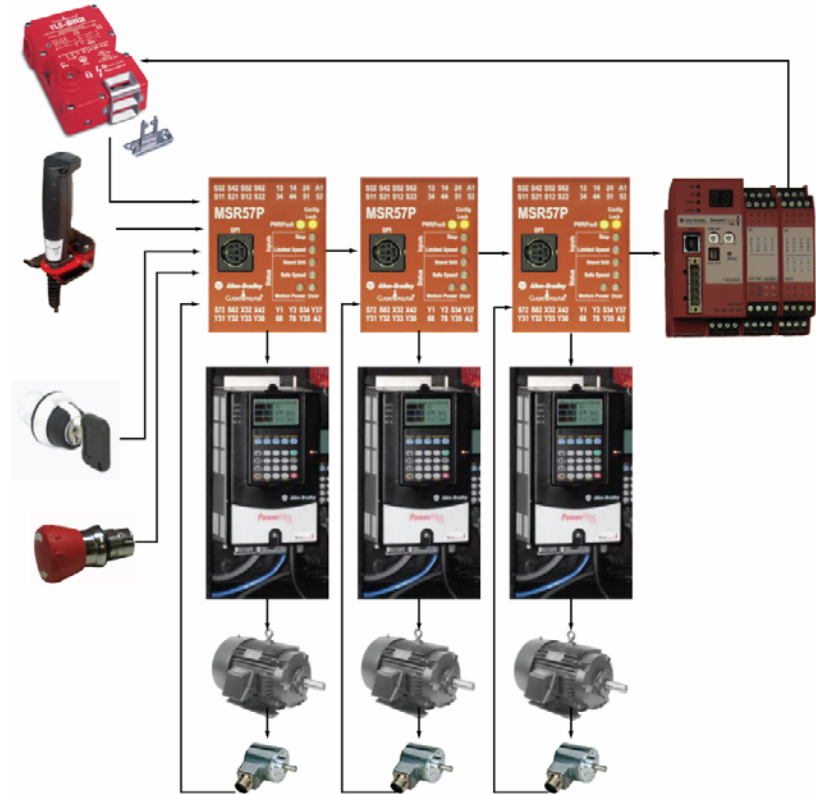


MSR57P Cascading Application with Safe Limited Speed, Door Monitoring and Enabling Switch



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Introduction

The MSR57P is a speed monitoring safety control relay. It provides safety rated outputs that control a process by using the speed of a process as measured by an encoder. Many machines consist of more than one axis (motor), which may be hazardous if not properly safeguarded. An MSR57P relay can be used to monitor each axis and the signals of each MSR57P relay can be cascaded from one axis to another to provide system-level control.

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 SGI-1.1 available from your local Rockwell Automation sales office or online at <http://literature.rockwellautomation.com>) 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.

<p>WARNING</p> 	<p>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.</p>
<p>IMPORTANT</p>	<p>Identifies information that is critical for successful application and understanding of the product.</p>
<p>ATTENTION</p> 	<p>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.</p>
<p>SHOCK HAZARD</p> 	<p>Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.</p>
<p>BURN HAZARD</p> 	<p>Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.</p>

General Safety Information

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

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

Description

This application note assumes that the machine cell has three motors that must be controlled in unison. Access to the machine is allowed through one solenoid-locked gate. Access is allowed when either of two conditions is met. At a safe operating speed, an operator can enter the cell while holding an enabling pendant or, an operator can enter the cell when the motors have achieved a ‘standstill condition’.

The MSR57P relay is uniquely designed to enforce certain sequences to help ensure the safe operation of the machine. The user selects the functions necessary to accomplish the desired tasks, and the MSR57P relay executes the steps in the proper order to achieve the safety function.

Safe Limited Speed

To enter the manufacturing cell, the operator must first command the machine to go to a safe operating speed. This is done by using a key-operated selector switch. After selection, the operator should remove the key to prevent someone else from returning the machine to its full running speed. After the machine achieves the safe speed, the operator must engage the GripSwitch enabling device by squeezing the handle to the middle position. With the GripSwitch engaged, the operator can open the door and enter the manufacturing cell.

<p>IMPORTANT</p>	<p>You must perform a risk assessment to determine the upper limit of the safe operating speed for each motor. Then, enter this value into the Safe Limited Speed parameter of the respective MSR57P relay and the Preset Speed parameter of the PowerFlex drives.</p>
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Releasing or fully squeezing the GripSwitch commands the motors to stop.

If the operator wants to return the manufacturing cell from limited speed to Run mode, the operator must follow the steps below while engaging the GripSwitch.

1. Leave the cell.
2. Close the access gate.
3. Turn the selector switch to Run.
4. Press the reset button.
5. Release the GripSwitch.

Safety Function

The MSR57 has multiple safety functions.

Guardlocking

While the guard door is open, none of the motors can start.

While the guard door is unlocked, none of the motors can start.

When the guard door is closed and locked, any of the motors can operate at any speed.

Safe Limited Speed

When the machine is operating at a safe limited speed, the motor is allowed to run only while the GripSwitch is engaged. If the GripSwitch is released or fully squeezed, the MSR57P relay issues a stop command to the PowerFlex drive.

