

Guardmaster Configurable Safety Relay

Catalog Number 440C-CR30-22BBB



Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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

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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).

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Notes:

Additional Resources

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

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, http://www.ab.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 Allen-Bradley® distributor or Rockwell Automation sales representative.

Notes:

Cat 1 Stop with Guardlocking Interlock (TLS-ZR or 440G-LZ)

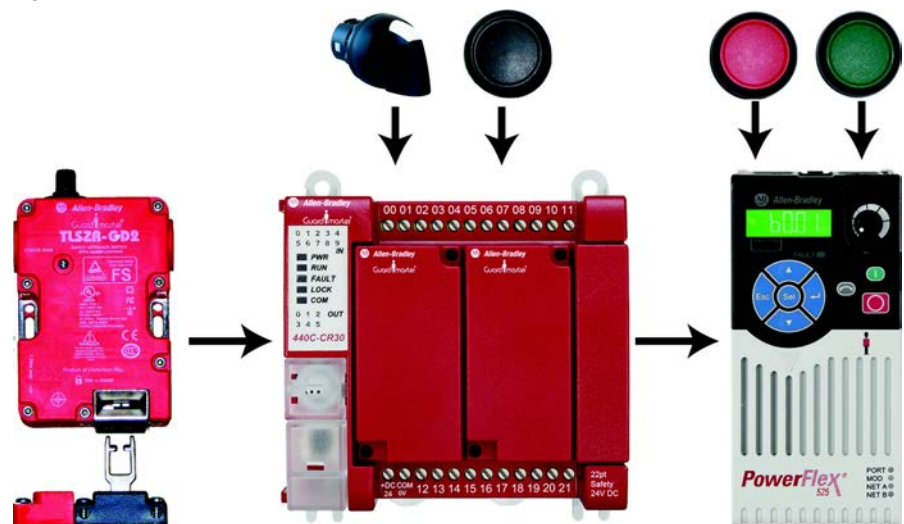
This example application shows how to configure the CR30 safety relay for a Guardlocking application that requires a Stop Category 1 function.

A TLS-ZR guardlocking interlock, which has Output Signal Switching Device (OSSD) outputs, locks a guard to help prevent full body access to the hazard. A PowerFlex® 525 is controlling a motor that is considered the hazard. A selector switch requests access to the hazard area. A push button locks access to the hazard. The CR30 safety relay performs the logic that monitors the interlock and the drive, and allows access to the hazard under safe conditions.

For partial body access, the 440G-LZ can be substituted for the TLS-ZR.

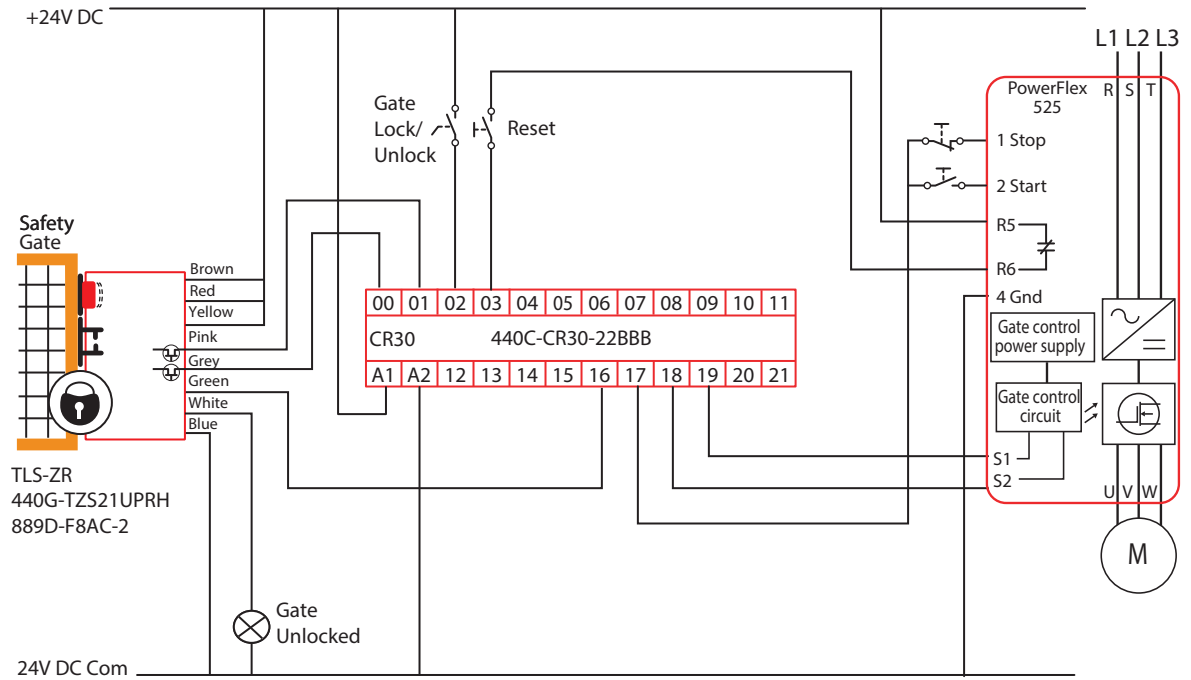
Product Overview

Figure 1 - Overview



Schematic

Figure 2 - Schematic



PowerFlex PF525 Settings

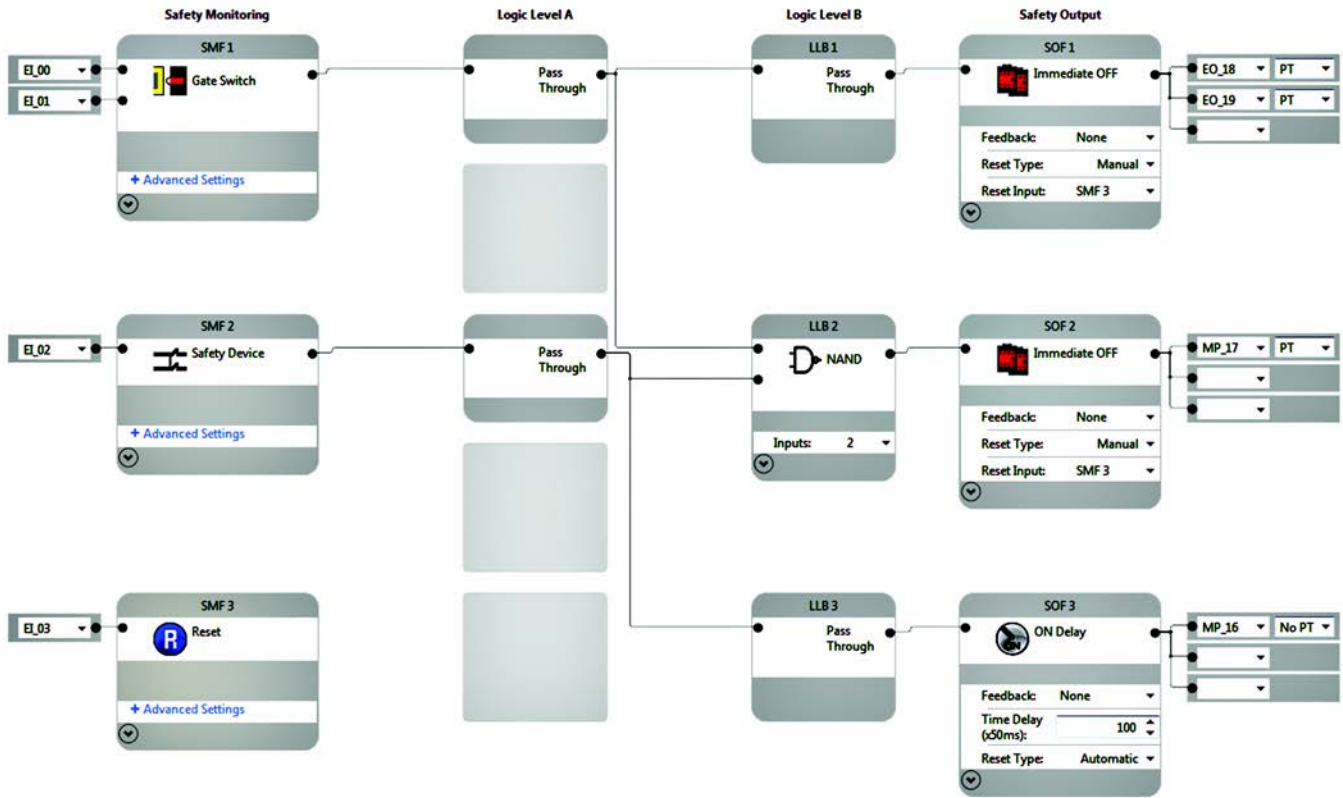
[Table 1](#) lists some of the parameter settings for this application. This is not a complete list of parameters for the PF525. You can set many other parameters to make this application successful.

Table 1 - Parameter Settings

Parameter	Name	Value	Unit/Description
P042	Decel Time	3	Seconds
P045	Stop Mode	0	Stop and Clear Fault
P046	Start Source	2	Digital Input Terminal Block
P047	Speed Reference 1	1	Drive Pot
T081	Relay 2	2	Motor Running Motor is receiving power from the drive.
T105	Safety Open En	1	Fault Disable

Connected Components Workbench Software

Figure 3 - Connected Components Workbench Example



Circuit Status

The gate switch is closed and locked. The safety signals to the PF525 drive are off, and the drive is disabled. The motor is off.

Operational Sequence

Table 2 - Operational Sequence

Action Taken	Results
1. Momentarily press the reset button.	The safety outputs at terminal 17, 18 and 19 turn ON.
2. Press the drive Start button.	The motor turns ON. The drive can now be used for normal production processes. The speed of the motor is controlled by the Drive Pot, located on the front of the PF525.
3. Rotate the Unlock request to the Unlock (closed) position.	The power is immediately removed from terminals 17, and the drive executes a ramp to stop command in 3 seconds (P042 is configured for 3s). After a 5 second delay, the gate switch is unlocked and the safety outputs to the drive open.
4. Open the gate switch.	The operator can access the hazard area.
5. Close the gate.	
6. Rotate the Unlock switch to the locked (open) position.	This locks the gate and the safety system is ready for reset. Go to Step 1.

Example Bill of Materials

Table 3 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster® 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	440G-TZS21UPRH	Guard Locking Switch - TLS-Z GD2 Solenoid Voltage: 24V AC/DC Contacts (Safety and Aux): 2 x PNP (0.2A max.), 1 x PNP (0.2A max.) Actuator: Fully-flex Conduit Entry: 8-pin micro (M12)	1
2.1	889D-F8AC-5	DC Micro (M12) Cordset Female, straight, 8-pin, PVC cable, yellow, unshielded, 22 AWG, IEC color coded, no connector, 5 m (16.4 ft)	1
3	800FM-P4MN3R	800F Pilot Light Metal (IP66, 4/13, IP66), red, standard pack	1
4	800FM-SM22MX10	800F 2-position Selector Switch Metal, maintained, black, standard knob, standard orientation, 1 N.O. contact block, standard pack	1
5	800FM-F611MX10	800F Push Button Metal, flush, blue, R, metal latch mount, 1 N.O. contact, 0 N.C. contacts, standard, standard pack	1
6	24B-V2P5A104AA-ND-P3	PowerFlex 525 Pre-engineered FasTrac, with Embedded EtherNet/IP™ and Safety 120VAC, 1-phase, 0.5 Hp, 0.4 kW normal duty; 0.5 Hp, 0.4 kW heavy duty, Type 1 / IP20, no filter, without bypass, without reactor, motor circuit protector (-P3)	1
7	800FM-F301	800F Push Button Metal, flush, green, START, standard pack	1
8	800FM-E402	800F Push Button Metal, extended, red, STOP, standard pack	1

Safety Rating

The safety function that is performed by the guard locking interlock meets the safety performance requirements of SIL CL2 per IEC 61061:2012 and SIL 2 per IEC 61508:2005 and has a Category 3 structure that can be used in systems requiring Performance Levels up to PLd per ISO 13849-1: 2006. The circuit executes a Stop Category 1.

Cat 1 Stop with GuardShield Light Curtain, T-15 Interlock, E-Stop, and PowerFlex 525

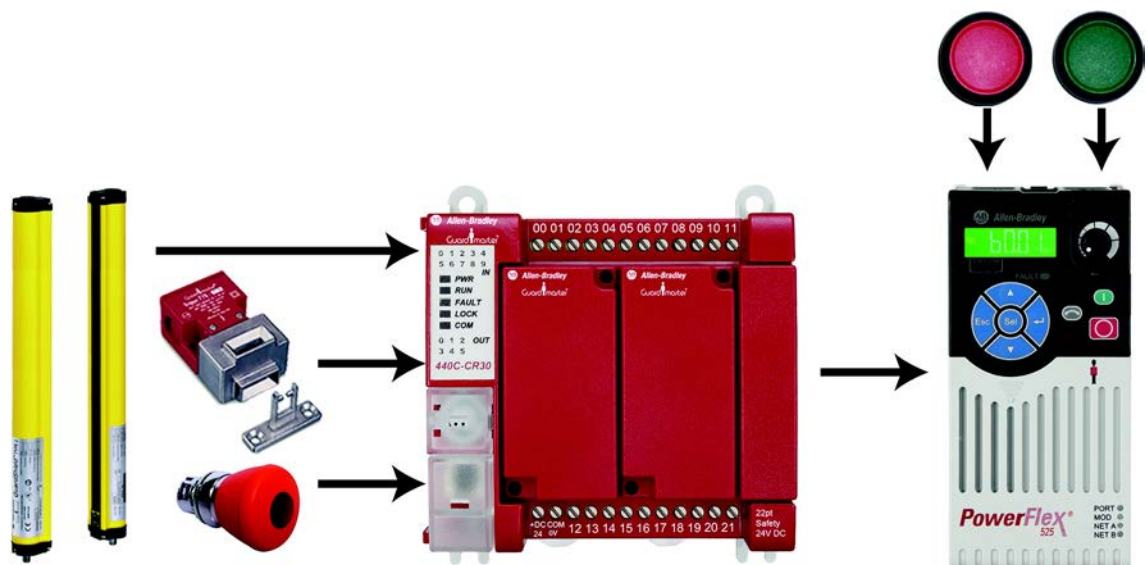
This example application shows how to configure the CR30 safety relay for a guarding application that requires a Stop Category 1 function.

A light curtain is used where an operator frequently accesses the hazard area. A mechanical tongue interlock switch is mounted on a gate where infrequent access to the hazard. Both the light curtain and gate are located far enough away from the hazard so the operator cannot reach the hazard until it has reached a safe state.

An E-stop button is also available at the control panel. Any of the three devices must cause the machine to go to a safe OFF state.

