuated, then both sets of contactors de-energize.

Safety Function

Each SensaGuard safety switch is connected to a pair of safety inputs of a 1734-IB8S module. The I/O module is connected via CIP Safety over an EtherNet/IP network to the Compact GuardLogix safety controller, 1768-L43S. The safety code in the safety processor monitors the status of the safety inputs using a pre-certified safety instruction named Dual Channel Input Stop (DCS). The safety code is run in parallel in a 1002 processor configuration. When all conditions are satisfied, the safety gate is closed, no faults are detected on the input modules, the global E-stop is not actuated, and the reset push button is pressed, a second certified function block called Configurable Redundant Output (CROUT) checks the status of the final control devices, a pair of 100S redundant contactors. The controller then issues an output signal to the 1734-OBS module to switch ON a pair of outputs to energize the safety contactors. The global E-stop function is also monitored by a DCS instruction. If the global E-stop is actuated, it shuts down both zones.

Bill of Material

Catalog Number	Description	Quantity
	SensaGuard switch	
440N-Z21SS2A	Non-contact plastic RFP,	2
	800F Reset Push Button - Metal, Guarded, Blue, R,	
800FM-G611MX10	Metal Latch Mount, 1 N.O. Contact(s), Standard,	4
100S-C09ZJ23C	Bulletin 100S-C - Safety Contactors	2
1768-ENBT	CompactLogix™ EtherNet/IP Bridge Module	1
	CompactLogix L43 Processor,	
1768-L43S	2.0 MB Standard Memory, 0.5 MB Safety Memory	1
1768-PA3	Power Supply, 120/240 VAC Input, 3.5 A @ 24V DC	1
1769-ECR	Right End Cap/Terminator	1
1734-AENT	24V DC Ethernet Adapter	1
1734-TB	Module Base with Removable IEC Screw Terminals	4
1734-IB8S	Safety Input Module	2
1734-OB8S	Safety Output Module	1
1783-US05T	Stratix 2000™ Unmanaged Ethernet Switch	1

This application example uses these components.

Setup and Wiring

For detailed information on installing and wiring, refer to the product manuals listed in the <u>Additional Resources</u> on page <u>16</u>.

System Overview

The 1734-IB8S input module monitors inputs from both the SensaGuard switches.

Sensaguard uses OSSD outputs which carry out periodic testing of the outputs. Thus, it is the OSSD outputs that are testing the integrity of the wiring between the SensaGuard switch and the safety inputs.

The Test pulse outputs are used as 24V sources.

The final control device is a pair of 100S safety contactors, K1 and K2. The contactors are controlled by the 1734-OBS safety output module. These are wired in a redundant configuration and are tested on startup for faults. The start-up test is achieved by monitoring the feedback circuit into input 2 (I2), before the contactors are energized. This is accomplished by using a Configurable Redundant Output (CROUT) instruction. The system is reset by the momentary push button, PB1.



Configuration

The Compact GuardLogix controller is configured by using RSLogix[™] 5000, version 18 or later. You must create a new project and add the I/O modules. Then, configure the I/O modules for the correct input and output types. A detailed description of each step is beyond the scope of this document. Knowledge of the RSLogix programming environment is assumed.

Configure the Controller and Add I/O Modules

Follow these steps.

1. In RSLogix 5000 software, create a new project.

New Controller			×
Vendor:	Allen-Bradley		
Туре:	1768-L43S CompactLogix5343S Safety Controller 💌	OK	
Revision:	18 🔽	Cancel	
	Redundancy Enabled	Help	
Name:	CGLX		
Description:			
	×		
Chassis Type:	<none></none>		
Slot:	0 Safety Partner Slot: <internal></internal>		
Create In:	C:\RSLogix 5000\Projects	Browse	

2. In the Controller Organizer, add the 1768-ENBT module to the 1768 Bus.

☐ Trends □	ration	New Module	
E P [0]	U	New Module	
🖻 🎒 1769 BL	ß	Paste	Ctrl+V
		Print	•