Safe Maximum Speed

If any of the motors exceeds a predetermined speed (the Safe Max Speed), the respective MSR57P relay initiates a shutdown. The shutdown cascades through all the MSR57P relays to bring the system to a stop. You must conduct a risk assessment to determine the safe maximum speed for each motor in the system.

Standstill Speed

Standstill Speed is used to declare motion as stopped. The system is at standstill when the speed detected is less than or equal to the configured Standstill Speed. Once the MSR57P relay determines that standstill has been reached, the door control logic is set to Unlock.

Standstill Position Tolerance defines the position limit in encoder 1 units that is tolerated after standstill has been reached. If the position changes by more than the amount specified by the Standstill Position Tolerance after standstill has been reached and the door is unlocked, a Motion After Stopped Fault occurs. This type of fault results in the system entering the Safe State.

System Behavior

The MSR57P relay supports single and cascaded axis applications. In a cascaded system, one MSR57P relay is required for each drive to monitor and control the speed of the corresponding axis. When the MSR57P relay is in a cascaded system, all stop and fault requests are passed from the first axis through each subsequent axis. If a fault occurs on a MSR57P relay in the middle of the system, only the downstream relays enter the safe state. The upstream MSR57P relays will not receive a notification to stop.

The SmartGuard 600 controller provides feedback from the last MSR57P unit back to the first in a cascaded system. In this configuration, a stop or fault request anywhere in the cascaded system cycles back through the first unit in the system to stop all MSR57P units in the system.

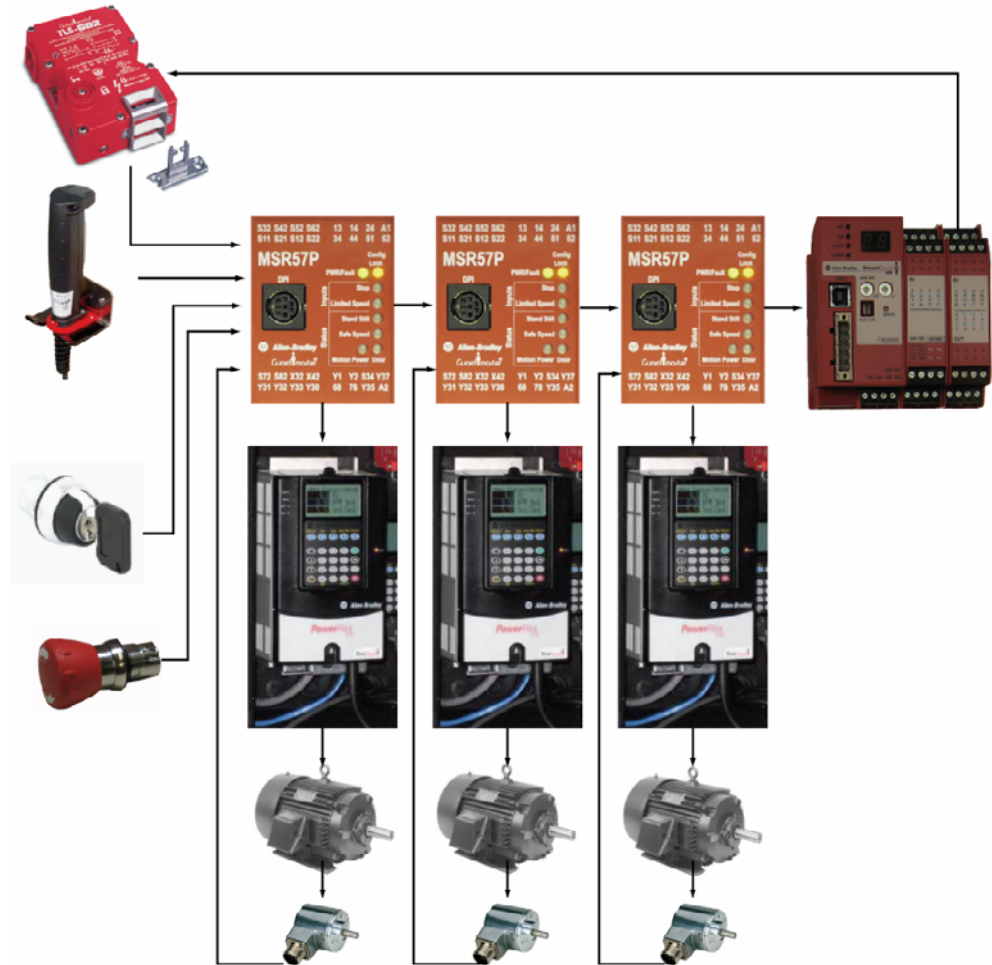
The two cases described below use the SmartGuard controller for this feedback purpose but can be configured as automatic reset or manual reset. Manual reset may be desirable if a safety PLC is already used and/or a network reset is desired. Then all the MSR57P relays would be configured for automatic reset and would depend on the SmartGuard controller for the reset signal.

The second case is best if all local control is preferred on the MSR57P system to free up more I/O on the SmartGuard controller for guardlocking or other safety functions on the machine.

Both options are suitable for SIL CL3, Cat 4 applications. The SmartGuard controller supports pulse-tested inputs and supplies them via their outputs. Depending on the fault, either the MSR57P relay or the SmartGuard controller detects a short-circuit fault and enters the safe state for the entire cascaded system.

