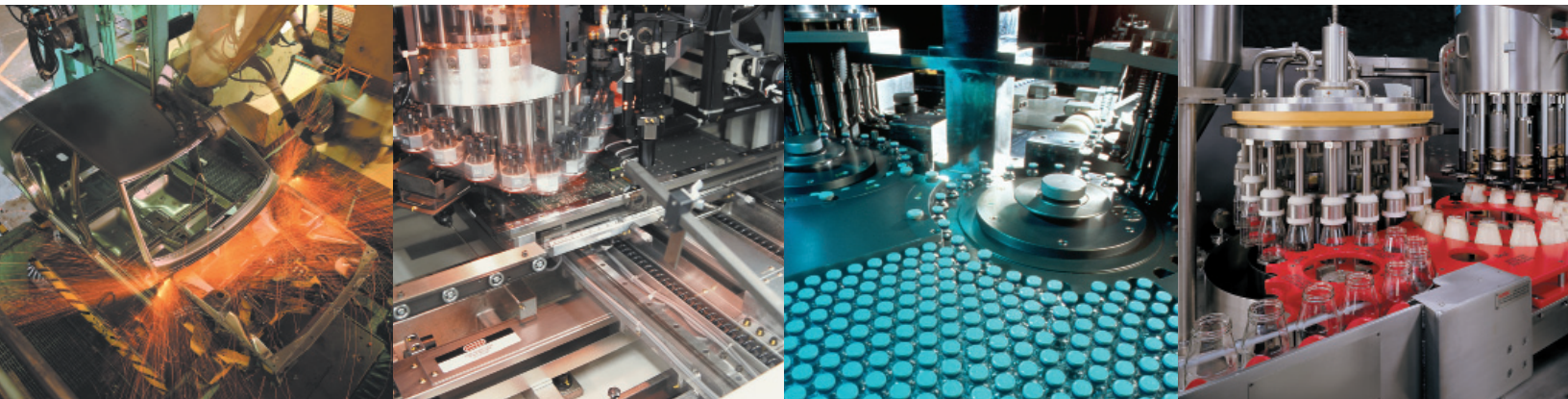


## Safety Exhaust Valve Integration Guide

FRL-SIF-625



the total systems approach to air preparation

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## Integration Guide

### Wilkerson E28/Q28 Safety Exhaust Valve

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# Integration Guide - Introduction

## Introduction

Wilkerson offers a variety of safety valves for use in various safety functions such as safe exhaust, safe cylinder, return, and safe load holding/stop. This document focuses specifically on valves that use sensors to provide feedback to a safety control system for external monitoring.

While all potential electrical safety control suppliers and solutions cannot be covered this document provides a template for the most common suppliers and their devices.

Each solution has been designed to meet a specific category and performance level based on ISO 13849. Meeting this levels requires other aspects of the system meet these requirements such as but not limited to plumbing, wiring, and pulse testing.

## Pulse Testing

In dual channel safety circuits, pulse testing is a method utilized to detect short circuit conditions that, without pulse testing, can mask other fault conditions. Pulse testing is required in dual channel circuits in order to reach performance level e (PL e). Pulse testing of the solenoids is encouraged and will not affect the performance of the Wilkerson valves. However, pulse testing of feedback sensors is not required.

Wiring examples are provided in this document and are shown using specific connections as wired and tested, but there may be other terminals available to use on the various controllers. These are just examples.

This integration guide is intended to assist you in integrating the product into your control circuit however; programs provided in this integration guide are for reference only. These programs have not been certified or tested unless indicated otherwise.

# Integration Guide for Exhaust Rates

## Exhaust Times and Faulted Flow Rates

When designing a safety circuit, the machine stopping time is critical to the placement of guarding equipment – safe distance. One factor in safe distance calculations is the exhaust time of the valve that is responsible for isolating and dumping the pneumatic energy from the machine. The faster your valve exhausts the quicker the machine can stop and the closer your safety devices may be placed to the hazardous area. This can improve the overall operating efficiency, and possibly allow the footprint of the machine to be smaller.

Even more important than exhaust times is the “Faulted exhaust flow rate”. Faulted exhaust flow rate is the exhaust rate of the valve in its worst state. Double valves (redundant valve systems used for safety applications) will not exhaust quite as quickly when there is an internal fault condition in the valve such as when one of the redundant valve components is actuated and the other one is not actuated. For this reason, double valves used in safety circuits should always be sized using faulted flow rates as the worst case condition.

The chart below shows Wilkerson’s very high flowing faulted exhaust flow times.