3. Select the 1768-ENBT module and click OK.

Select Module		x
Module	Description	Vendor
- Communications		
1768-CNB/A	1768 ControlNet Bridge	Allen-Bradley
1768-CNBR/A	1768 ControlNet Bridge, Redundant Media	Allen-Bradlev
1768-ENBT/A	1768 10/100 Mbps Ethernet Bridge, Twisted-Pair Media	Allen-Bradley
i 1/68-EWEB/A	1/68 10/100 Mbps Ethernet Bridge w/Enhanced Web Ser	v Allen-Bradley
. ∰. Motion		
. ⊡. Other		
J		
	Find	Add Eavorite
By Category By 1	Vendor Favorites	
	OK Cancel	Help

4. Name the module, type its IP address, and click OK.

We used 192.168.1.8 for this application example. Yours may be different.

New Module			×
Туре:	1768-ENBT/A 1768 10/100 Mbps Etherr Twisted-Pair Media	iet Bridge,	
Vendor:	Allen-Bradley		
Parent:	Local		
Name:	ENBT	Address / Host Name	
L Description:	A	IP Address: 192 . 168 . 1 . 8 Host Name:	
Slot:	1 🗄		
Revision:	4 1 💼	Electronic Keying: Compatible Keying 💌	
🔽 Open Mod	ule Properties	OK Cancel Help	

5. Add the 1734-AENT adapter by right-clicking the 1768-ENBT module in the Controller Organizer and choosing New Module.



6. Select the 1734-AENT adapter and click OK.

Select Module		x
Module	Description	Vendor
- Communications		
	1734 Ethernet Adapter, Twisted-Pair Media	Allen-Bradley
···· 1734-AENTR	1734 Ethernet Adapter, 2-Port, Twisted Pair Media	Allen-Bradley
1738-AENT	1738 Ethernet Adapter, Twisted-Pair Media	Allen-Bradley
1738-AENTR	1738 Ethernet Adapter, 2-Port, Twisted Pair Media	Allen-Bradley
1756-EN2F	1756 10/100 Mbps Ethernet Bridge, Fiber Media	Allen-Bradley
1756-EN2T	1756 10/100 Mbps Ethernet Bridge, Twisted-Pair Media	Allen-Bradley
1756-EN2TR	1756 10/100 Mbps Ethernet Bridge, 2-Port, Twisted-Pair	. Allen-Bradley
1756-EN3TR	1756 10/100 Mbps Ethernet Bridge, 2-Port, Twisted-Pair	. Allen-Bradley
1756-ENBT	1756 10/100 Mbps Ethernet Bridge, Twisted-Pair Media	Allen-Bradley
1756-ENET/A	1756 Ethernet Communication Interface	Allen-Bradley
1756-ENET/B	1756 Ethernet Communication Interface	Allen-Bradley
	1756 10/100 Mbps Ethernet Bridge w/Enhanced Web Serv.	Allen-Bradley 💌
	Find	Add Favorite
By Category By V	/endor Favorites	
	OK Cancel	Help

7. Name the module, type its IP address, and click OK.

We used 192.168.1.11 for this application example. Yours may be different.

8. Click Change.

New Module	X
New Module General* Connection Module Info Internet Protocol Port Configure Type: 1734-AENT 1734 Ethernet Adapter, Twisted-Pair Med Vendor: Allen-Bradley Parent: ENBT Name: AENT Description: Image:	ation Chassis Size dia Ethemet Address Private Network: 192.168.1. Host Name: Slot: 0
Module Definition Revision: 3.1 Electronic Keying: Compatible Module Connection: Rack Optimization Chassis Size: 1	C Host Name:
Status: Creating	OK Cancel Help

9. Set the Chassis Size as 4 for the 1734-AENT adapter and click OK.

Chassis size is the number of modules that will be inserted in the chassis. The 1734-AENT adapter is considered to be in slot 0, so for two input modules and one output module, the chassis size is 4.