Block Diagram

The block diagram below shows one guardlocking switch – which locks the access gate to the machine. A Safe-Stop button initiates a stop. A GripSwitch is used by the operator during access to the machine under safe operating (limited) speed. A selector switch commands the MSR57P relay to initiate and monitor safe limited speed.



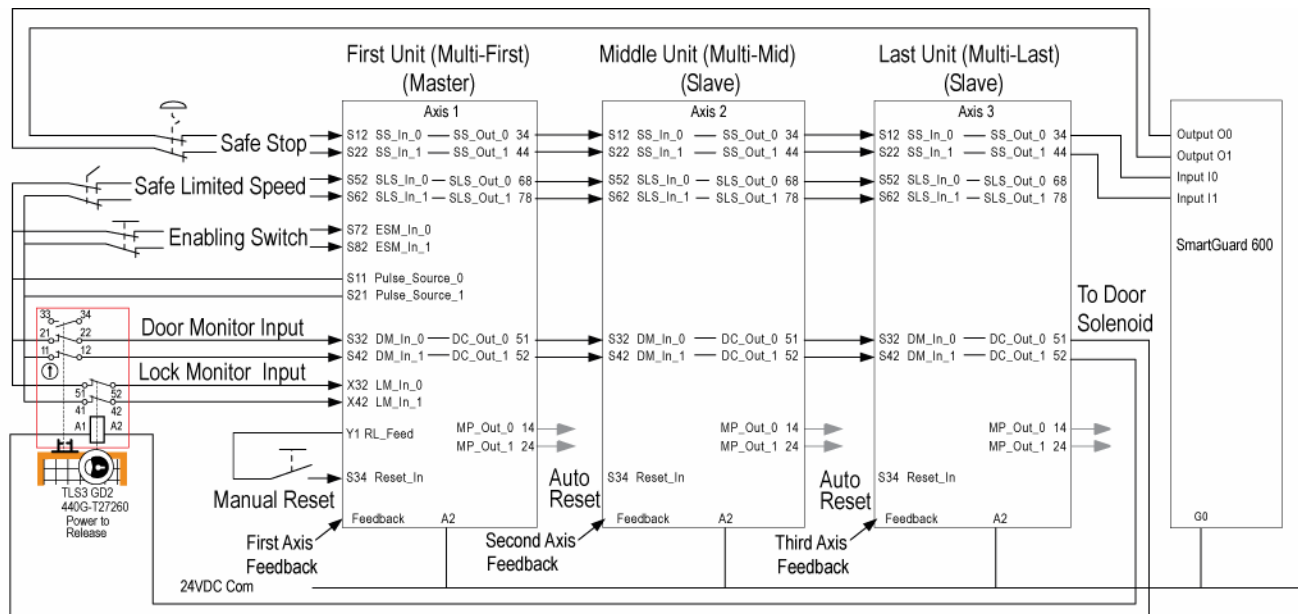
Example Bill of Material

This application example uses these components.

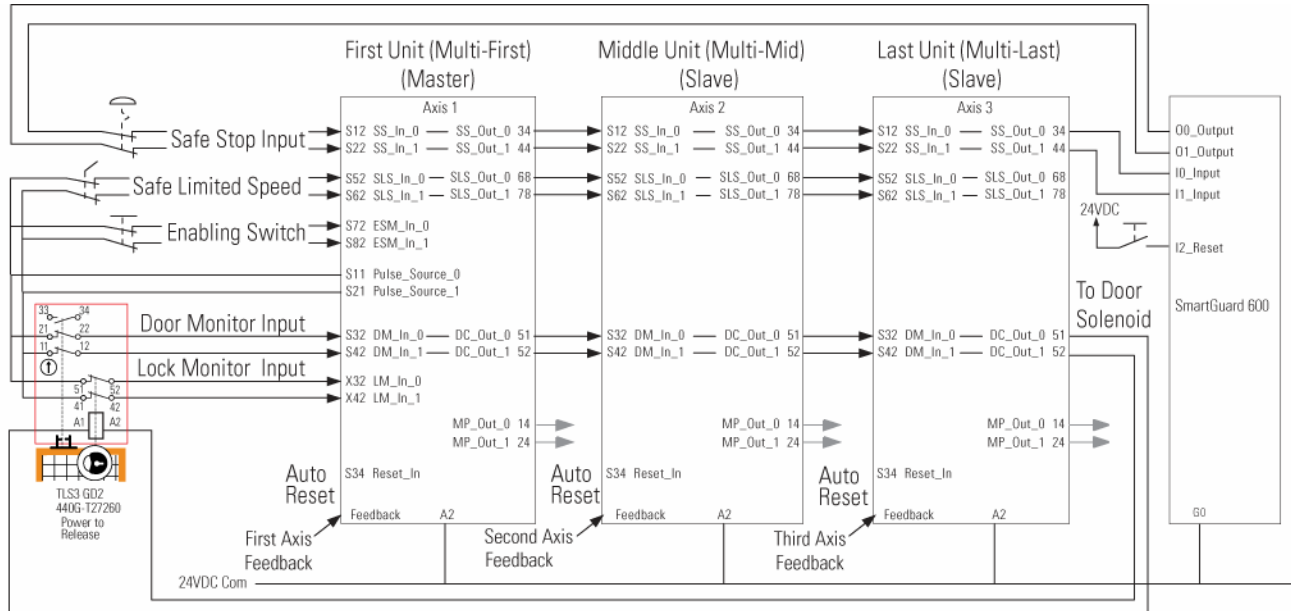
Catalog Part Number	Description	Quantity
440R- S845AER-NNL	MSR57p Speed Monitoring Relay	3
1752-L24BBB	SmartGuard 600 Safety Controller	1
20AB-2P2A3AYNNNG1	PowerFlex 70 with SafeOff	3
1585J-M8RB-2M5	RJ45 Encoder Cable to MSR57P	3
440J-N21TNPM-NP	GripSwitch Enabling Device with Jog switch	1
440G-T27260	TLS3-GD2 Guardlocking Interlock	1
845T-DZ42PEN-1	Incremental Encoder, 3000PPR,	3
700-HLT2Z24	Relay, 24V dc coil, Form C	1
800FP-MT34 800F-PX02S	S-Stop Push button, 2NC with monitored contacts for Safe Stop	1
800FP-KM23 800F-MX02V	Two-position rotary switch with 2NC low voltage contacts for Safe Limited Speed	1
800FP-F6MX10	Momentary pushbutton, blue, 1NO for Reset	1
800FP-SM22 800F-PX11	Two-position rotary switch, 1NC + 2NC for Fed/Rev	1
800FP-SM22 800F-PX01	Two-position rotary switch, 1NC for Start/Stop	1
800F-POT6	Potentiometer, for Motor Speed Control	1
800FP-SM22 800F-PX01	Two-position rotary switch, 1NC for Deceleration Rate selection	1
800FP-SM22 800F-PX01	Two-position rotary switch, 1NC for Acceleration Rate selection	1
800FP-P5 800F-PN3Y	SLS Request Indicator	1