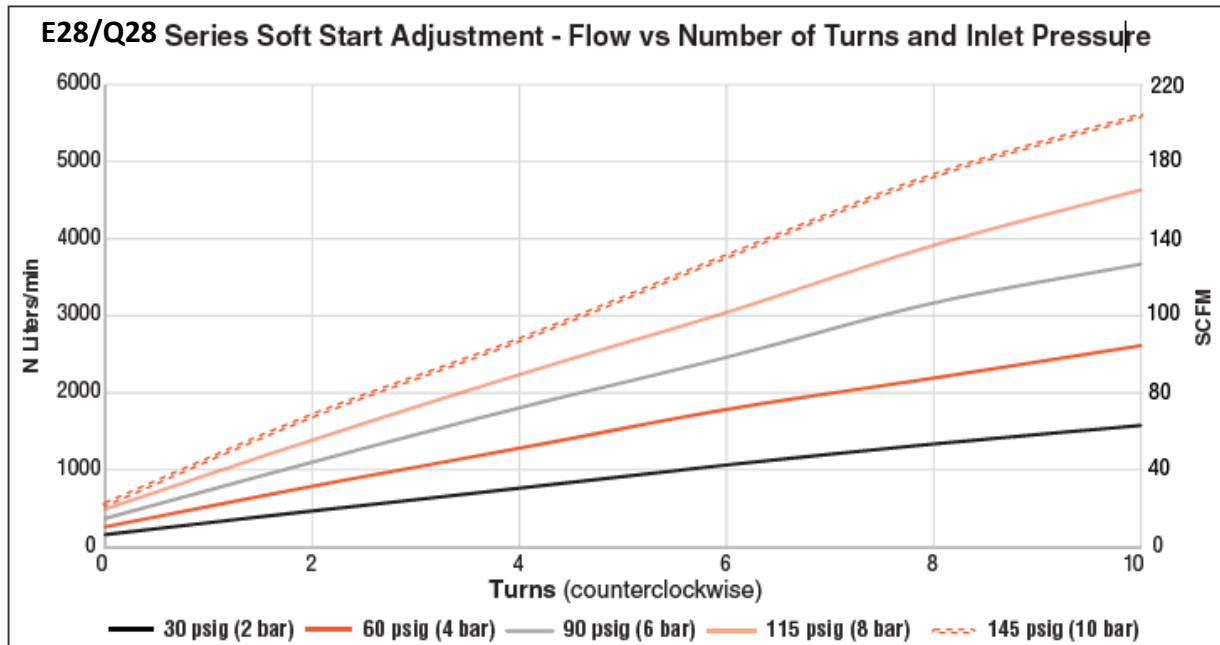
Exhaust Time - Normal and Faulted Conditions (s)							
Volume ft <sup>3</sup> (L)	Normal or Faulted	Operating Pressure					
		30 psig (2 bar)		90 psig (6 bar)		145 psig (10 bar)	
		to 15 psig (1 bar)	to 7psig (0.5 bar)	to 15 psig (1 bar)	to 7psig (0.5 bar)	to 15 psig (1 bar)	to 7psig (0.5 bar)
0.071 (2)	N	0.05	0.07	0.09	0.11	0.12	0.14
	(F)	0.07	0.10	0.15	0.18	0.20	0.25
0.035 (10)	N	0.13	0.21	0.32	0.39	0.42	0.51
	(F)	0.18	0.30	0.53	0.71	0.79	1.02
0.071 (20)	N	0.23	0.38	0.60	0.75	0.80	0.97
	(F)	0.33	0.56	1.02	1.37	1.53	2.00
1.41 (40)	N	0.42	0.72	1.16	1.45	1.56	1.90
	(F)	0.61	1.06	1.98	2.69	3.00	3.94
5.30 (150)	N	1.46	2.60	4.23	5.33	5.74	7.01
	(F)	2.16	3.86	7.30	9.93	11.11	14.63

# Integration Guide for Soft Start Adjustment

## Introduction

The function of the optional soft start module is to, on energization, allow outlet pressure to increase at a slower than normal rate until it reaches approximately 60% of inlet pressure, at which point the valve will then open fully to finish filling the system at full flow rate. This feature can be used to lessen the shock of sudden, rapid pressurization of cylinders, and to gradually refill the system.

The soft start module has an adjusting screw that is used to control the rate of pressurization according to number of turns and inlet pressure. The charts below can be used to approximate the number of turns (clockwise from full open) it will take in order to adjust the soft start for your system. The necessary setting is dependent upon the number of turns, inlet pressure, and downstream volume to be filled by the valve.