				_
4 Compatible Module	1		-	
Rack Optimization			-	
4			•	
			and the second	
Cancel	1	lelp]	
	Compatible Module Rack Optimization	Compatible Module Back Optimization	4 1 Compatible Module Bank Optimization 4 Cancel	4 1 Compatible Module • Bank Optimization • 4 • Cancel Help

10. In the Controller Organizer, right-click the 1734-AENT adapter and choose New Module.



11. Expand Safety, select the 1734-IB8S module, and click OK.

Select Module	2	×
Module	Description	I
		1
		l
	8 Point 24V DC Sink Input Allen-Bradley	
1734-OB8S	8 Point 24V DC Source Output Allen-Bradley	
- Decisity		1
		I
		I
		I
	Find Add Favorite	
By Category	By Vendor Favorites	
	Cancel Help	//.

12. In the New Module dialog box, name the device 'CellGuard_1' and click Change.

New Module				×
General* Connection	Safety Module Info Input Config	uration Test Outpu	t]	
Туре: 1734	-IB8S 8 Point 24V DC Sink Input			
Vendor: Allen-	Bradley			
Parent: AEN	<u>r </u>			
Name: Cell	Guard_1	Module Number:	1 💌	
Description:		Safety Network Number:	36B9_0253_9D0B	
	T		5/10/2010 11:50:34.123 AM	
Module Definition Series: Revision: Electronic Keying: Configured By: Input Data: Output Data: Input Status:	A 1.1 Compatible Module This Controller Safety Test Combined Status-Power-Muting			
Status: Creating			OK Cancel Help	,

13. When the Module Definition dialog box opens, change the Input Status to Combined Status-Power, and click OK.

Module Definition*		×
Series: Revision: Electronic Keying:	A	
Configured By: Input Data: Output Data: Input Status: Data Format:	This Controller]
<u> </u>	Cancel Help	_

- 14. Close the Module Properties dialog box by clicking OK.
- 15. Repeat steps 10 -14 to add a second 1734-IB8S safety input module and a 1734-OB8S safety output module.

Configure the I/O Modules

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

- 1. In the Controller Organizer, right-click a 1734-IB8S module and choose Properties.
- 2. Click Input Configuration and configure the module as shown.

	Point O	peration		Test	Input Delay	Time (ms)	
Point	Туре	Discrepancy Time (ms)	Point Mode	Source	Off->On	On->Off	
0	Single 💂	0 🔺	Safety 💌	None 💌	0 ≑	0 🚔	
1		· ·	Safety 💌	None 💌	0 ≑	0 🚔	
2	Single 🗸	0 -	Safety	None 💌			
4	Single	- 0 +	Safety 💌	None V			
5		• <u>-</u>	Safety •	None 🔻	0	0	
6	Single	0 🔺	Safety 💌	None 💌	0 ≑	0 🌲	
7		-	Safety 💌	None 💌	0 🛢	0 🌩	
nput E	Error Latch Time: [1000 <u>+</u> ms					

3. Click Test Output and configure the module as shown.

0 Power Supply V 1 Power Supply V 2 Power Supply V 3 Power Supply V	0 Power Supply V 1 Power Supply V 2 Power Supply V 3 Power Supply V	Point Point Mode	1		
2 Power Supply V 3 Power Supply V	2 Power Supply	0 Power Supply			
		2 Power Supply V 3 Power Supply V			
			ł.		

- 4. Click OK.
- 5. In the Controller Organizer, right-click the second 1734-IB8S module and choose Properties.
- 6. Click Input Configuration and configure the module as shown.