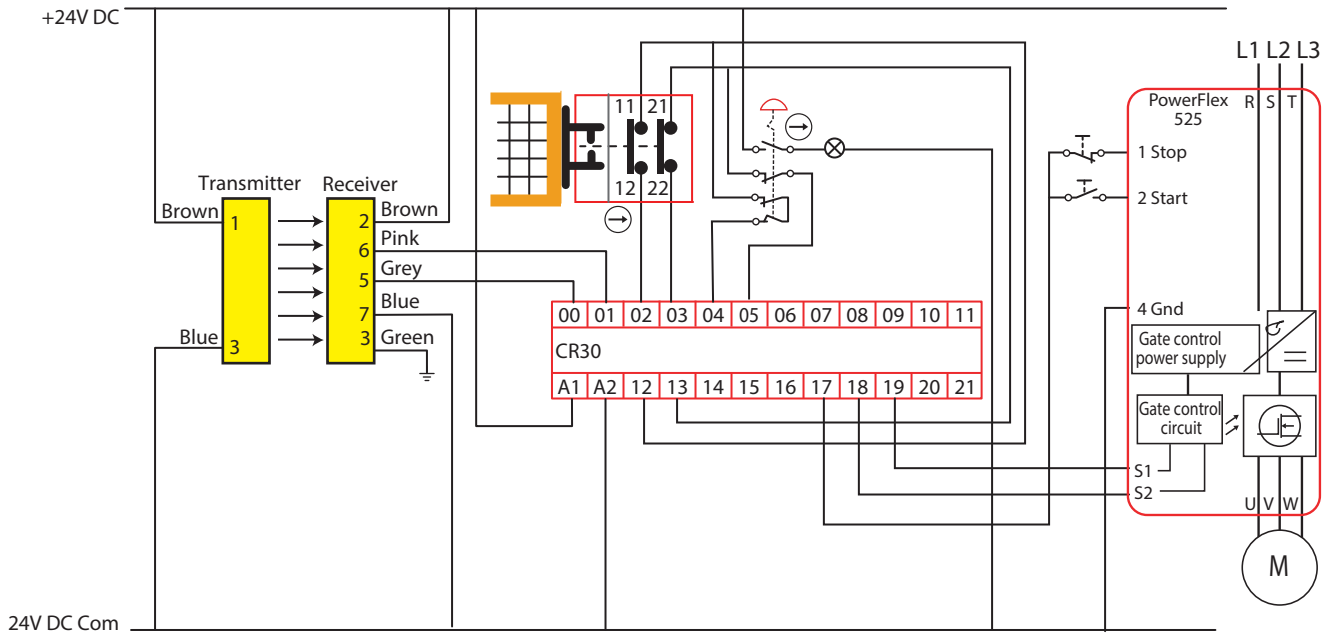
Product Overview

Figure 4 - Overview



Schematic

Figure 5 - Schematic



PowerFlex PF525 Settings

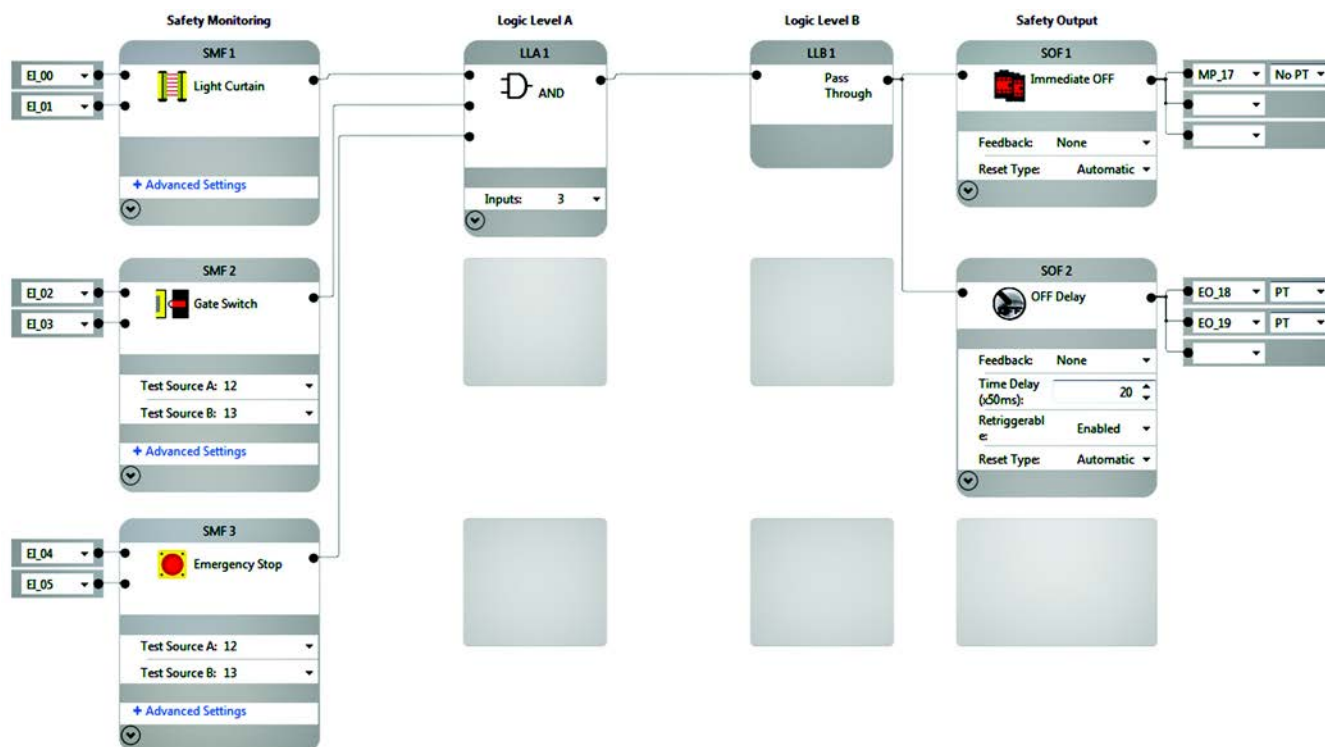
Table 4 shows a list of some of the parameter settings for this application. The list is not a complete list of the parameters for the PF525. You can set many other parameters to make this application successful.

Table 4 - Parameter Settings

Parameter	Name	Value	Unit/Description
P042	Decel Time	1	Seconds
P045	Stop Mode	0	Stop and Clear Fault
P046	Start Source	2	Digital Input Terminal Block
P047	Speed Reference 1	1	Drive Pot
T081	Relay 2	2	Motor Running Motor is receiving power from the drive.
T105	Safety Fault En	0	Fault Enable

Connected Components Workbench Software

Figure 6 - Connected Components Workbench Example



Circuit Status

The light curtain is clear. The gate switch is closed. The E-stop is reset. The CR30 safety outputs at terminal 17, 18, and 19 are ON. The PF525 shows an F059 fault. The motor is off.

Operational Sequence

Table 5 - Operational Sequence

Action Taken	Results
1. Press the drive Stop button.	The F059 Fault on the PF25 is cleared. The motor is ready to run. Normally, the motor would be stopped by the machine control system, which is not shown in the schematic.
2. Press the drive Start button.	The motor turns ON. The drive can now be used for normal production processes. The speed of the motor is controlled by the Drive Pot, located on the front of the PF525.
3. Do any of the following actions: – Block the light curtain, – Open the gate switch, or – Press the E-stop.	The power is immediately removed from terminals 17, and the drive executes a ramp to stop command in 1 seconds (P042 is configured for 1s). One second later, terminals 18 and 19 turn off, and the PF525 executes a safe torque off function. The PF525 shows an F059 fault in its display.
4. Do the opposite action from Step 2: – Clear the light curtain, – Close the gate switch, or – Release the E-stop.	The CR30 safety outputs at terminal 17, 18 and 19 are ON. The PF525 still shows an F059 fault. The motor remains off. Go to Step 1.

Example Bill of Materials

Table 6 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	440L-P4K1760YD	GuardShield™ Safety Light Curtain Res 30 mm, Pt Ht 1760 mm, 88 beams	1
2.1	889D-F4AC-5	DC Micro (M12) Female, straight, 4-pin, PVC cable, yellow, unshielded, 22 AWG, 5 m (16.4 ft)	1
2.2	889D-F8AB-5	DC Micro (M12) Female, straight, 8-pin, PVC cable, yellow, unshielded, 24 AWG, 5 m (16.4 ft)	1
3	440K-T11287	Tongue Switch - Trojan™ T15 Contacts (safety and aux): 2 N.C., BBM Preference: N/A Actuator: Fully-flex Model Type: GD2 front entry Conduit Entry: 1/2in NPT conduit	1
4	800FM-LMT64	800F Illuminated Mushroom Operators Illuminated, twist-to-release, 60 mm, round metal (Type 4/13, IP66), red, standard pack (Qty. 1)	1
5	800F-X01L	22.5 mm Push Button No latch, screw contact block, 1 N.C.L.B.	1
6	800F-ALM	Metal Latch	1
7	800F-X01S	22.5 mm PB No latch, screw contact block, 1 N.C. self-monitoring	1
8	800F-N3R	Integrated LED Latch mount, 24V AC/DC, red LED	1
9	800F-X10	22.5 mm Push Button No latch, screw contact block, 1 N.O.	1
10	800FM-F301	800F Push Button Metal, flush, green, START, standard pack (Qty. 1)	1
11	800FM-E402	800F Push Button Metal, extended, red, STOP, standard pack (Qty. 1)	1
12	24B-V2P5A104AA-ND-P3	PowerFlex 525 Pre-engineered FasTrac, with Embedded EtherNet/IP and Safety 120V AC, 1-phase, 0.5 Hp, 0.4 kW normal duty; 0.5 Hp, 0.4 kW heavy duty, Type 1 / IP20, no filter, without bypass, without reactor, motor circuit protector (-P3)	1

Safety Rating

The safety function that is initiated by the light curtain can meet up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC 62061, and SIL 2 per IEC 61508. It does not achieve Cat 4 PLe due to the rating of the PF5252 drive

The safety function that is initiated by the gate interlock switch can meet up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC 62061, and SIL 2 per IEC 61508 when using fault exclusion as described in ISO 14119.

The safety function that is initiated by the E-stop can meet up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC 62061, and SIL 2 per IEC 61508.

Safety Mats - Two Zones

This application demonstrates two zones using safety mats and E-stop push buttons. Each zone is controlled by a safety mat and an E-stop push button. In this example, a sequential manufacturing process has two zones. If an operator enters the first zone, that zone stops while the second zone continues to function. If an operator enters zone 2, then both zones 1 and 2 must stop. An indicator lamp shows which zone is not operating, and the user is allowed to enter for normal production type operations.

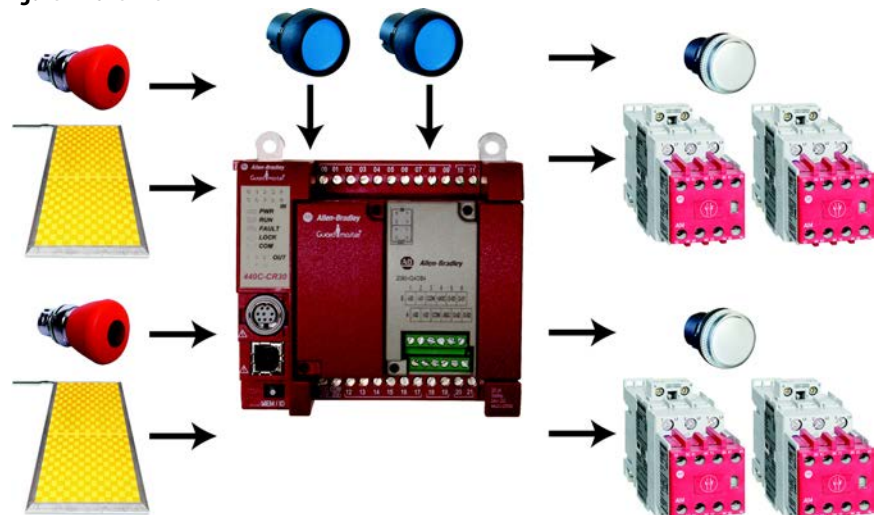
The safety mats for each zone can be single mats or multiple mats that are connected in series. The safety mats must be connected to pulse tested outputs to operate properly with the CR30 safety relay. In this example, the Zone 1 mats use pulses from 12 and 13 and Zone 2 uses pulses from 16 and 17. The maximum size of the mat system is 65 square meters for each zone.

The two E-stop buttons use the same test pulses, from terminals 14 and 15 - this arrangement is preferred. Alternatively, the E-stops can be powered directly by the 24V DC supply, but powering directly from 24V does not provide cross-channel fault detection.

Note: The outputs of the CR30 safety relay are driving 100S contactors. Due to the inrush current limitations of the CR30 safety relay, it can only switch the 100S-C09EJ contactors. The CR30 safety relay cannot switch the C43EJ contactors.

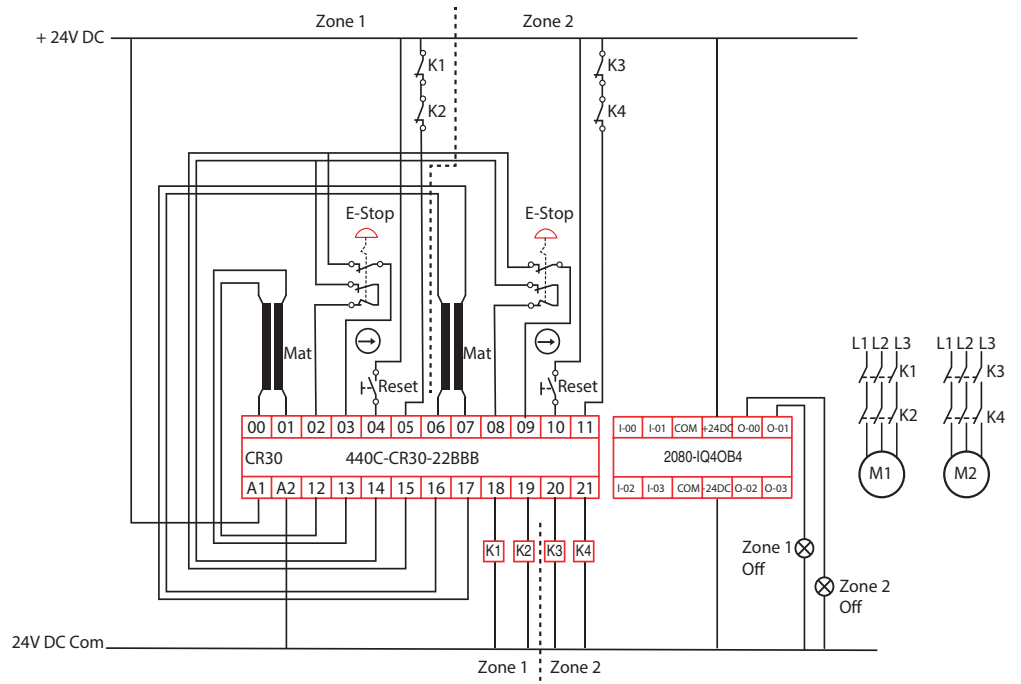
Product Overview

Figure 7 - Overview



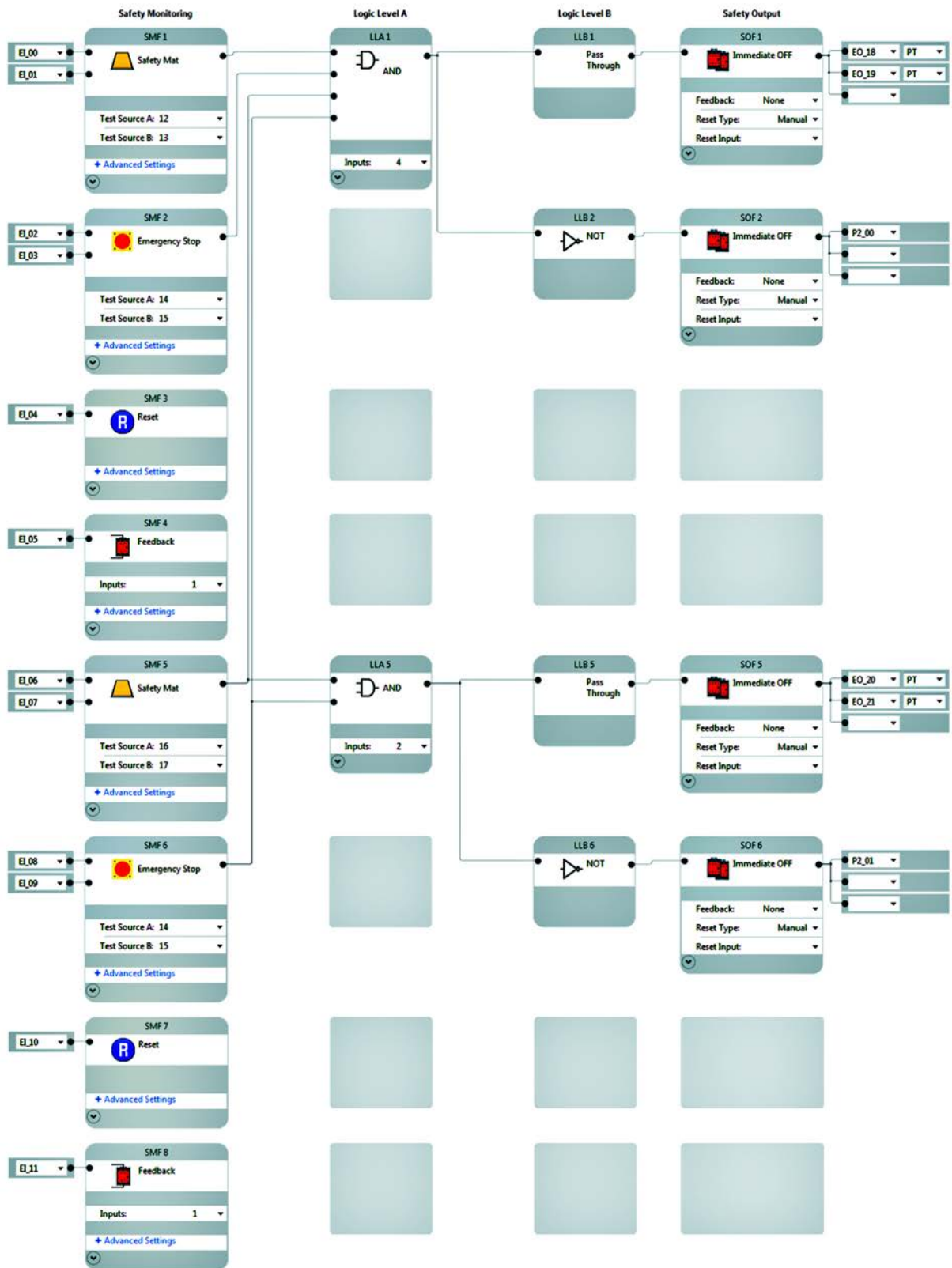
Schematic

Figure 8 - Schematic



Connected Components Workbench Software

Figure 9 - Connected Components Workbench Example



Circuit Status

No presence is sensed on both mat systems. All four contactors are off, and both motors (hazards) are off. The system is ready for reset.