Setup and Wiring

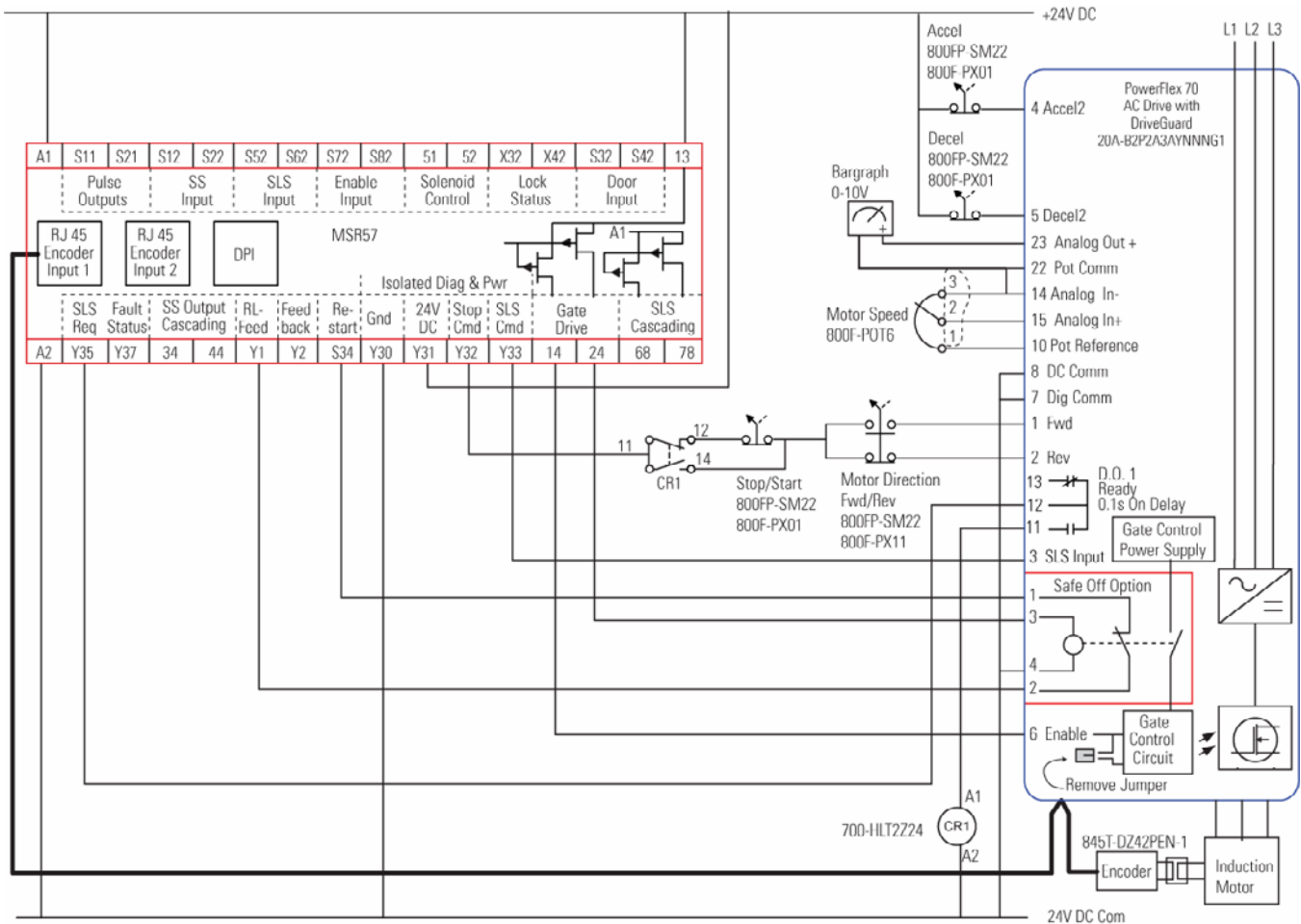
The following two diagrams show the essential connections for achieving the cascading function. The first diagram employs a reset function on the first MSR57P relay.