Genera	General Connection Safety Module Info Input Configuration Test Output						
	Point O	peration		Teat	Input Delay	Time (ms)	
Poin	Туре	Discrepancy Time (ms)	Point Mode	Source	Off->On	On->Off	
0	Single 🗸	0 🔺	Safety Pulse Test	0	0	0	
2	single 🗸	0 -	Not used	None 💌	0		ļ
3	Single	· ·	Not Used	None	0 ≑	0 ≑	
5	- Singio	Ī	Not Used	None 💌	0	0	
6	Single 🗸	0 -	Not Used	None	0	0 🗧	
Input	Error Latch Time:	1000 📩 ms					
Status	: Offline		ОК	Ca	incel	Apply	Help

7. Click Test Output and configure the module as shown.

General	Connection	Safety N	lodule Info In	put Configurati	on Test Our	tput		
Point 0 1 2 3	Point Mod Pulse Test Pulse Test Not Used Not Used							
Status:	Offline				OK	Cancel	Apply	Help

- 8. Click OK.
- 9. In the Controller Organizer, right-click the 1734-OB8S module and choose Properties.
- 10. Click Output Configuration and configure the module as shown.

General	General Connection Safety Module Info Output Configuration							
Point	Point Operati Type	ion	Point Mode					
0	Dual	•	Safety Pulse Test 💌 Safety Pulse Test 💌					
2	Dual	•	Safety Pulse Test 💌 Safety Pulse Test 💌					
4	Dual	•	Not Used 🗸					
6	Dual	•	Not Used 💌					
Output	t Error Latch T	ìme	e: 1000 📻 ms					
Status:	Offline				ОК	Cancel	Apply	Help

11. Click OK.

Programming

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

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

The safety application code in the safety output routine prevents outputs from restarting if the input channel resets automatically, providing antitiedown functionality for the Circuit Reset.

The InputOK status is used as a permissive in the safety output routines.



		DCS
7		Dual Channel Input Stop
		DCS Zone2_Safety_Gate1 -(01)-
		Safety Function SAFETY GATE
		Discremence Time (Mose)
		Restart Type ALITOMATIC
		Cold Start Type AUTOMATIC
		Channel A AENT:1:I.Pt02Data
		0 🔶
		Channel B AENT:1:I.Pt03Data
		0 ←
		Input Status AENT:1:I.CombinedInputStatus
		Reset FaultReset
		<aent:1:i.pt05data></aent:1:i.pt05data>
		0 🔶
	Zone2 Safety Gate1 01	Sts Zone2 Safety Gate1 InputOK
8		
	50	
	Sts_Zone2_Safety_Gate1_InputOK	Sts_Zone2_InputsOK
9		0
	Output Enable Rung	
	This rung provides the operator action required to reset or enable the safety zone output.	
	The operator account is a state of the state	k fault on the output circuit
	The indust site output entance in the enter a demand on a precedent of a dense y input, there is a input of name of output of name in output of a reductation of a	the zone.
	The 'CombinedOutputStatus' will go LO if any output channel on the Zone Module faults.	
	The .FP feedback fault present drops out the ouput enable in the event of a feedback fault, so that reset or enable cannot occur w	ithout operator action.
	Reset	
	A Sts_Global_Estop_1_InputOK Sts_Global_Estop_1_InputOK Sts_Zone2_InputsOK ZoneName_DeviceName.FP	Cmd_Zone2_OutputEnable
10		O
	Crind Zone2 OutputEnable	
44		CROUT
		CROUT Zope2 K2K3 (01)
		Feedback Type NEGATIVE
		Feedback Reaction Time (Msec) 500 -(02)-
		Actuate Cmd_Zone2_OutputEnable
		0 ← (FP)—
		Feedback 1 AENT:1:I.Pt0/Data
		Feedback 2 AENT:1:1 Pt07Date
		Input Status AENT:1:I.CombinedInputStatus
		0 ←
		Output Status AENT: 2:1.CombinedOutputStatus
		Pepet FaultPaget
		<aent:1:1 ph05datas<="" th=""></aent:1:1>
		0 ←
	Safety Output Rung	
	This Safety Output Logic Example controls dual outputs on a Guard I/O module Named "ModuleName". The ROUT instruction Outputs O1 and O2 are used to drive safe	ty outputs 00 and 01 (Tags: ModuleName:O.Pt00Data and
	ModuleName: O.Pt01Data) which are wired to dual safety contactors.	
	Reassignment of EDM and output channels will need to be made to match your unique safety wiring configuration	on.
	Zone2_K2K3.01 Zone2_K2K3.02	AENT:2:0.Pt04Data
12	36-36-	()
		IENT-2-O PROFE-H-
		AENT:2:0.Pt05Data
(End)		

Falling Edge Reset

ISO 13849-1 stipulates that instruction reset functions must occur on falling edge signals. To comply with this requirement, add a **One Shot Falling** instruction to the rung immediately preceding the Cmd_Zone1_OutputEnable rung, Then use the OSF instruction Output Bit tag as the reset bit for the following rung. The Cmd_Zone1_OutputEnable is then used to Enable the CROUT instruction.