Operational Sequence

Press Reset 1 to enable the start of Zone 1. Press Reset to enable the start of Zone 2.

To gain access to either zone, the operator steps on the mat or presses the E-stop button. Both devices initiate an immediate stop command to its associated hazard. An indicator at Plug-in terminal P200 and P201 show when someone or something is on the mat or if the E-stop is pressed for that zone.

If the operator enters Zone 1, then only Zone 1 stops and Zone 2 continues to run. If the operator enters Zone 2, then both zones stop.

After leaving the Zone 2, the operator must press the reset button to enable the restart of Zone 2. After leaving Zone 1, the operator must press the reset buttons for both Zone 1 and 2 to enable the restart the machine.

Example Bill of Materials

Table 7 - Bill of Materials

Item	Product	Description	Qty
1	2080-IQ40B4	4-ch Digital Input/Output Combination Module	1
2	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
3	800FM-P4MN3R	800F Pilot Light Rd. Metal (IP66, 4/13, IP66), red, standard pack (Qty. 1)	2
4	800FM-MT44	800F Non-illuminated Mushroom Operators Twist-to-release, 40 mm, round metal (Type 4/13, IP66), red, standard pack (Qty. 1)	2
4.1	800F-ALM	Metal Latch	2
4.2	800F-X01S	22.5 mm PB No Latch Screw contact block, 1 N.C. self-monitoring	4
5	440F-M2036BYNN	Safety Mat Yellow, 1000 x 1800 mm, two 4.5 m (15 ft) 2-wire cables, exit out "B" corners, no trim, no controller	2
6	440F-T2036	Trim Kit Standard trim, 1000 x 1800 mm	2
7	100S-C09EJ14BC	MCS 100S-C Safety Contactor 9A, 24V DC (with electronic coil), bifurated contact	4
8	800FM-P7MN3W	800F Pilot Light Rd. metal (IP66, 4/13, IP66), clear, standard pack (Qty. 1)	2

Safety Rating

The safety function that is initiated by the safety mats can meet up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC 62061, and SIL 2 per IEC 61508.

The safety function that is initiated by the E-stops can meet up to Cat 4, PLe and SIL3 per IEC61508 and SIL CL3 per IEC 62061.

Enabling Switch (GripSwitch) with Jog Function

The GripSwitch is a hold-to-run enabling device. While holding the GripSwitch in the center (enabled) position, the operator then presses and holds the jog switch to operate the PowerFlex drive for a specified duration.

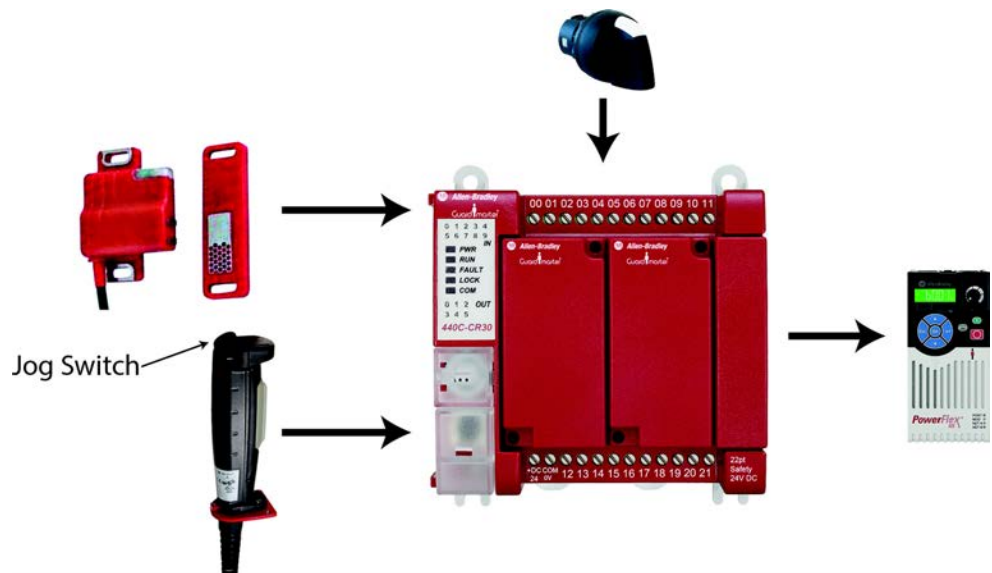
This example requires a two-position selector switch. The position of the selector switch determines whether the gate switch is used or the GripSwitch is used.

This application has four distinct safety-related functions:

1. Interlock 'Logic' Drive
2. Enabling Switch 'Logic' Drive
3. Selector switch 'Logic' Drive
4. Jog Switch 'Logic' Drive

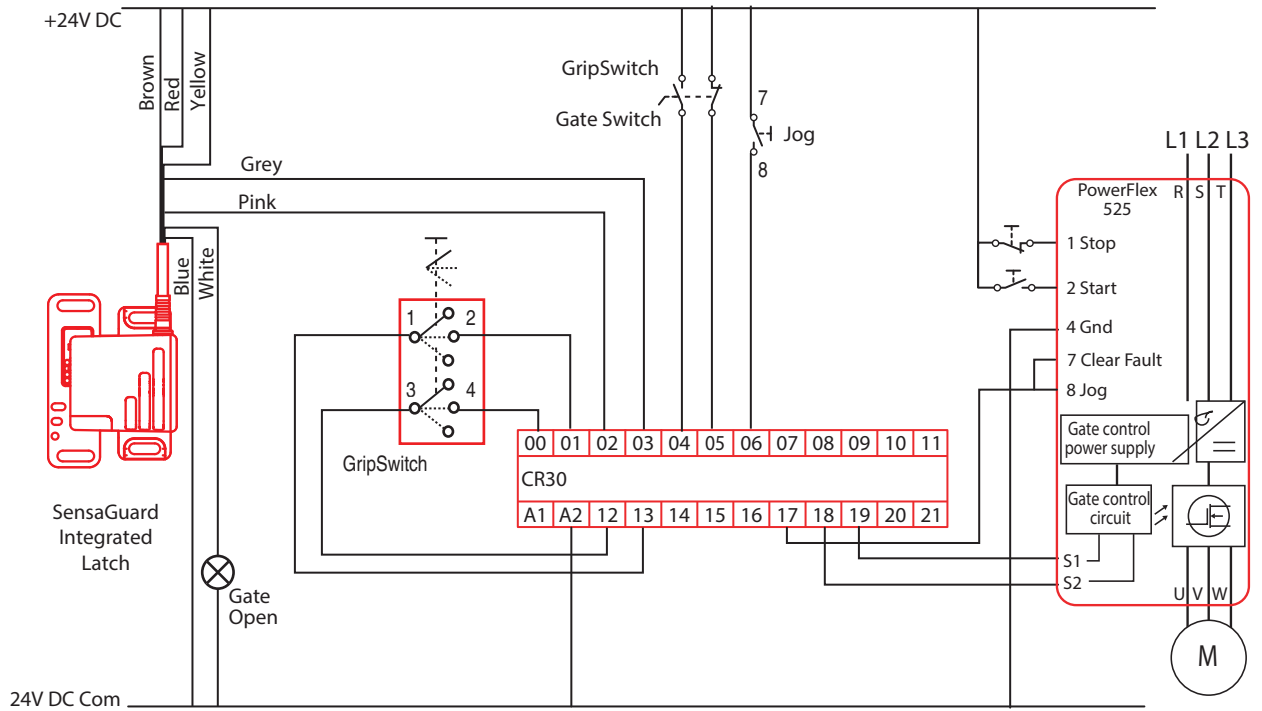
Product Overview

Figure 10 - Overview



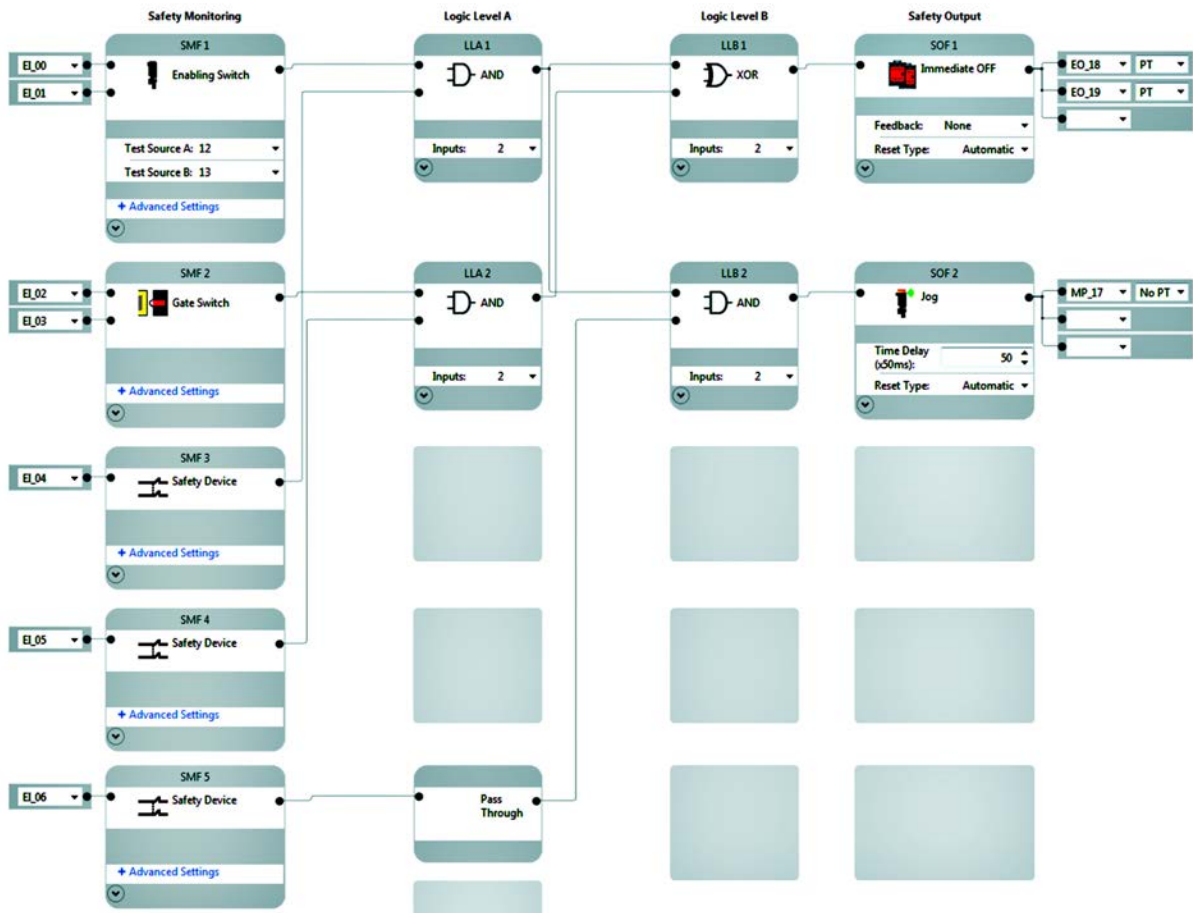
Schematic

Figure 11 - Schematic



Connected Components Workbench Software

Figure 12 - Connected Components Workbench Example



Logic Level B1 block is an XOR, rather than a simple OR. The Selector switch chooses either the gate interlock switch or GripSwitch. If a short circuit to 24V occurs on terminal 5, and the gate closed behind the operator, the GripSwitch would be bypassed if the simple OR block were used. To avoid a potential bypass situation, an XOR block is used. The SOF1 output block turns off if both the gate switch and GripSwitch were both on.

The SOF2 jog output is only enabled when the GripSwitch is both selected and enabled. Therefore, when the Selector switch is set to the gate switch, the jog button is disabled. The jog parameter is set to 50 (50 x 50 ms), which is 2.5 seconds. When the jog switch is held down, the PF525 jogs the motor for 2.5 seconds. If the jog button is released sooner than 2.5 seconds, the motor stops immediately.

Circuit Status

The safety gate is closed. The selector switch is set to Gate Switch. The GripSwitch is off and the Jog switch is off. The PF525 is off.

Operational Sequence

Table 8 - Operational Sequence

Action Taken	Results
1. Press the drive Stop button.	This clears faults in the drive. Fault F059 may be present, due to its safety inputs being off.
2. Press the drive Start button.	The motor turns ON. The drive can now be used for normal production processes. Normally, the motor would be stopped by the machine control system.
3. Rotate the Selector switch to GripSwitch.	The operator must hold the GripSwitch in the center position to prevent the drive from going to a fault condition.
4. Open the guard (opens the gate interlock switch).	The operator can access the hazard area.
5. Grab the GripSwitch and squeeze to the center ON position.	
6. Momentarily press the jog button.	This clears the F059 fault on the PpwerFlex 525.
7. Press and hold the jog button.	The PF525 turns on the motor for 2.5 seconds. To get the PF525 to jog again, the operator can release the jog button and then depress it again.
8. Set the selector switch to Gate Switch.	
9. Press the Stop button.	This clears the F059 fault on the PF525.
10. The PF525 is ready for normal production operations.	

Example Bill of Materials

Table 9 - Bill of Materials

Item	Product	Description	Qty
1	2080-IQ40B4	4-ch Digital Input/Output Combination Module	1
2	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	
3	800FM-P4MN3R	800F Pilot Light Rd. metal (IP66, 4/13, IP66), red, standard pack (Qty. 1)	
4	800FM-MT44	800F Non-illuminated Mushroom Operators Twist-to-release, 40 mm, round metal (Type 4/13, IP66), red, standard pack (Qty. 1)	
4.1	800F-ALM	Metal Latch	
4.2	800F-X01S	22.5 mm Push Button No latch, screw contact block, 1 N.C. self-monitoring	
5	440F-M2036BYNN	Safety Mat Yellow, 1000 x 1800 mm, two 4.5 m (15 ft) 2-wire cables, exit out "B" corners, no trim, no controller	
6	440F-T2036	Trim Kit Standard trim, 1000 x 1800 mm	
7	100S-C09EJ14BC	MCS 100S-C Safety Contactor 9 A, 24V DC (with electronic coil), bifurated contact	
8	800FM-P7MN3W	800F Pilot Light Rd. metal (IP66, 4/13, IP66), clear, standard pack (Qty. 1)	

Safety Rating

This application has four distinct safety-related functions:

- 1. Interlock -> Logic -> Drive**
The safety function that is performed by the gate switch can meet the requirements up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC62061, and SIL 2 per IEC61508.
- 2. Enabling Switch -> Logic -> Drive**
The safety function that is performed by the enabling switch can meet the requirements up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC62061, and SIL 2 per IEC61508.
- 3. Selector switch -> Logic -> Drive**
The safety function that is performed by the enabling switch can meet the requirements up to Cat 3 PLd per ISO13849-1, SIL CL2 per IEC62061, and SIL 2 per IEC61508.
- 4. Jog Switch-> Logic -> Drive**
The safety function that is performed by the jog switch can meet the requirements up to Cat 2 PLc per ISO13849-1, SIL CL1 per IEC62061, and SIL 1 per IEC61508.