The second diagram relies on the SmartGuard 600 controller for the reset function. For detailed information on installing and wiring, refer to the product manuals listed in the Additional Resources on page 16.



The schematic below shows the essential connections from the MSR57P relay to the PowerFlex 70 drive for the first axis. The 700-HLT2Z24 relay is only needed on the PowerFlex 70 drive when an enabling switch is connected to its MSR57P relay.



Encoder Connections

An incremental encoder (845T-DZ42PEN-1) is used in this application. The encoder is connected to the option board (M003737635) in the PowerFlex 70 drive. For this encoder, the voltage supply jumper must be set to 12V. The RJ45 cable (1585J-M8RB-2M5) connects the PowerFlex 70 drive to the MSR57P relay. Wiring is shown in the table below.

Drive Pin	Description	Wire Color
1	12V	Orange
2	Gnd	White/Orange
3	B-	White/Brown
4	B+	Brown
5	A-	White/Blue
6	A+	Blue

Configure the MSR57P Relay

The parameters of the MSR57P relay are set by using DriveExplorer or DriveTools software, or by using a HIM Module. Refer to the Guardmaster MSR57P Speed Monitoring Safety Relay User Manual, publication [440R-UM004](#) for details.

The table below shows the parameters for each of the MSR57P units (first, middle and last) for this application. Set the values for each MSR57P relay.

Param #	Description	First Unit Values	Mid Unit Values	Last Unit Values
1	Password	0	0	0
2	Reserved	0	0	0
3	Reserved	0	0	0
4	Reserved	0	0	0
5	Lock State	Unlock	Unlock	Unlock
6	Operating Mode	Run	Run	Run
7	Reset Defaults	No Action	No Action	No Action
8	Reserved	0	0	0
9	Reserved	0	0	0
10	Signature ID	3317762599	3317762600	3317762601
11	Reserved	0	0	0
12	Reserved	0	0	0
13	New Password	0	0	0
14	Reserved	0	0	0
15	Reserved	0	0	0
16	Reserved	0	0	0
17	Password Command	No Action	No Action	No Action
18	Security Code	256	256	256
19	Vendor Password	0	0	0
20	Cascaded Config	Multi First	Multi Mid	Multi Last
21	Safety Mode	LimSpd DM ES	Slv Lim Spd	Slv Lim Spd
22	Reset Type	Monitored	Automatic	Automatic
23	Reset Loop	Enable	Disable	Disable
24	OverSpd Response	84	84	84
25	Language Code	English	English	English