Modify the reset code as shown below.

4	Reset <aent:1:i.pt04data></aent:1:i.pt04data>	OsF One Shot Falling Storage Bit Wrk_Zone1_SafetyReset_ONF Output Bit Wrk_Zone1_SafetyReset_FallingEdge
5	Wrk_Zone1_SafetyReset_FallingEdge Sts_Global_Estop_1_InputOK Sts_Zone1_SafetyGate	1_InputOK Zone1_K1K2.FP Cmd_Zone1_OutputEnable

Performance Data

When configured correctly, each safety function can achieve a safety rating of PLe, Cat. 4 according to EN ISO 13849.1 2008.

Calculations are based on operation 360 days per year for 16 hours per day with an actuation of the safety gate once every hour for a total of 5760 operations per year. The global E-stop function is tested once per month.

Safety Gate			
PLr	e		
PL	e		
PFH [1/h]	2.64E-8		
SF Estop 1	SF Estop 1		
PLr	Ь		
PL	e		
PFH [1/h]	5E-8		

Each safety function and can be represented as follows.



5B Interlock Switch: SensaGuard		
PL	e	
PFH [1/h]	1.12E-9	
Cat.	4	
MTTFd [a]	not relevant	
DCavg [%]	not relevant	
CCF	not relevant	

58 Safety I/O: 1734-IB8S		
PL	e	
PFH [1/h]	2.25E-10	
Cat.	4	
MTTFd [a]	not relevant	
DCavg [%]	not relevant	
CCF	not relevant	

Sefety PLC: Compact GuardLogix 1768		
PL	e	
PFH [1/h]	2.1E-10	
Cat.	4	
MTTFd [a]	not relevant	
DCavg [%]	not relevant	
CCF	not relevant	

Safety I/O: 1734-0B8S		
PL	e	
PFH [1/h]	2.29E-10	
Cat.	4	
MTTFd [a]	not relevant	
DCavg [%]	not relevant	
CCF	not relevant	

SB Contactors		
PL	e	
PFH [1/h]	2.47E-8	
Cat.	4	
MTTFd [a]	100 (High)	
DCavg [%]	99 (High)	
CCF	65 (fulfilled)	

Additional Resources

For more information about the products used in this example refer to these resources.

Resource	Description
Compact GuardLogix Controllers	Provides information on configuring,
User Manual, publication	operating, and maintaining Compact
<u>1768-UM002</u>	GuardLogix controllers.
POINT Guard I/O Safety Modules	Provides information on installing,
Installation and User Manual,	configuring, and operating POINT Guard I/O
publication <u>1734-UM013</u>	modules.
GuardLogix Controller Systems	Contains detailed requirements for
Safety Reference Manual,	achieving and maintaining safety ratings
publication <u>1756-RM093</u>	with the GuardLogix controller system.
GuardLogix Safety Application	Provides detailed information on the
Instruction Set Reference Manual,	GuardLogix Safety Application Instruction
publication <u>1756-RM095</u>	Set.
Safety Accelerator Toolkit for GuardLogix Systems Quick Start Guide, publication <u>IASIMP-QS005</u>	Provides a step-by-step guide to using the design, programming, and diagnostic tolls in the Safety Accelerator Toolkit.

Safety Products Catalog

You can view or download publications at

<u>http://www.rockwellautomation.com/literature</u>. To order paper copies of technical documentation, contact your local Allen-Bradley[®] distributor or Rockwell Automation sales representative.

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