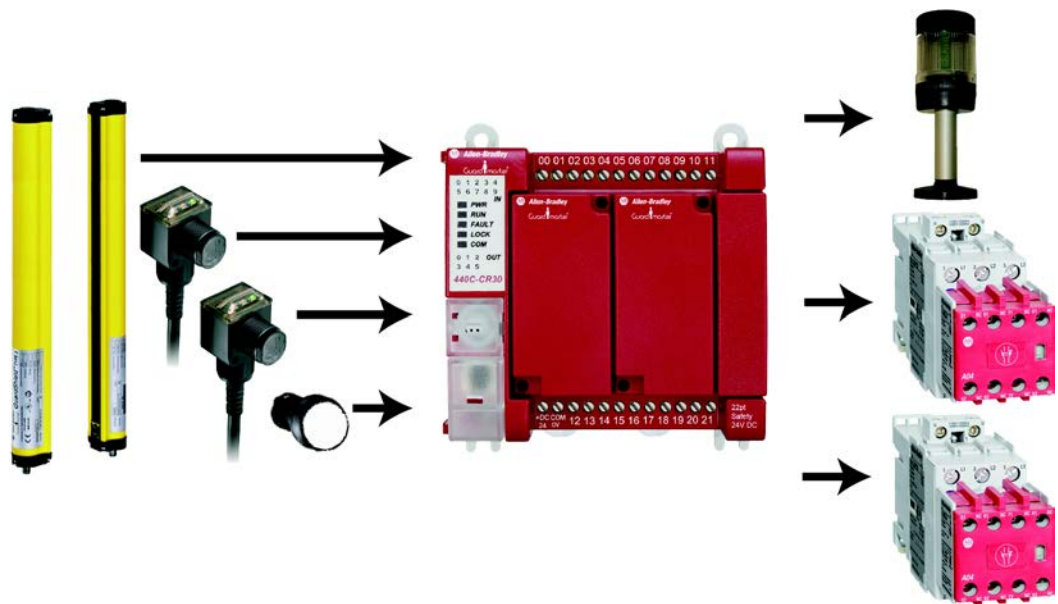
Notes:

Muting 2-Sensor L-Type Unidirectional

The CR30 safety relay has a function block that supports 2-sensor L-type muting. With this function block, the material can only move in one direction: from the hazard area to the non-hazard area. The two muting sensors are located within the hazard area, and the material must be large enough to block both sensors and the light curtain. The function block contains timing parameters that allow you to accommodate a wide range of operating speeds.

Product Overview

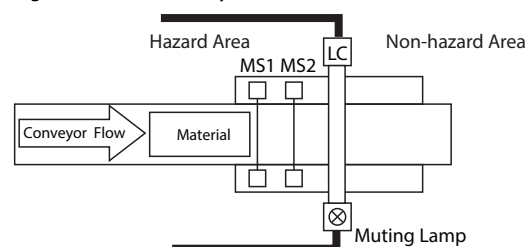
Figure 13 - Overview



Machine Layout

The material can only flow from the hazard area to the non-hazard area. The material must be large enough to block muting sensor 1, muting sensor 2, and the light curtain concurrently.

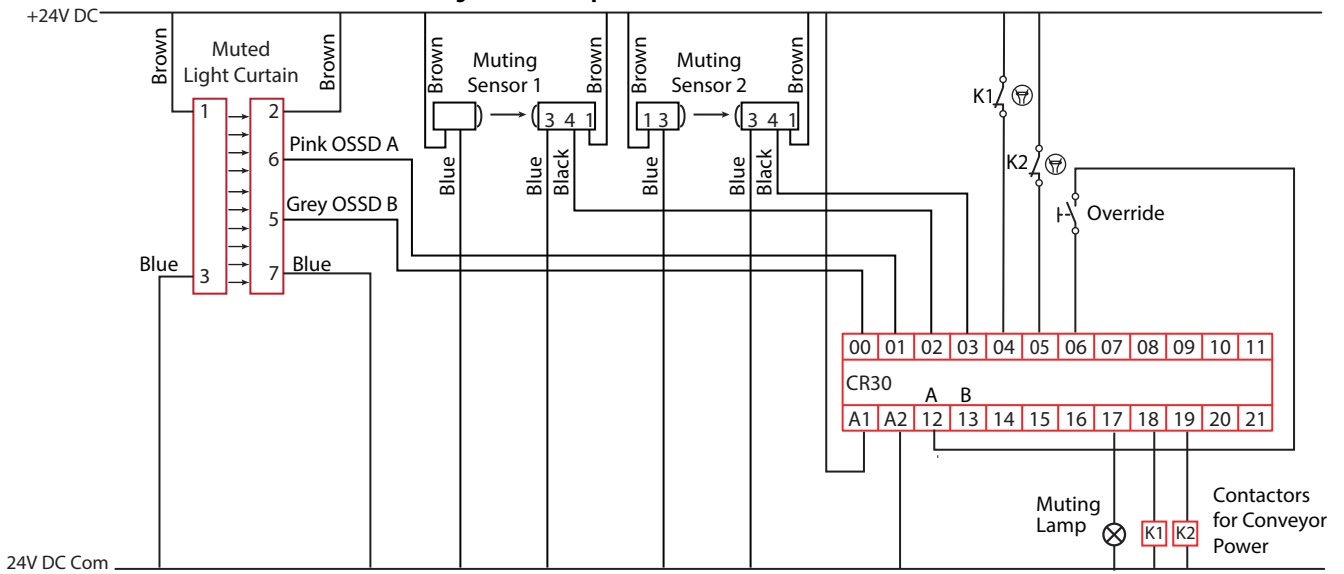
Figure 14 - Machine Layout



Schematic

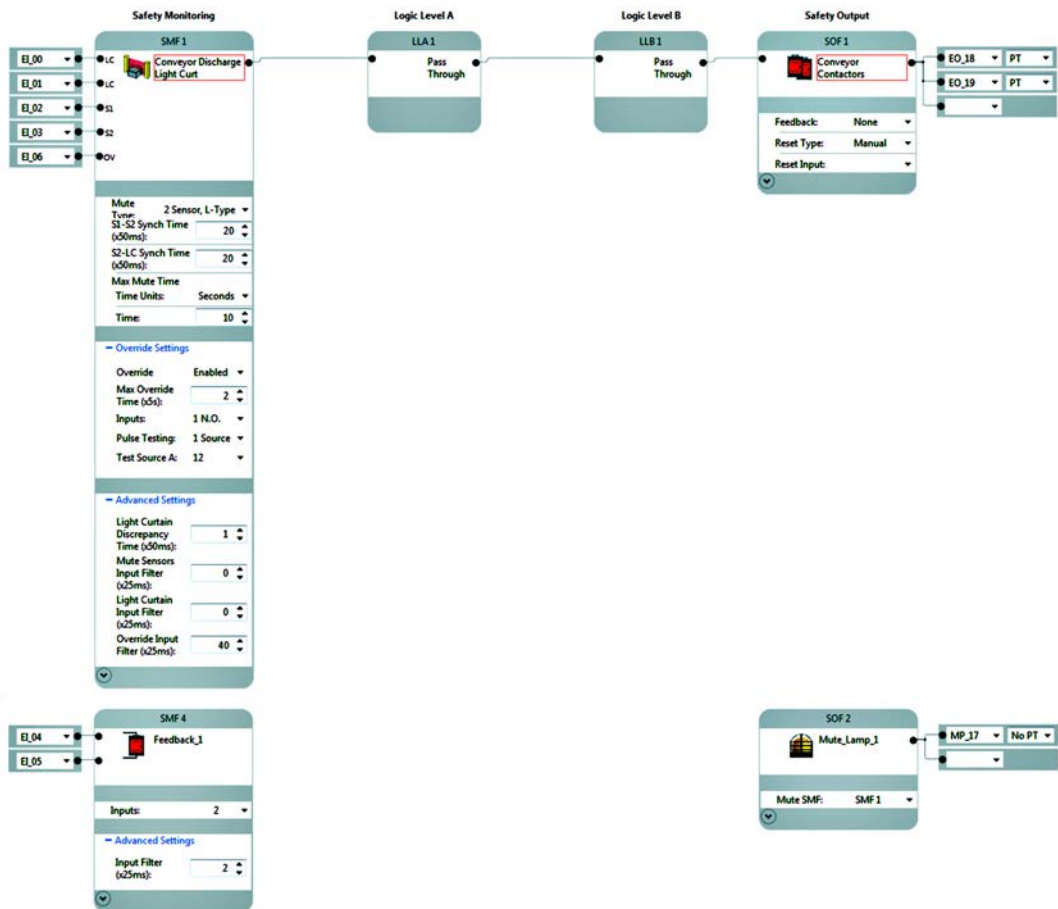
The example schematic is set up to agree with the terminals shown in the Connected Components Workbench™ software and the example bill of materials.

Figure 15 - Example Schematic



Connected Components Workbench Software

Figure 16 - Connected Components Workbench Example



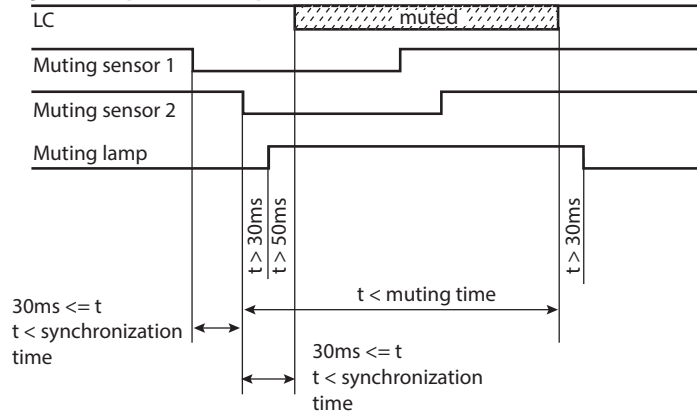
Circuit Status

The circuit is ready to run. The muting sensors and the light curtain are clear.

Operational Sequence

The muting sensors and the light curtain participate in the sequence of events to achieve the muting. The material must move past the sensors and into the light curtain within the synchronization times, which are set in the Connected Components Workbench function block. In addition, the material must move through the light curtain within the muting time, which is also set in the Connected Components Workbench function block.

Figure 17 - Operational Sequence



As the material moves out of the hazard area, it first breaks muting sensor 1 (MS1). The material continues to move and must break muting sensor 2 (MS2) within the first synchronization time, which is set on the Connected Components Workbench software to 1 second. Then, the muting lamp turns ON and the light curtain is muted. The material continues to move and must break the light curtain within the second muting time, which is also set on the Connected Components Workbench software to 1 second. Finally, the material must move through the light curtain within the muting time, which is configured on the Connected Components Workbench software to 10 seconds.

If the material movement exceeds one of the synchronization times or the muting time, the conveyor stops. An operator can press and hold down the override button during the override time. The conveyor contactors turn on until the override time expires (or the operator releases the button).

Example Bill of Materials

Table 10 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	440L-P4K1760YD	GuardShield Safety Light Curtain Res 30 mm, protective height 1760 mm, 88 beams	1
2.1	889D-F4AC-5	DC Micro (M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 22 AWG, 5 m (16.4 ft)	1
2.2	889D-F8AB-5	DC Micro (M12), Female, Straight 8-pin, PVC cable, yellow, unshielded, 24 AWG, 5 m (16.4 ft)	1
3	42EF-E1EZB-F4	PHOTOSWITCH® Photoelectric Sensor RightSight, transmitted beam, infrared, DC, 4-pin DC micro QD on 152 mm (6 in.) pigtail	2
3.1	889D-F4AC-5	DC Micro(M12), Female, Straight 4-pin PVC, yellow, unshielded, 5 m (16.4 ft)	2
4	42EF-R9KBBV-F4	PHOTOSWITCH Photoelectric Sensor RightSight, transmitted beam receiver, DC - dark operate, both sink (NPN) and source (PNP), 4-pin DC micro QD on 152 mm (6 in.) pigtail	2
4.1	889D-F4AC-5	DC Micro(M12), Female, Straight 4-pin PVC, yellow, unshielded, 5 m (16.4 ft)	2
5	855T-BPM10C	Control Tower™ Stack Light Mounting Base 10 cm pole mount, black housing, cap included	1
6	855T-B24TL7	Control Tower Stack Light Black housing, 24V AC/DC full voltage, clear steady LED (socket mount)	1
7	800FM-F1	800F Push Button Metal, flush, white, no legend, standard pack (Qty. 1)	1
8	800F-MX10	Metal Latch Mount 1 N.O. contact(s), 0 N.C. contact(s), standard	1
9	100S-C09EJ304BC	MCS 100S-C Safety Contactor 9 A, 24V DC (with electronic coil), bifurcated contact	2

Safety Rating

The 2-sensor L-type muting meets the performance requirements of Cat 4, PLe per ISO13849-1, SIL CL3 per IEC 62061, and SIL 3 per IEC 61508.

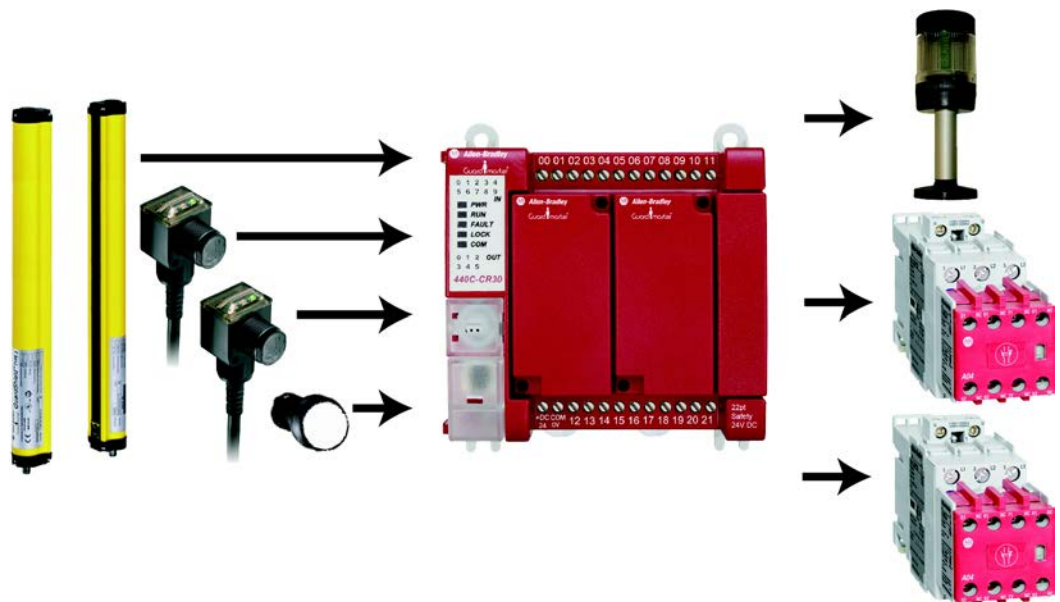
Notes:

Muting 2-Sensor T-Type Bidirectional

The CR30 safety relay has a function block that supports two-sensor T-type muting. With this function block, the material can only move in either direction: from the hazard area to the non-hazard area or reverse. The two muting sensors are arranged so that their beams form an “X” pattern where the crossover occurs very close to the light curtain beam. The shape of the material must be such that it breaks the muting sensor and light curtain beams in a specific pattern. The function block contains timing parameters that allow you to accommodate a wide range of operating speeds.

Product Overview

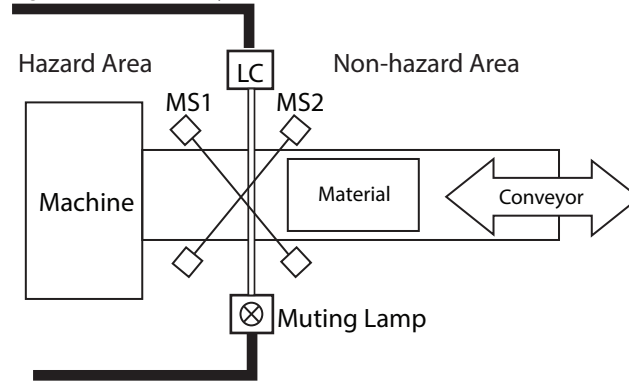
Figure 18 - Overview



Machine Layout

The material can flow in either direction: to the hazard area from the non-hazard area or reverse. The shape of the material must be such that it blocks both muting sensors before it blocks the light curtain. The order in which the muting sensors are blocked is not critical, but the synchronization time (time between blocking one sensor and the other sensor) must be met.