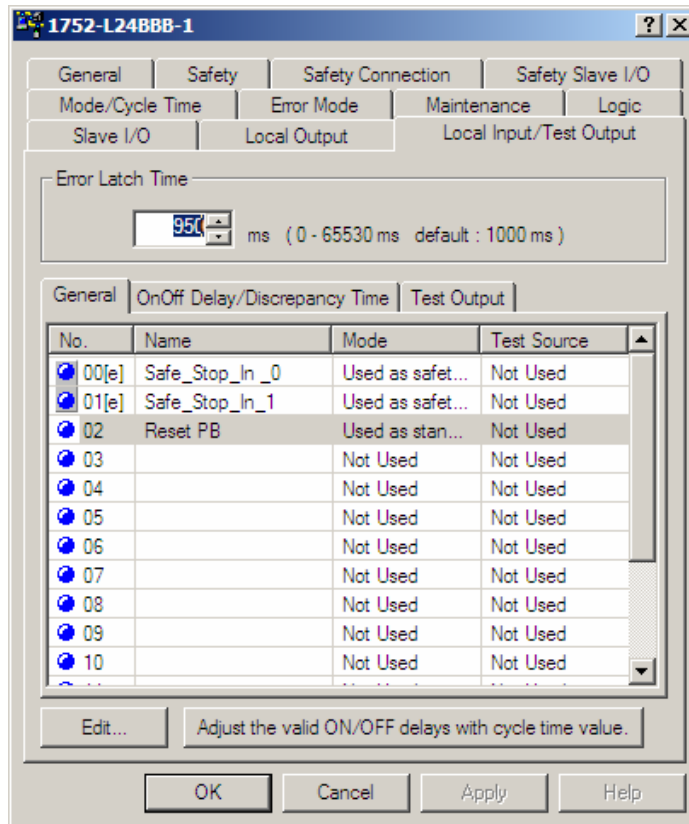
Param #	Description	First Unit Values	Mid Unit Values	Last Unit Values
26	Max Display Spd	1800	1800	1800
27	Fbk Mode	Single Fbk	Single Fbk	Single Fbk
28	Fbk 1 Type	Incremental	Incremental	Incremental
29	Fbk 1 Units	Rev	Rev	Rev
30	Fbk 1 Polarity	Normal	Normal	Normal
31	Fbk 1 Resolution	3000	3000	3000
32	Fbk 1 Volt Mon	0	0	0
33	Fbk 1 Speed	0	0	0
34	Fbk 2 Units	Rev	Rev	Rev
35	Fbk 2 Polarity	Reverse	Reverse	Reverse
36	Fbk 2 Resolution	0	0	0
37	Fbk 2 Volt Mon	0	0	0
38	Fbk 2 Speed	0	0	0
39	Fbk Speed Ratio	0	0	0
40	Fbk Speed Tol	0	0	0
41	Fbk Pos Tol	0	0	0
42	Direction Mon	Disable	Disable	Disable
43	Direction Tol	0	0	0
44	Safe Stop Input	2 OSSD 3s	2 OSSD 3s	2 OSSD 3s
45	Safe Stop Type	Torque Off	Torque Off	Torque Off
46	Stop Mon Delay	0	0	0
47	Max Stop Time	0	0	0
48	Standstill Speed	0.1	0.1	0.1
49	Standstill Pos	10	10	10
50	Decel Ref Speed	0	0	0
51	Stop Decel Tol	0	0	0
52	Lim Speed Input	2 NC	2 OSSD 3s	2 OSSD 3s
53	LimSpd Mon Delay	3	3	3
54	Enable SW Input	2 NC	Not Used	Not Used
55	Safe Speed Limit	650	650	650
56	Speed Hysteresis	0	0	0
57	Door Out Type	2Ch Sourcing	2Ch Sourcing	Pwr to Rel
58	DM Input	2 NC	2 OSSD 3s	2 OSSD 3s
59	Lock Mon Enable	Enable	Disable	Disable
60	Lock Mon Input	2NC	Not Used	Not Used
61	Max Speed Enable	Enable	Enable	Enable
62	Safe Max Speed	1700	1700	1700
63	Max Spd Stop Typ	Torque Off	Torque Off	Torque Off
64	Max Accel Enable	Disable	Disable	Disable
65	Safe Accel Limit	0	0	0
66	Max Acc Stop Typ	Torque Off	Torque Off	Torque Off
67	Fault Status	Read only status bits		
68	Guard Status			
69	IO Diag Status			
70	Config Flt Code	Read only configuration fault status		
71	MP Out Mode	No Pulse Test	No Pulse Test	No Pulse Test
72	SS Out Mode	Pulse Test	Pulse Test	Pulse Test
73	SLS Out Mode	Pulse Test	Pulse Test	No Pulse Test
74	Door Out Mode	Pulse Test	Pulse Test	Pulse Test

Configure the Controller

The SmartGuard 600 controller performs the loop-back function. It monitors the output of the last device and transfers the signal back to the first device through the Safe Stop signal. SmartGuard 600 controllers are configured and programmed by using RSNNetWorx for DeviceNet software.

Local Input Settings

The diagram below shows the input setup for the SmartGuard controller, where the manual reset is performed by the SmartGuard controller. When the SmartGuard controller is set for automatic reset, the Reset PB on line 02 is not used.



The Safe_Stop_In signals are set up as 'Used as safety input' and 'Dual Channel Equivalent'. They must not be set up as 'Test pulse from test out'. The Test Outputs of the SmartGuard 600 controller are not used in this example. To protect against short circuits, the MSR57P relay uses diagnostic test pulses on its Safe Stop output (SS_Out) signals.

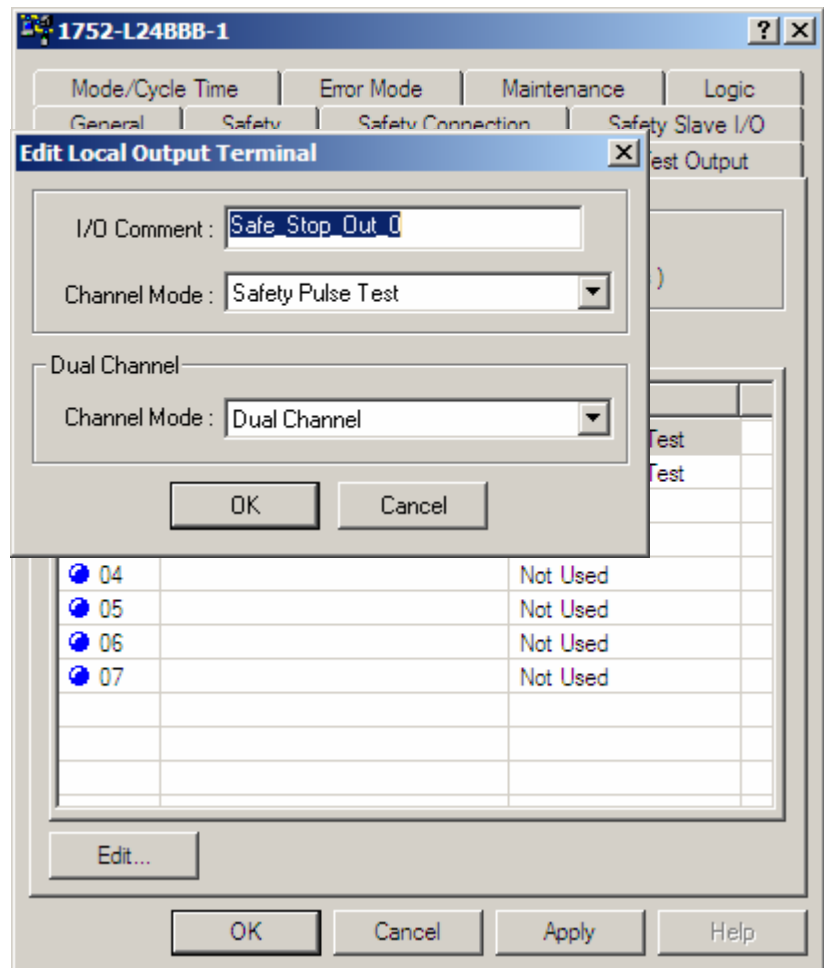
The screenshot shows the 'Edit Local Input Terminal' dialog box for the signal 'Safe_Stop_In_0'. The 'I/O Comment' field contains 'Safe_Stop_In_0'. The 'Channel Mode' is set to 'Used as safety input'. The 'Test Source' is 'Not Used'. The 'Off On Delay' and 'On Off Delay' are both set to 0 ms. The 'Cycle Time' is 4.0 ms. The 'Dual Channel' section is expanded, showing 'Channel Mode' set to 'Dual Channel Equivalent' and 'Discrepancy Time' set to 0 ms. The 'OK' and 'Cancel' buttons are at the bottom.