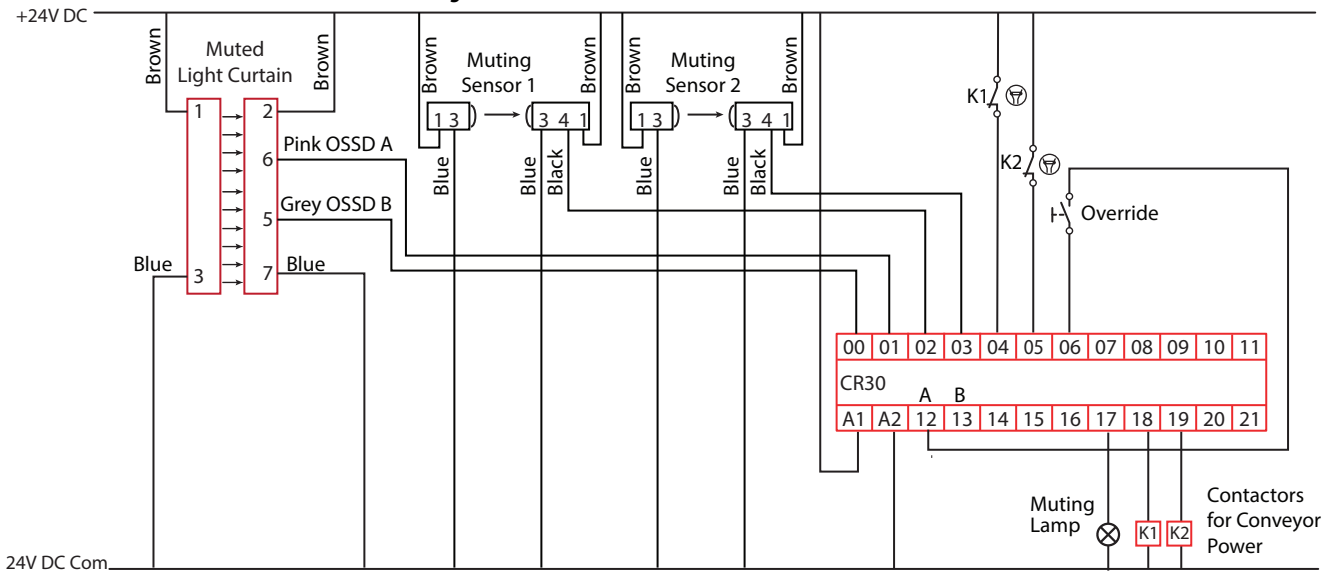
Figure 19 - Machine Layout



Schematic

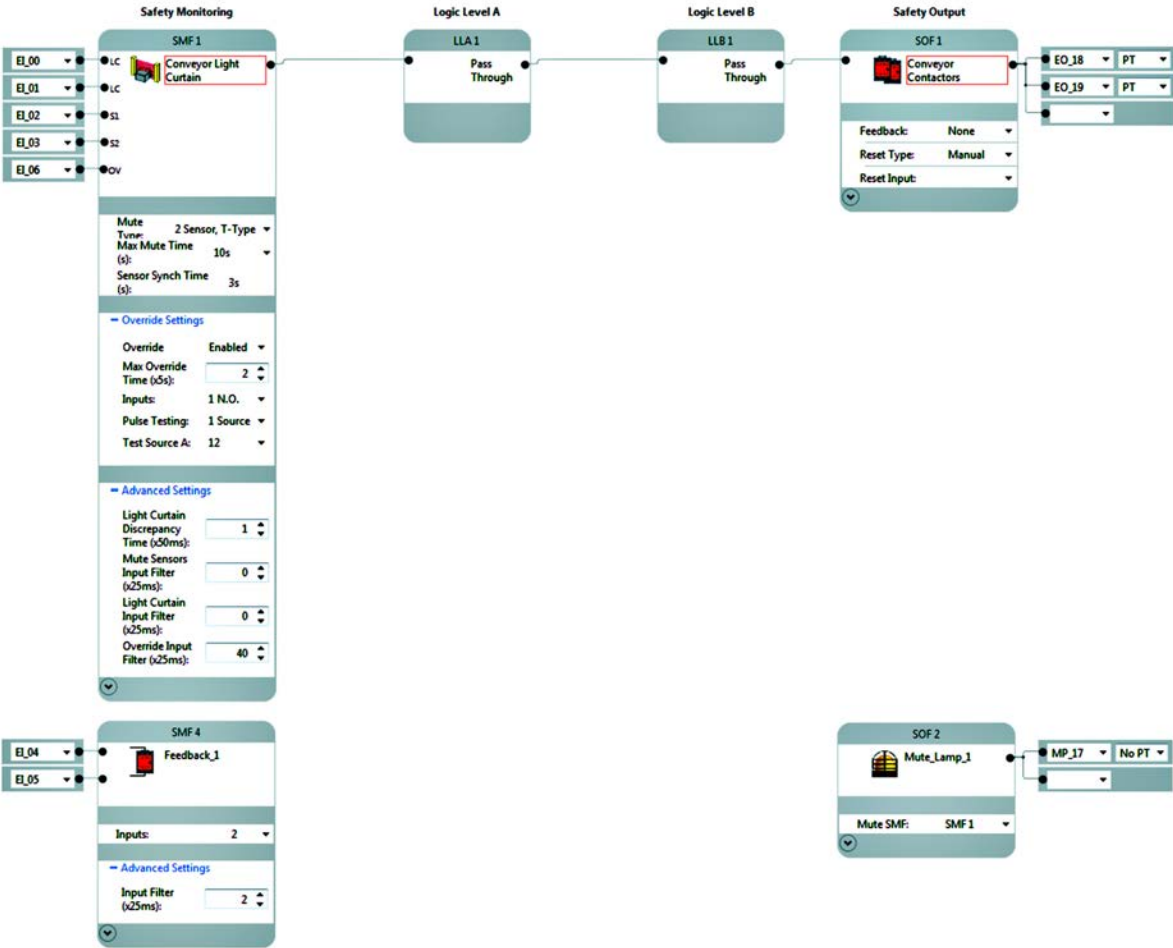
The example schematic is set up to agree with the terminals shown in the Connected Components Workbench software and the example bill of materials.

Figure 20 - Schematic



Connected Components Workbench Software

Figure 21 - Connected Components Workbench Example



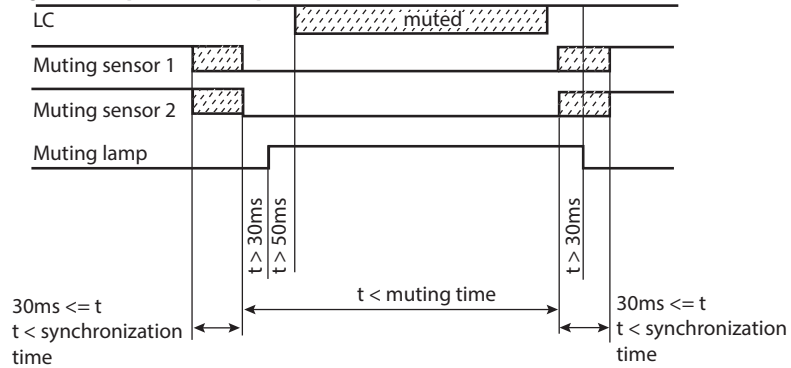
Circuit Status

The circuit is ready to run. The muting sensors and the light curtain are clear.

Operational Sequence

The muting sensors and the light curtain participate in the sequence of events to achieve the muting. The material must move past the sensors and into the light curtain within the synchronization times, which are set in the Connected Components Workbench function block. In addition, the material must move through the light curtain within the muting time, which is also set in the Connected Components Workbench function block.

Figure 22 - Operational Sequence



As the material moves, it must block both muting sensors within their synchronization times, which are configured in the Connected Components Workbench function block for 3 seconds. The light curtain is then muted. The material must move through the light curtain within the specified muting time, which is configured in the Connected Components Workbench software to be 10 seconds.

If the material movement exceeds one of the synchronization times or the muting time, the conveyor stops. An operator can press and hold down the override button during the override time. The conveyor contactors turn on until the override time expires (or the operator releases the button).

Example Bill of Materials**Table 11 - Bill of Materials**

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	440L-P4K1760YD	GuardShield Safety Light Curtain Res 30 mm, protective height 1760 mm, 88 beams	1
2.1	889D-F4AC-5	DC Micro (M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 22 AWG, 5 m (16.4 ft)	1
2.2	889D-F8AB-5	DC Micro (M12), Female, Straight 8-pin, PVC cable, yellow, unshielded, 24 AWG, 5 m (16.4 ft)	1
3	42EF-E1EZB-F4	PHOTOSWITCH Photoelectric Sensor RightSight, transmitted beam, infrared, DC, 4-pin DC micro QD on 152 mm (6 in.) pigtail	2
3.1	889D-F4AC-5	DC Micro(M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 5 m	2
4	42EF-R9KBBV-F4	PHOTOSWITCH Photoelectric Sensor RightSight, transmitted beam receiver, DC - dark operate, both sink (NPN) and source (PNP), 4-pin DC micro QD on 152 mm (6 in.) pigtail	2
4.1	889D-F4AC-5	DC Micro (M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 22 AWG, 5 m (16.4 ft)	2
5	855T-BPM10C	Control Tower Stack Light Mounting Base 10 cm pole mount, black housing, cap included	1
6	855T-B24TL7	Control Tower Stack Light Black housing, 24V AC/DC full voltage, clear steady LED (socket mount)	1
7	800FM-F1	800F Push Button Metal, flush, white, no legend, standard pack (Qty. 1)	1
8	800F-MX10	Metal Latch Mount 1 N.O. contact(s), 0 N.C. contact(s), standard	1
9	100S-C09EJ304BC	MCS 100S-C Safety Contactor 9 A, 24V DC (with electronic coil), bifurcated contact	2

Safety Rating

The 2-sensor T-type muting meets the performance requirements of Cat 4, PLe per ISO13849-1, SIL CL3 per IEC 62061, and SIL 3 per IEC 61508.

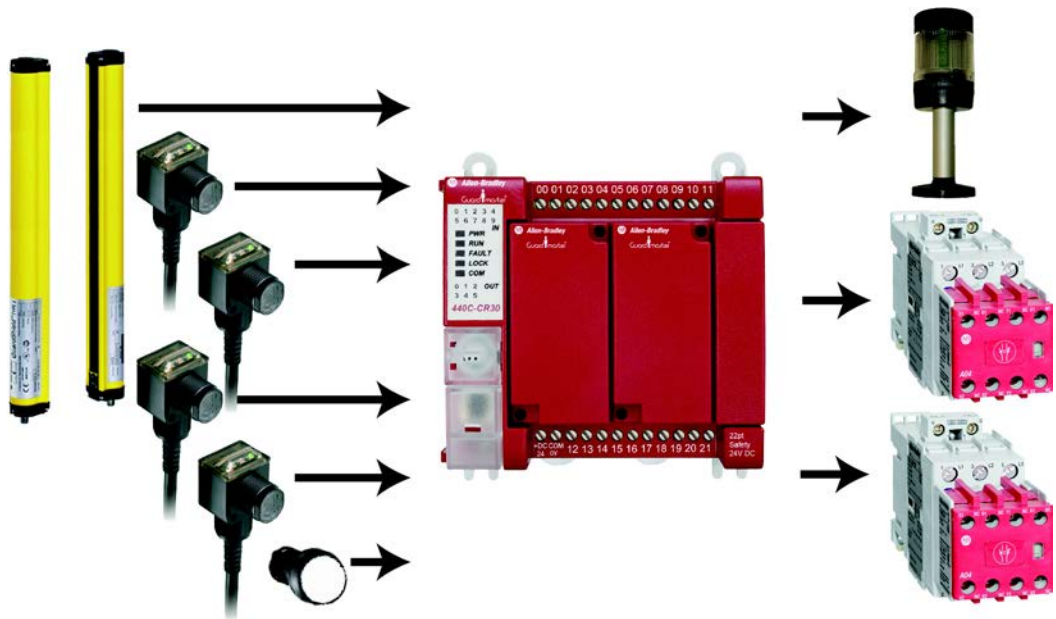
Notes:

Muting 4-sensor T-type Bidirectional

The CR30 safety relay has a function block that supports 4-sensor T-type muting. With this function block, the material can only move in either direction: from the hazard area to the non-hazard area or reverse. The four muting sensors are arranged so that their beams cross orthogonally across the conveyor: two inside the hazard area and two outside the hazard area. The length of the material must be such that it breaks all four muting sensors and light curtain beams simultaneously. The function block contains timing parameters that allow you to accommodate a wide range of operating speeds.

Product Overview

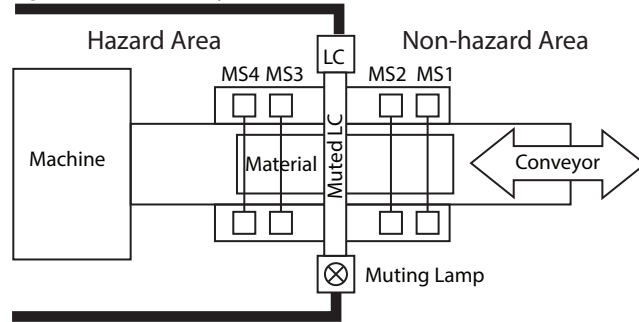
Figure 23 - Overview



Machine Layout

The material can flow in either direction: to the hazard area from the non-hazard area or reverse. The shape of the material must be such that it blocks both muting sensors before it blocks the light curtain. The order in which the muting sensors are blocked is not critical, but the synchronization time (time between blocking one sensor and the other sensor) must be met.

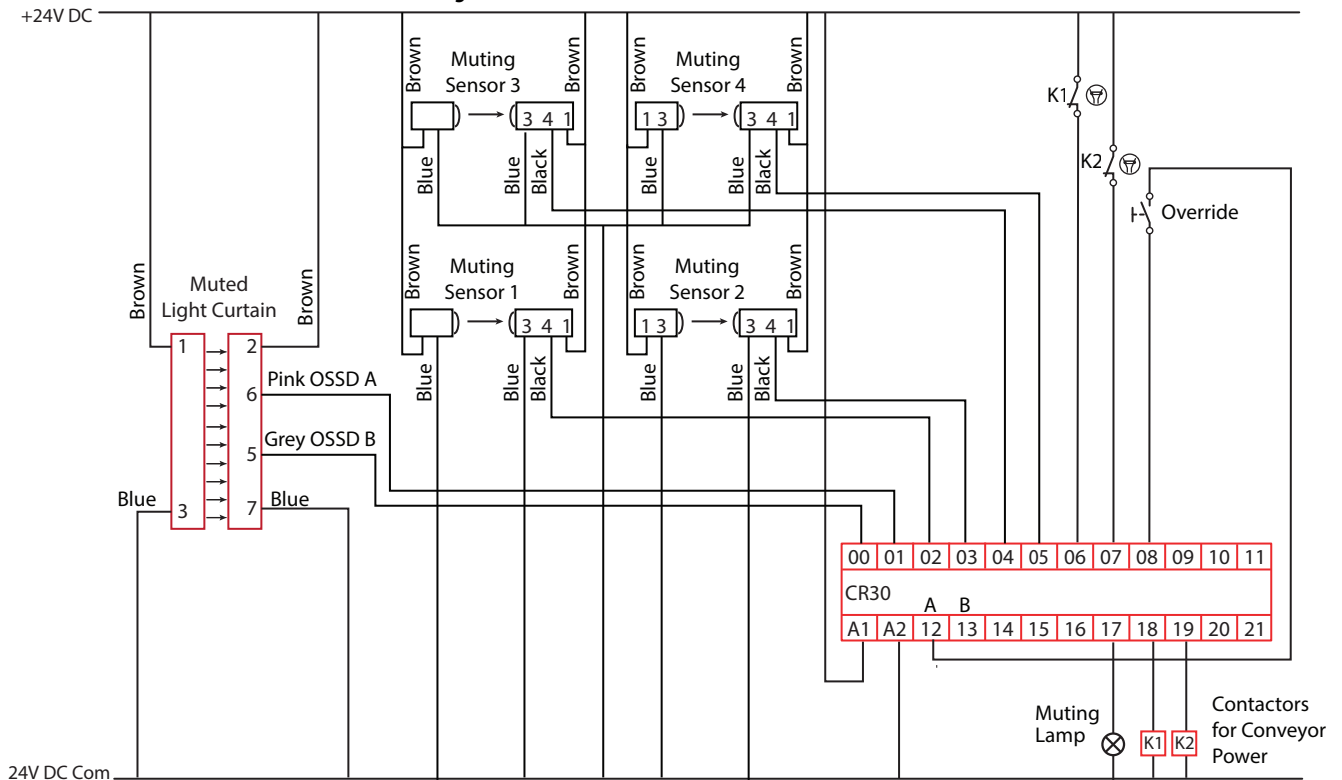
Figure 24 - Machine Layout



Schematic

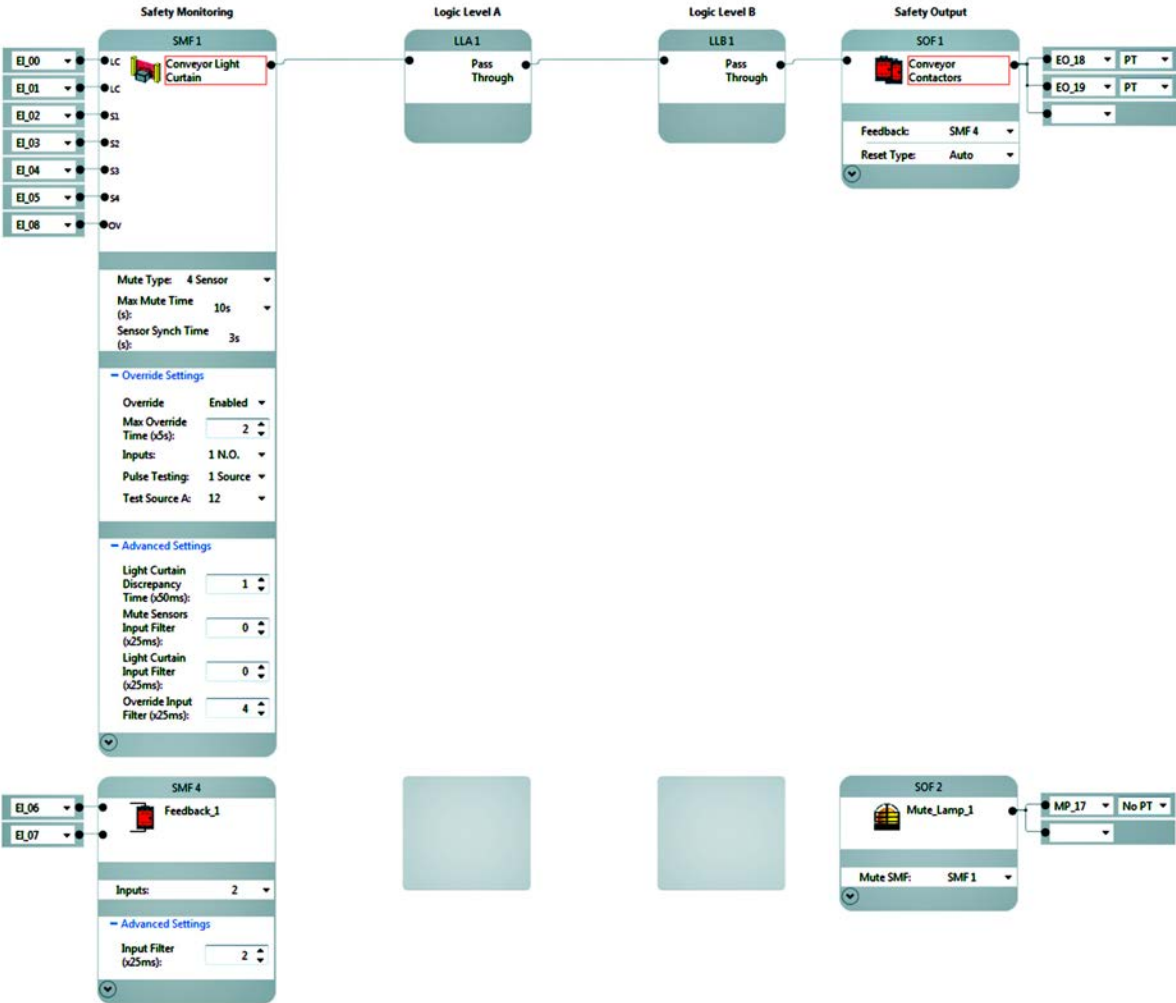
The example schematic is set up to agree with the terminals shown in the Connected Components Workbench software and the example bill of materials.

Figure 25 - Schematic



Connected Components Workbench Software

Figure 26 - Connected Components Workbench Example



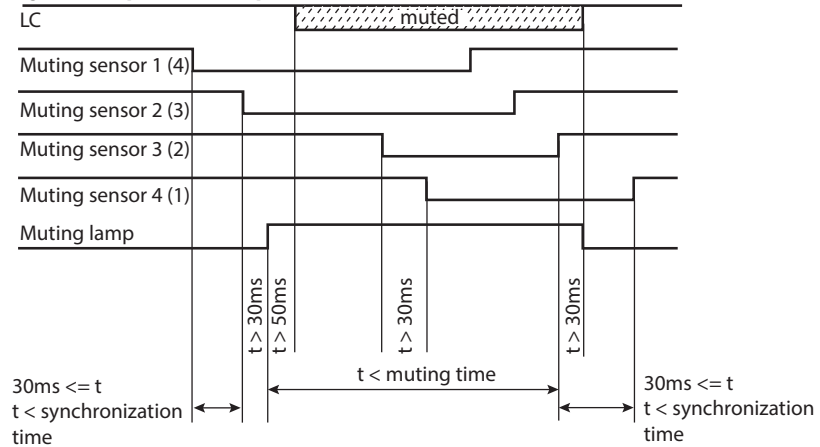
Circuit Status

The circuit is ready to run. The muting sensors and the light curtain are clear.

Operational Sequence

The muting sensors and the light curtain participate in the sequence of events to achieve the muting. The material must move past the sensors and into the light curtain within the synchronization times, which are set in the Connected Components Workbench function block. In addition, the material must move through the light curtain within the muting time, which is also set in the Connected Components Workbench function block.

Figure 27 - Operational Sequence



As the material moves, it must block both muting sensors within their synchronization times, which are configured in the Connected Components Workbench function block for 3 seconds. The light curtain is then muted. The material must move through the light curtain within the specified muting time, which is configured in the Connected Components Workbench software to be 10 seconds.

If the material movement exceeds one of the synchronization times or the muting time, the conveyor stops. An operator can press and hold down the override button during the override time. The conveyor contactors turn on until the override time expires (or the operator releases the button).

Example Bill of Materials**Table 12 - Bill of Materials**

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	440L-P4K1760YD	GuardShield Safety Light Curtain Res 30 mm, protective height 1760 mm, 88 beams	1
2.1	889D-F4AC-5	DC Micro (M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 22 AWG, 5 m (16.4 ft)	1
2.2	889D-F8AB-5	DC Micro (M12), Female, Straight 8-pin, PVC cable, yellow, unshielded, 24 AWG, 5 m (16.4 ft)	1
3	42EF-E1EZB-F4	PHOTOSWITCH Photoelectric Sensor RightSight, transmitted beam, infrared, DC, 4-pin DC micro QD on 152 mm (6 in.) pigtail	4
3.1	889D-F4AC-5	DC Micro(M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 5 m	4
4	42EF-R9KBBV-F4	PHOTOSWITCH Photoelectric Sensor RightSight, transmitted beam receiver, DC - dark operate, both sink (NPN) and source (PNP), 4-pin DC micro QD on 152 mm (6 in.) pigtail	4
4.1	889D-F4AC-5	DC Micro (M12), Female, Straight 4-pin, PVC cable, yellow, unshielded, 22 AWG, 5 m (16.4 ft)	4
5	855T-BPM10C	Control Tower Stack Light Mounting Base 10 cm pole mount, black housing, cap included	1
6	855T-B24TL7	Control Tower Stack Light Black housing, 24V AC/DC full voltage, clear steady LED (socket mount)	1
7	800FM-F1	800F Push Button Metal, flush, white, no legend, standard pack (Qty. 1)	1
8	800F-MX10	Metal Latch Mount 1 N.O. contact(s), 0 N.C. contact(s), standard	1
9	100S-C09EJ304BC	MCS 100S-C Safety Contactor 9 A, 24V DC (with electronic coil), bifurcated contact	2

Safety Rating

The 2-sensor L-type muting meets the performance requirements of Cat 4, PLe per ISO13849-1, SIL CL3 per IEC 62061, and SIL 3 per IEC 61508.

Notes:

Single-wire Safety

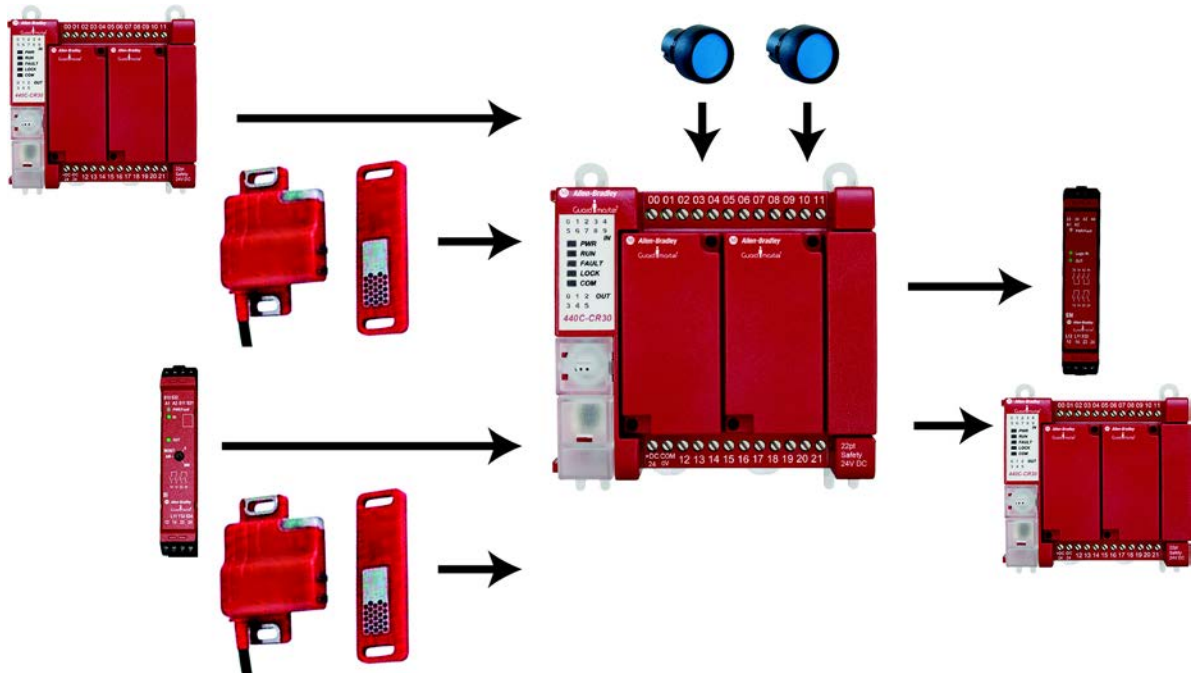
This example application focuses on the single-wire safety (SWS) feature built into the CR30 safety relay. The CR30 safety relay has two input terminals that can be configured to use single wire safety and two output terminals that can be configured to use single wire safety.

Products that have single-wire safety outputs can be connected to the inputs of the CR30 safety relay. This application example shows a CR30 safety relay and SI as the single-wire safety inputs of a CR30 safety relay. On the output side, the CR30 safety relay is driving another CR30 safety relay and an EM relay using the single-wire safety output.

Two SensaGuard™ non-contact switches with integrated latch are included in the example to show that the SWS signals can be incorporated into the logic performed by the CR30 safety relay.

Product Overview

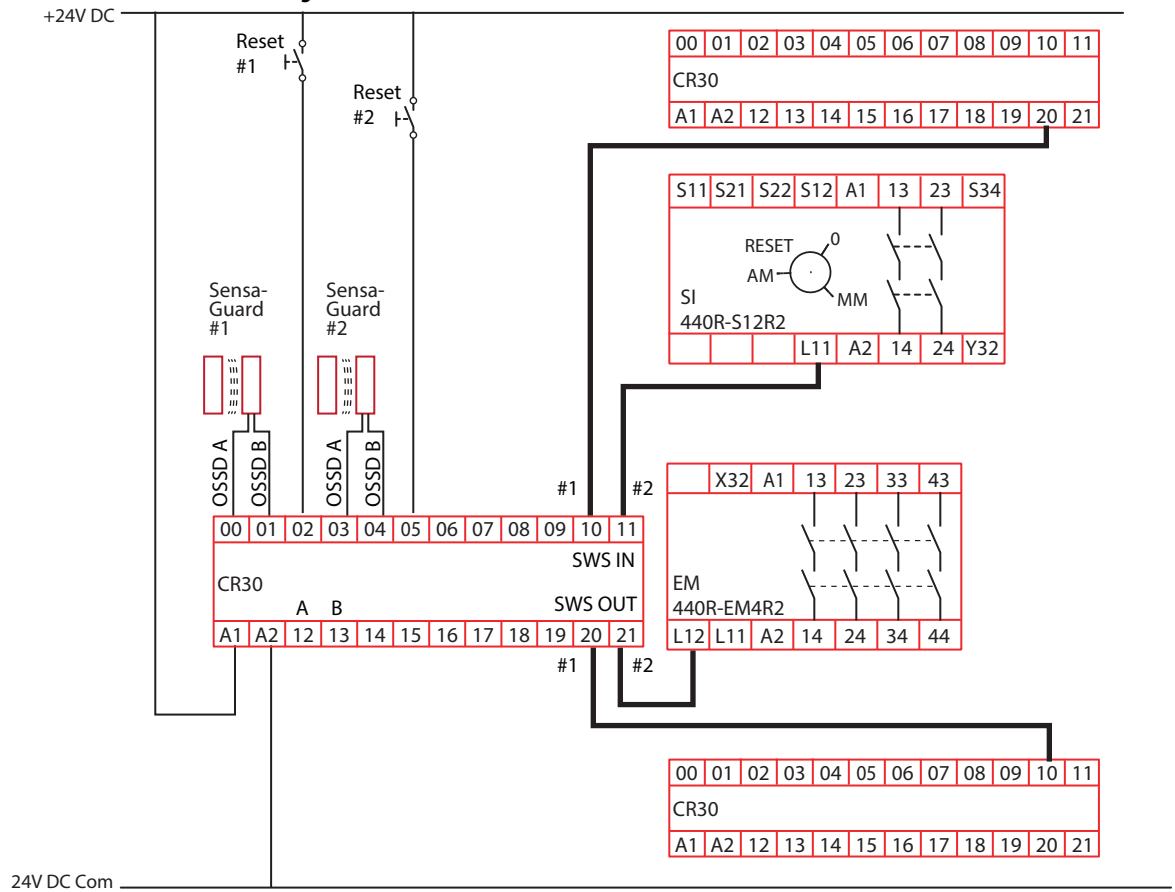
Figure 28 - Overview



Schematic

A partial schematic is shown in [Figure 29](#) to highlight the SWS connections.

Figure 29 - Schematic

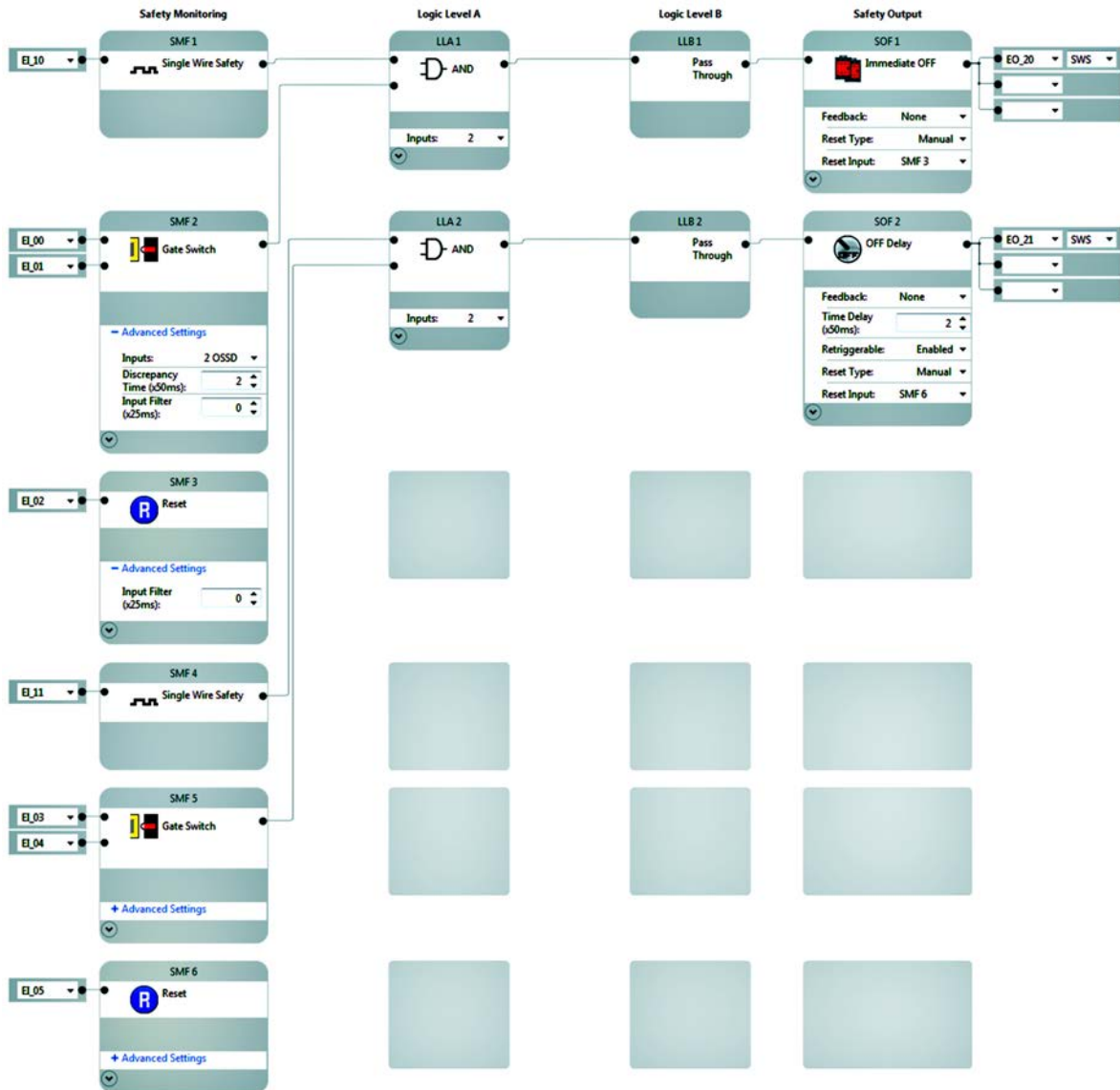


Connected Components Workbench Software

The Connected Components Workbench software shows two safety functions:

- SWS In #1 & Gate #1 → SWS Out #1 (Immediate OFF)
- SWS In #2 & Gate #2 → SWS Out #2 (Delayed OFF)

Figure 30 - Connected Components Workbench Example



Circuit Status

The safety gates are closed and the SWS safety inputs are active.