The Reset PB signal can be set up as a standard input and single channel.

The screenshot shows the 'Edit Local Input Terminal' dialog box for the signal 'Reset PB'. The 'I/O Comment' field contains 'Reset PB'. The 'Channel Mode' is set to 'Used as standard input'. The 'Test Source' is 'Not Used'. The 'Off On Delay' and 'On Off Delay' are both set to 0 ms. The 'Cycle Time' is 4.0 ms. The 'Dual Channel' section is expanded, showing 'Channel Mode' set to 'Single Channel' and 'Discrepancy Time' set to 0 ms. The 'OK' and 'Cancel' buttons are at the bottom.

Local Output Settings

Redundant outputs of the SmartGuard controller drive the safe stop inputs of the MSR57P relay, with a safe stop button in the circuit.



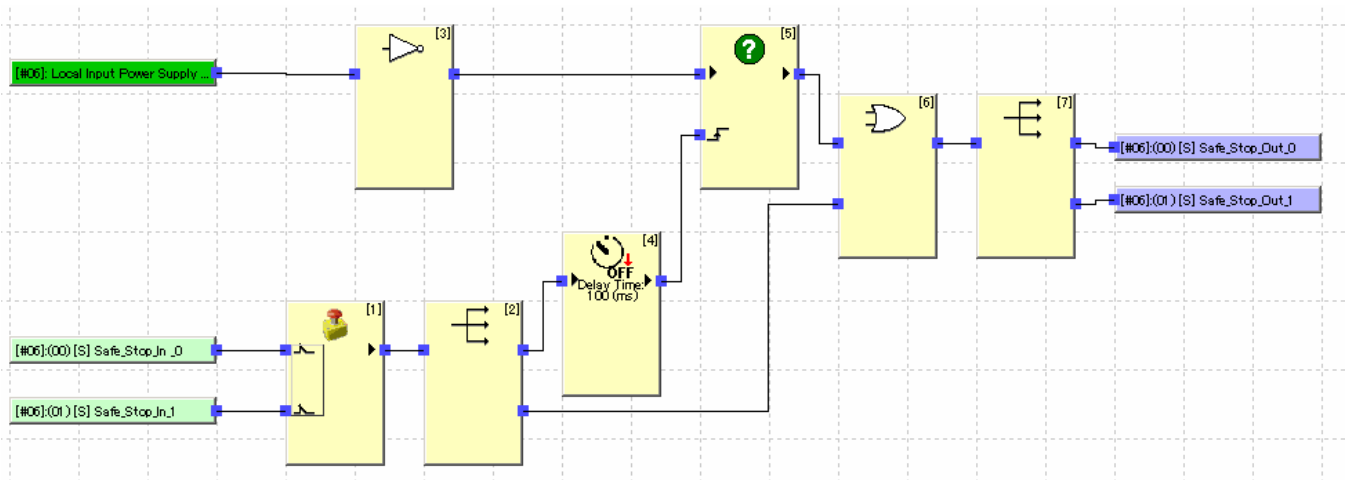
The Safe_Stop_Out signals are set up for safety pulse testing. This is needed to check for potential short circuits in the safe stop button on the Multi-First MSR57P relay.

Block Diagram – Automatic Reset of a SmartGuard 600 Controller

In this example, the SmartGuard controller, on DeviceNet node [#06], receives the safe stop output signals from the last MSR57P relay and accepts them as inputs at terminals #00 and #01.

The use of the RS-FF block causes the output of the SmartGuard controller to momentarily turn OFF for the duration of the OFF-Delay block. The 'Local Input Power Supply' can be found under the Standard Inputs. This block is LO when power is applied to terminals V1 and V2, therefore an inverter is used to create a HI input signal to the RS-FF block.