Operational Sequence

Press Reset #1 to activated SWS output #1 (terminal 20).

Press Reset #2 to activate SWS output #2 (terminal 21).

Deactivating SWS In #1 on terminal 10 or opening Gate #1 turns off SWS output #1.

Deactivating SWS In #2 on terminal 11 or opening Gate #2 turns off SWS output #2.

Example Bill of Materials

Table 13 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	3
2	440R-S12R2	Guardmaster Single-input Safety Relay (SI) 1 dual channel universal input, 1 N.C. solid-state auxiliary outputs	1
3	440R-EM4R2	Guardmaster Expansion Module Safety Relay (EM) Expansion module (single-wire safe is only input), 1 N.C. solid-state auxiliary outputs	1
4	440N-Z21SS2H	SensaGuard Plastic rectangular, 2 x PNP, 0.2 A, max safety output, 6 in. pigtail, 8-pin micro (M12)	2
4.1	889D-F8AB-5	DC Micro (M12), Female, Straight 8-pin, PVC cable, yellow, unshielded, 24 AWG, IEC color coded, no connector, 5 m (16.4 ft)	2
5	800FM-F611MX10	800F Push Button Metal, flush, blue, R, metal latch mount, 1 N.O. contact(s), 0 N.C. contact(s), standard, standard pack (Qty. 1)	2

Safety Rating

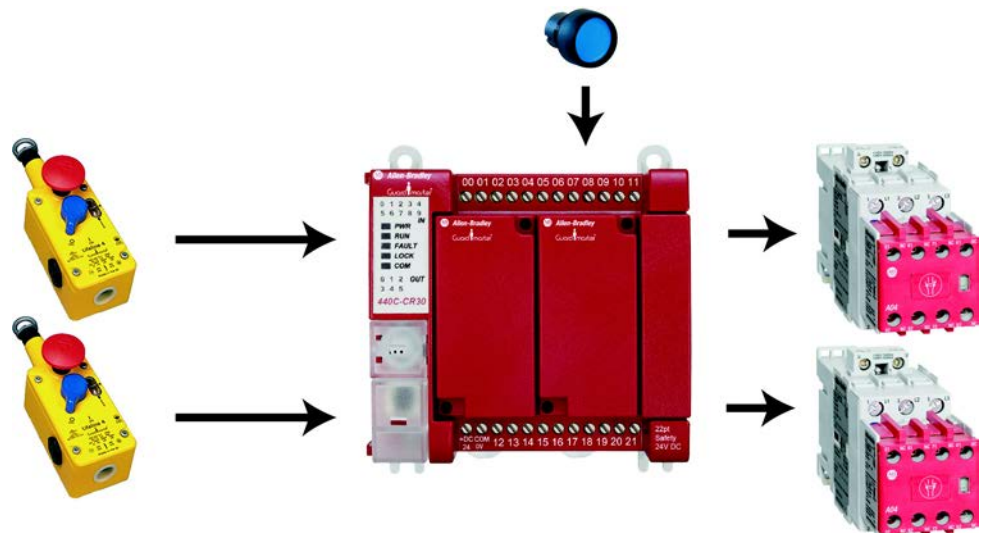
The safety ratings of the two safety functions depend on additional components that are not included in the example. The SWS portion of the circuit can be used in applications up to Cat 4 PLe and SIL3.

Lifeline Cable Pull

Lifeline™ cable pull switches are emergency stop devices with mechanical contacts. The application uses pulse testing to check for potential short-circuits to 24V, ground and across channels. Manual monitored reset prevents the outputs from turning ON when Lifeline switches are reset.

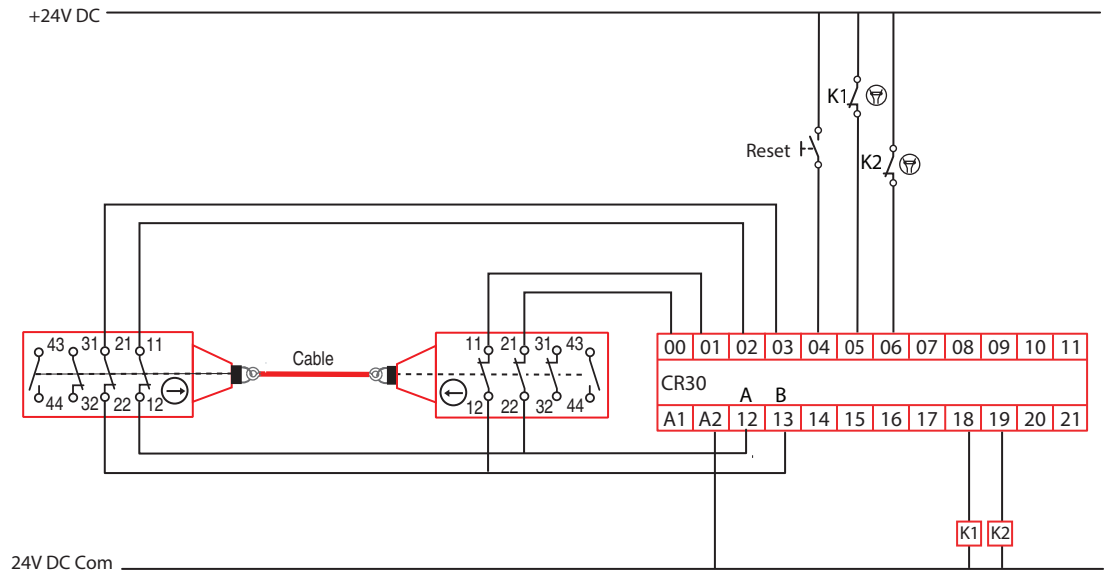
Product Overview

Figure 31 - Overview



Schematic

Figure 32 - Schematic



Connected Components Workbench Software

The Lifeline 4 switches are emergency stop devices. The emergency stop function blocks are ANDed as both must be closed for the Immediate Safety Output to turn ON. When either Lifeline switch opens, the Safety Output turns OFF immediately.

Circuit Status

Both Lifeline switches are closed. The contactors are OFF.

Operational Sequence

Press the reset button to turn both contactors ON. Pull on the cable to turn the contactors OFF.

Example Bill of Materials

Table 14 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	440E-L13043	440E Emergency Stop Device	
2.1	440E-A13085	Installation Kit 75 m	
3	440E-L13043	440E Emergency Stop Device	
4	800FM-F611MX10	800F Push Button Metal, flush, blue, R, metal latch mount, 1 N.O. contact(s), 0 N.C. contact(s), standard, standard pack (Qty. 1)	
5	100S-C09EJ23BC	MCS 100S-C Safety Contactor 9 A, 24V DC (with electronic coil), bifurcated contact	

Safety Rating

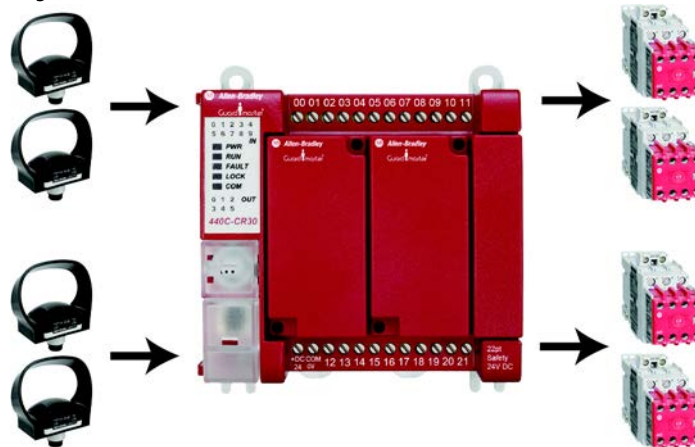
The safety rating that is initiated by either cable pull switch meets the requirements of Cat 4 PLe and SIL3.

Two-hand Control

This application example shows the setup for two separate 2-hand controls each that meets ISO 13851 Type IIIC. One uses mechanical outputs, and the other uses OSSD outputs. Each of the 800Z Zero-Force Touch Buttons™ has a normally open and normally closed contact. The two systems operate independently of each other.

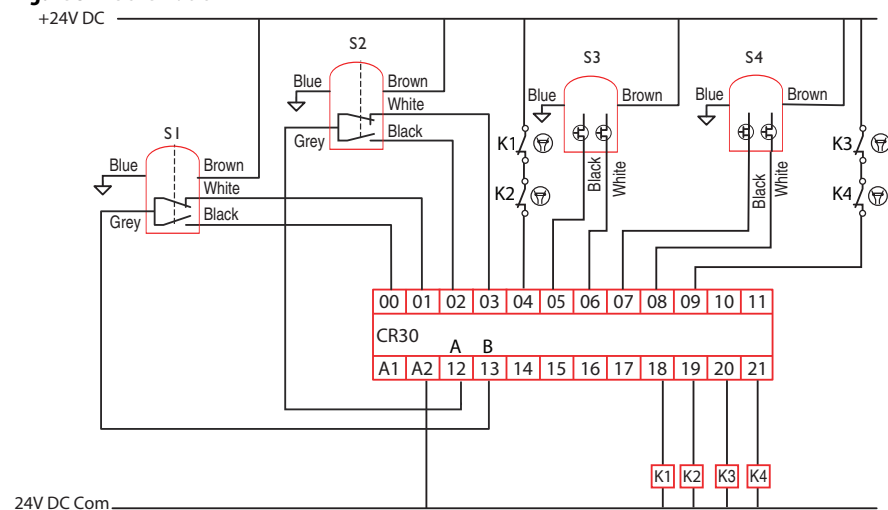
Product Overview

Figure 33 - Overview



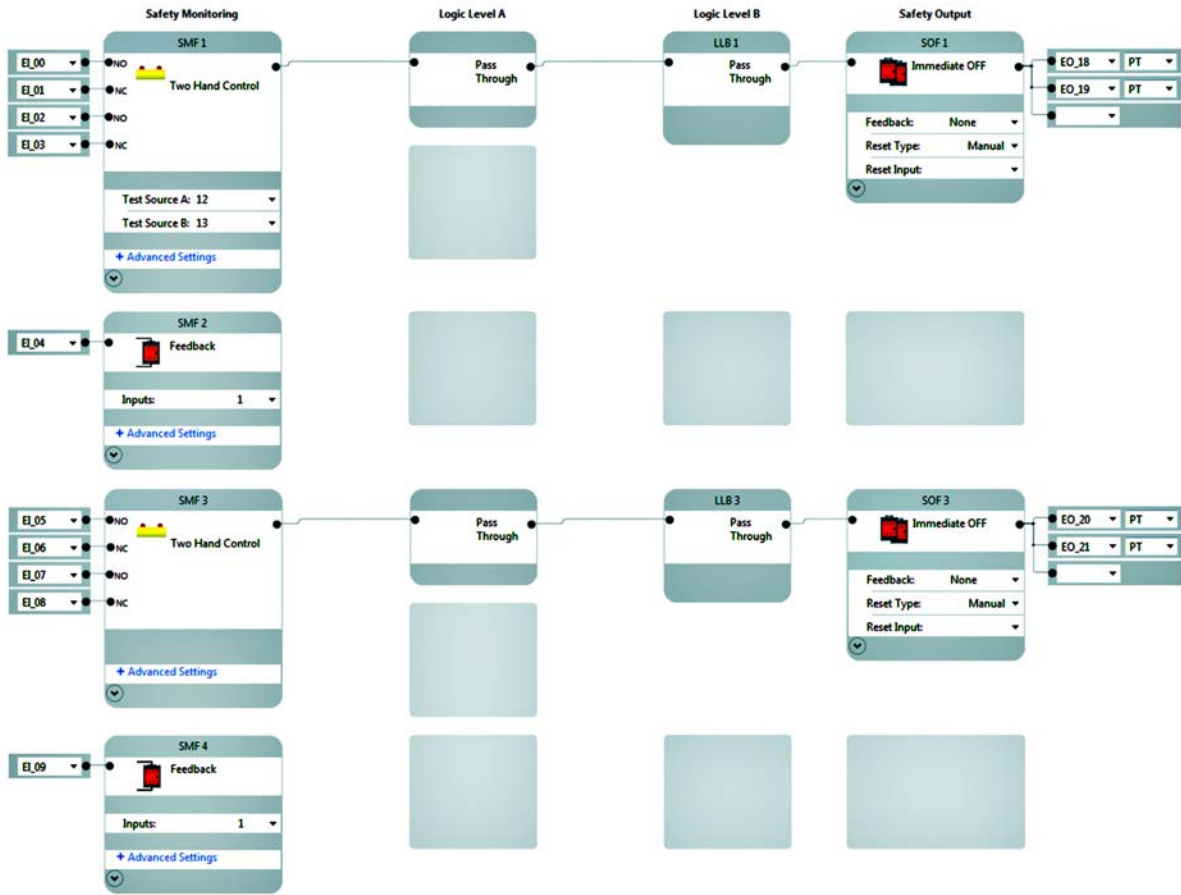
Schematic

Figure 34 - Schematic



Connected Components Workbench Software

Figure 35 - Connected Components Workbench Example



Circuit Status

In both circuits, there are no hands on the buttons. All four output contactors are off.

Operational Sequence

The two circuits work independently.

You must simultaneously press S1 and S2 (or S3 and S4) to turn on contactors K1 and K2 (or K3 and K4), where simultaneously means within a half second of each other. You must maintain their hands on both buttons to maintain the contactors in the ON state. Removing your hands from either button causes the contactors to turn OFF.

Example Bill of Materials

Table 15 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	800Z-GL3Q5	30.5 mm Type 4/4X/13 IP66 Zero-Force Momentary General Purpose Touch Button 10...40V DC and 20...30V AC input, relay output - 5-pin QD	
2.1	800Z-G3AH1	Plastic Mounting Kit For 30.5 mm holes, (GP)	
2.2	889N-F5AE-12F	5-Pin Straight QD Cable 30.5 mm mounting hole, 12 ft length	
3	800Z-G3AG2	Guard Black, 22.5 mm/30.5 mm mounting, (GP)	
4	800Z-GP3Q4	30.5 mm Type 4/4X/13 IP66 Zero-Force Momentary General Purpose Touch Button 10...30V DC, PNP (sourcing output), 4-pin QD	
4.1	800Z-G3AH1	Plastic Mounting Kit For 30.5 mm holes, (GP)	
4.2	889D-F4AE-5	4-Pin Straight QD Micro Cable 30.5 mm mounting hole, 12 ft length	
5	100S-C09EJ23BC	MCS 100S-C Safety Contactor 9 A, 24V DC (with electronic coil), bifurcated contact	

Safety Rating

Although the wiring is a little different, both 2-hand control systems meet ISO13851 Type IIIC.

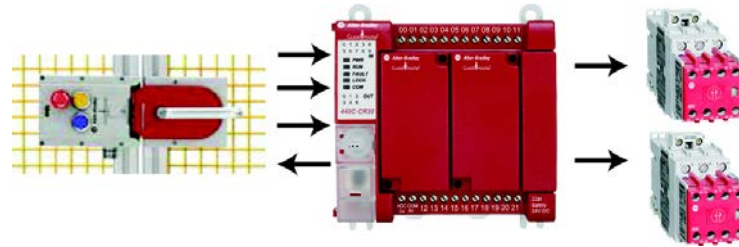
Notes:

Multifunction Access Box

This application example shows the setup of a multifunction access box (MAB). The MAB is a guardlocking interlock with additional features to facilitate access to a hazard area. In this example, you press a button to request access. The safety system shuts down the hazard and then unlocks the door. The operator is then allowed to enter the hazard area. Upon exiting the hazard area, the operator closes the gate and presses a button to reset the safety system.

Product Overview

Figure 36 - Overview



The MAB has an E-stop button and two illuminated push buttons.

The E-stop button can be used to initiate a Stop Category 0.