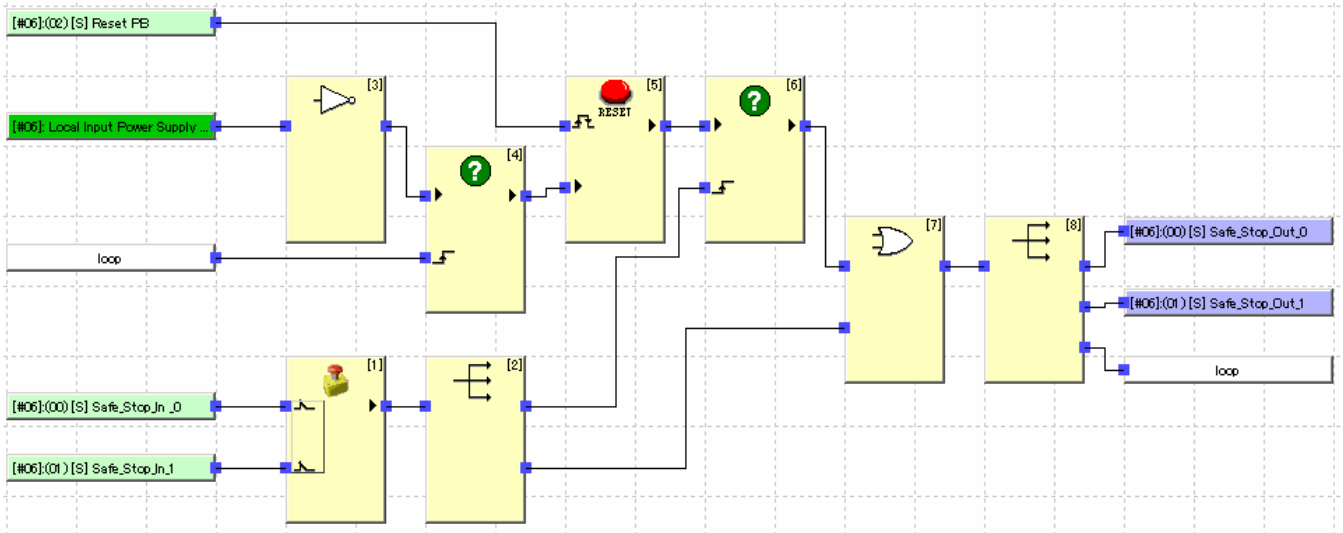
In the timing diagram below, the Safe_Stop_Out signal turns OFF about 10 ms after the Safe_Stop_In signal is received. Approximately 100 ms later, the Safe_Stop_Out automatically re-arms itself to allow the reset function to take place on the Multi-First MSR57P unit.



The OFF-Delay must be set to a duration that exceeds the recovery time of the MSR57P relay. Recovery time is the minimal amount of time required for the safety signal, a stop, to be absent. This allows the MSR57P relay, or any other logic device, to execute the safety function (a stop, in this case). As an example, diagnostic pulse-testing is much less than the recovery time, and is therefore not long enough to be considered a safety signal.

Block Diagram – Manual Reset of a SmartGuard 600 Controller

The manual reset of the SmartGuard 600 controller builds on the auto reset approach. Please read the auto-reset section first. Here, the SmartGuard automatically re-arms, but a manual operation (the reset push button) is introduced into the scenario.



PowerFlex 70 Drive

The PowerFlex 70 drive has over 600 parameters. The table below shows the essential parameters for this example application.

Param #	Description	Values	Comment
1:0.93	Speed Ref B Sel	Preset Spd1	Sets the safe limited speed
1:0.94	Speed Ref B Hi	60.0 Hz	Sets the maximum level of the speed reference – must be greater than 10Hz
1:0.95	Speed Ref B Hi	0 Hz	Sets the maximum level of the speed reference – must be less than 10Hz
1:0.101	Preset Speed 1	10 Hz	Sets the safe limited speed, which must be determined by a risk assessment.
1:0.140	Accel Time 1	25 sec	Sets the slow acceleration rate.
1:0.141	Accel Time 2	5 sec	Sets the fast acceleration rate
1:0.142	Decel Time 1	25 sec	Sets the slow deceleration rate.
1:0.143	Decel Time 2	5 sec	Sets the fast deceleration rate
1:0.361	Digital In1 Sel	8 Run Forward	
1:0.362	Digital In2 Sel	9 Run Reverse	
1:0.363	Digital In3 Sel	15 Speed Sel 1	Terminal 3 is the input for Safe Limit Speed
1:0.364	Digital In4 Sel	21 Accel 2	
1:0.365	Digital In5 Sel	22 Decel 2	
1:0.366	Digital In6 Sel	1 Enable	Terminal 6 is the Enable Signal
1:0.381	Dig Out1 OnTime	0.1 sec	Creates a short delay

Additional Resources

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

Resource	Description
Guardmaster MSR57P Speed Monitoring Safety Relay User Manual, publication 440R-UM004	Provides information on the safety requirements, installation, wiring, configuration, and operation of the MSR57P relay.
SmartGuard 600 Controllers Safety Reference Manual, publication 1752-RM001	Provides information on the safety requirements for SmartGuard 600 controller safety systems.
SmartGuard 600 Controllers User Manual, publication 1752-UM001	Provides information on installing, configuring, and operating SmartGuard 600 controllers.
PowerFlex 70 User Manual, publication 20A-UM001	Provides information on installation, startup, programming and troubleshooting PowerFlex 70 Adjustable Frequency AC Drives
Safety Products Catalog, publication S116-CA001	Provides information on the TLS-GD2 Guardlocking Interlock and Enabling GripSwitch used in this application

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

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