The yellow unlock button must be pressed to unlock the gate. Since the buttons on the MAB are momentary, an off-delay function block (SOF3) powers the unlock solenoid for fixed duration. In this example, the duration is 4 seconds and then relocks the gate. The 4 second duration can be changed in the function block.

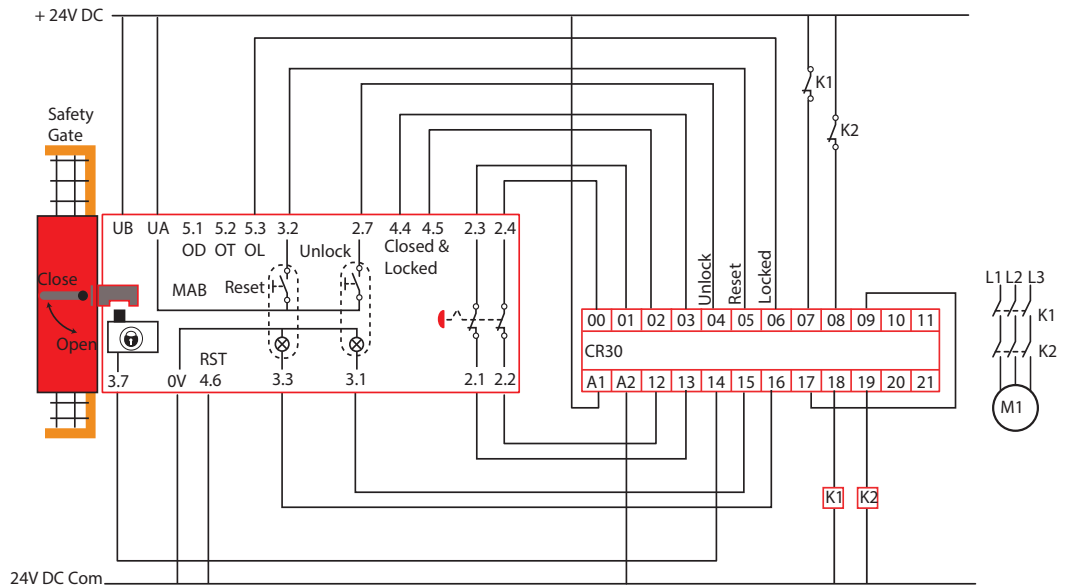
The yellow unlock indicator turns ON and remains ON while the unlock command is given (in this example, for 4 seconds) so you know that the gate can be opened during this time.

A blue reset indicator informs you that the safety system is ready to be turned ON.

When the blue reset indicator turns ON, the button must be pressed and released to turn the contactors ON.

Schematic

Figure 37 - Schematic



The signal from MP17 is fed back into the CR30 safety relay at terminal 9. This signal is used as part of the logic to turn on the reset indicator. We want the reset indicator to turn ON when the contactors are OFF.

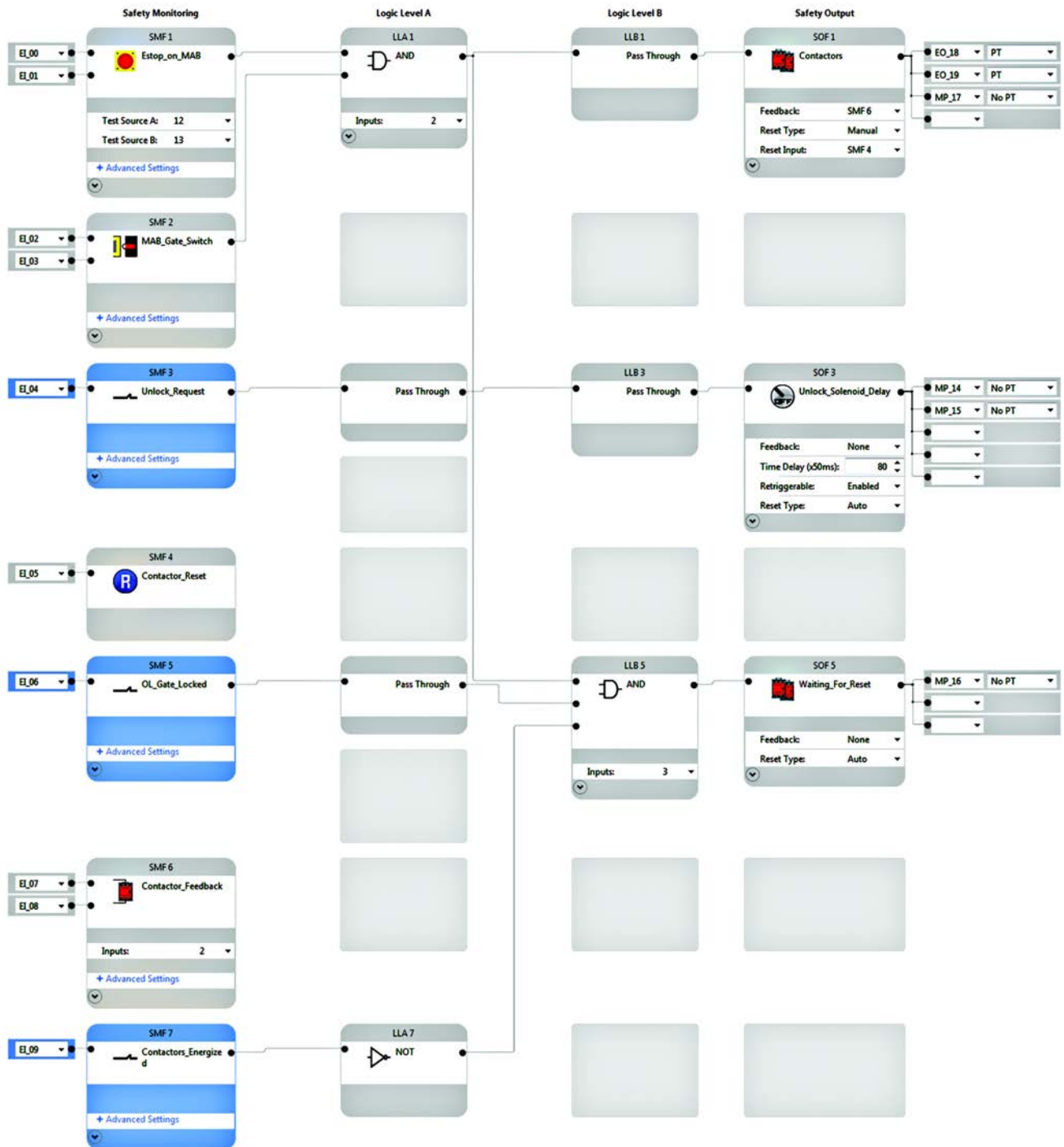
This application note assumes that the MAB lock module has been taught to recognize its handle assembly.

The MAB internal switch settings are:

1. ON
2. ON
3. OFF
4. OFF
5. OFF
6. ON

Connected Components Workbench Software

Figure 38 - Connected Components Workbench Example



Circuit Status

The gate is closed and locked. The E-stop is released. The 100S contactors are de-energized, and the motor is OFF. On the MAB, the reset indicator is ON, which indicates that the reset button must be pressed.

Operational Sequence

1. Press the reset button.
The contactors turn ON, and the reset indicator turns OFF.
2. Press the E-stop.
The contactors turn OFF.
3. Release the E-stop.
The reset indicator turns ON.
4. Press the reset button.
The contactors turn back ON.
5. Press the unlock button.
The contactors turn OFF, the unlock indicator turns ON, and the gate is unlocked.
6. Rotate the gate handle and open the gate, while the indicator is ON.
If you wait until the indicator turns OFF, the gate locks. Press the unlock button again to unlock the gate.
7. Close the gate and rotate the handle back to the locked position.
As soon as the handle is in position, the gate becomes locked, and the reset indicator turns ON.

Example Bill of Materials

Table 16 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	442G-MABH-R	Handle Assembly 442G access box, right-hinged door, with bolt locking mechanism	1
3	442G-MABR-UTC03	Lock Module 442G access box, power-to-release, unique code, M20 conduit, E-stop, 2 push buttons	1
4	442G-MABE1	Escape Release 442G-MAB, standard shaft	1
5	100S-C43QJ14BC	100S-C Safety Contactor 43 A, 24V DC (with electronic coil), bifurcated contact, fast drop out time	2

Safety Rating

The safety ratings of the guardlocking function is PLe, Cat 4 for interlocking and guard lock monitoring per ISO13849-1:2008.

Dynamic Feedback

This application example shows how to configure the CR30 safety relay to monitor the feedback contact of an output device dynamically.

With safety rated relays and contactors, the normally closed feedback contacts are either positively guided, mechanically linked, or mirrored. These features are designed to help ensure that the normally closed contact moves with the normally open contacts. If the safety rated relay or contactor were to weld or get stuck in the closed position, the normally closed contact would remain open. If open, then the safety system would not turn the outputs ON.

The process that is described in the previous paragraph does not detect wiring shorts across the normally closed contacts, and some devices do not have mechanically linked contacts.

The application note shows how to monitor one or more feedback contacts dynamically. If any one of the feedback contacts does not open (or is shorted to 24), and the output device is energized; the CR30 safety relay turns off all output devices.

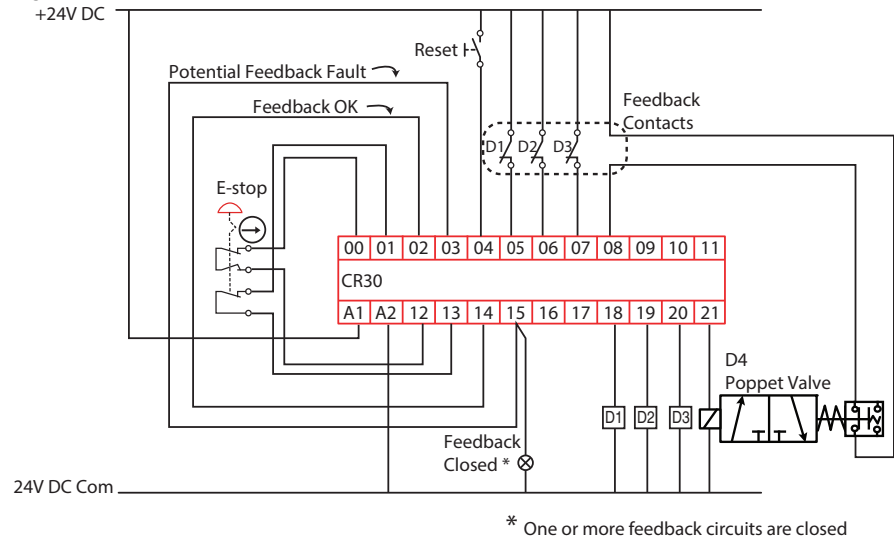
Product Overview

Figure 39 - Overview



Schematic

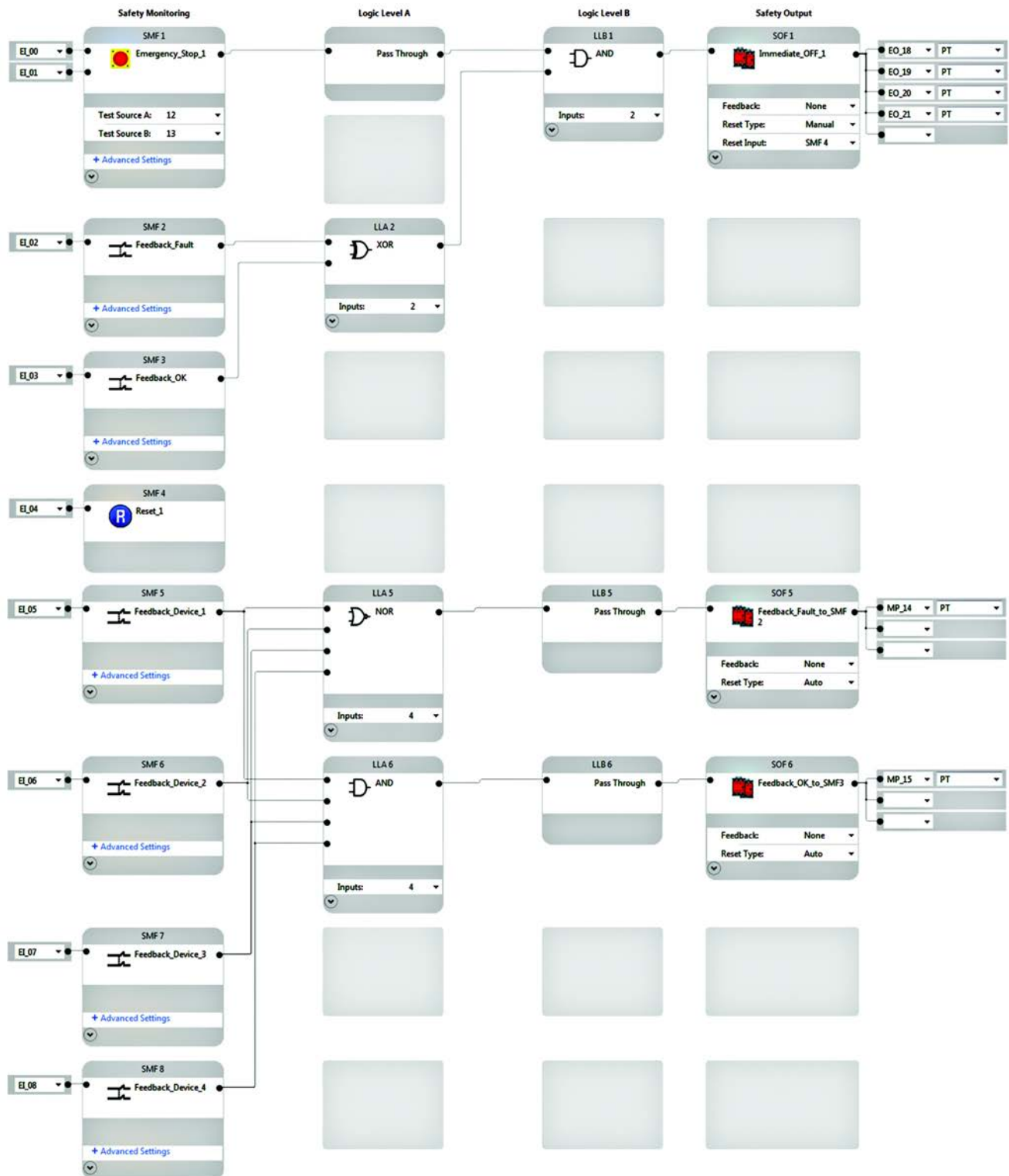
Figure 40 - Schematic



The feedback indicator is ON when the E-stop is pressed and the outputs (D1...D4) are OFF. When the E-stop is released and the reset button is pressed, this indicator turns OFF unless one or more of the feedback contacts are shorted.

Connected Components Workbench Software

Figure 41 - Connected Components Workbench Example



Circuit Status

The E-stop is released and all output devices (D1...D4) are OFF. The Feedback Closed indicator is ON.

Operational Sequence

1. Press the Reset button.
All four output devices D1...D4 turn ON and the Feedback Closed indicator turns OFF.
2. Press the E-stop button.
All four output devices D1...D4 turn OFF and the Feedback Closed indicator turns ON.

With a short circuit across one of the output device contacts:

1. Press the Reset button.
All four output devices D1...D4 turn ON and the Feedback Closed indicator remains ON. After approximately 50 ms, the output devices D1...D4 turn OFF and the Feedback Closed indicator remains ON.

Each time the reset button is pressed, the output turns ON momentarily and then turns OFF. The CR30 safety relay detects the short circuit with the XOR logic in the LL2A function block. This block allows either the Feedback_OK or Feedback_Fault to turn on the output devices, but not both signals.

Example Bill of Materials

Table 17 - Bill of Materials

Item	Product	Description	Qty
1	440C-CR30-22BBB	Guardmaster 440C-CR30 Software Configured Safety Relay PLe SIL 3, 22 Safety I/O, embedded serial port, USB programming port, 2 plug-in slots, 24V DC	1
2	800FM-MT44	800F Non-illuminated Mushroom Operators Twist-to-release, 40 mm, round metal (Type 4/13, IP66), red, standard pack (Qty. 1)	1
2.1	800F-ALM	Metal Latch	1
2.2	800F-X01S	Screw Contact Block 1 N.C. self-monitoring	1
2.3	800F-X01	Screw Contact Block 1 N.C.	1
3	800FM-F611MX10	800F Push Button Metal, flush, blue, R, metal latch mount, 1 N.O. contact, 0 N.C. contacts, standard, standard pack (Qty. 1)	1
4	TBD	Customer-specified Output Device	4

Safety Rating

Depending on how the output devices are connected, this application can meet Cat 1, Cat 3, or Cat 4 per ISO13849-1.

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