# Integration Guide for Soft Start Adjustment

## Soft Start Adjustment Guide (Turns Versus Input Pressure)

Measured in Nominal L/Min

Turns	2 bar	4 bar	6 bar	8 bar	10 bar
0	158.28	259.37	366.97	487.88	551.31
2	464.94	785.48	1098.37	1384.93	1700.37
4	759.43	1279.03	1803.72	2235.83	2687.18
6	1061.56	1782.77	2459.81	3042.83	3771.69
8	1333.68	2190.80	3165.72	3913.27	4820.51
10	1574.93	2611.30	3669.18	4633.06	5597.50
Full Open	1594.47	2665.10	3769.70	4897.81	5833.94

Measured in SCFM

Turns	29 PSI	58 PSI	87 PSI	116 PSI	145 PSI
0	5.59	9.16	12.96	17.23	19.47
2	16.42	27.74	38.79	48.91	60.05
4	26.82	45.17	63.70	78.96	94.90
6	37.49	62.96	86.87	107.46	133.20
8	47.10	77.37	111.80	138.20	170.24
10	55.62	92.22	129.58	163.62	197.68
Full Open	56.31	94.12	133.13	172.97	206.03



# Integration Guide for Pressure Sensors & Gauges

## Gauge Port Details

Safety Valves are available in BSPP or NPT threads. The thread selected for porting will be the threads used for the gauge port.

- BSPP = 1/8" BSPP gauge port
- NPT = 1/8" gauge port

The safety valve can be ordered with 4 gauge options:

## Ordering Information

<b>E28</b>	-	<b>0</b>	-	<b>6</b>	-	<b>A</b>	<b>A</b>	<b>N</b>																																										
<table border="1"> <tr><td>Series</td><td></td></tr> <tr><td>Safety redundant with soft start</td><td>E28</td></tr> <tr><td>Safety redundant no soft start</td><td>Q28</td></tr> </table>	Series		Safety redundant with soft start	E28	Safety redundant no soft start	Q28		<table border="1"> <tr><td>Thread type</td><td></td></tr> <tr><td>NPT</td><td>0</td></tr> <tr><td>BSPP</td><td>C</td></tr> </table>	Thread type		NPT	0	BSPP	C		<table border="1"> <tr><td>Port size</td><td></td></tr> <tr><td>3/4"</td><td>6</td></tr> </table>	Port size		3/4"	6		<table border="1"> <tr><td>Output for Solenoid, M12 Connector Pin</td><td></td></tr> <tr><td>A</td><td>2 &amp; 4, common 3</td></tr> <tr><td>C</td><td>3 &amp; 4</td></tr> <tr><td>D</td><td>2 &amp; 4</td></tr> </table>	Output for Solenoid, M12 Connector Pin		A	2 & 4, common 3	C	3 & 4	D	2 & 4	<table border="1"> <tr><td>Output for Sensors, M12 Connector Pin</td><td></td></tr> <tr><td>A</td><td>1 &amp; 2, 1 &amp; 4, common 3</td></tr> <tr><td>B</td><td>1 &amp; 2, 5 &amp; 4, common 3</td></tr> <tr><td>C</td><td>5 &amp; 2, 1 &amp; 4, common 3</td></tr> </table>	Output for Sensors, M12 Connector Pin		A	1 & 2, 1 & 4, common 3	B	1 & 2, 5 & 4, common 3	C	5 & 2, 1 & 4, common 3	<table border="1"> <tr><td>Gauge *</td><td></td></tr> <tr><td>N</td><td>No gauge</td></tr> <tr><td>G</td><td>Dial gauge (standard)</td></tr> <tr><td>D</td><td>Digital gauge **</td></tr> <tr><td>M</td><td>MPS -P34 Gauge</td></tr> </table>	Gauge *		N	No gauge	G	Dial gauge (standard)	D	Digital gauge **	M	MPS -P34 Gauge
Series																																																		
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C	5 & 2, 1 & 4, common 3																																																	
Gauge *																																																		
N	No gauge																																																	
G	Dial gauge (standard)																																																	
D	Digital gauge **																																																	
M	MPS -P34 Gauge																																																	

Notes:  
 \* Gauges shipped loose.  
 \*\* Digital gauge not available on BSPP version.  
 Note: Mounting hardware sold separately.  
 See offer of sale: [www.parker.com/offerofofsale](http://www.parker.com/offerofofsale)

1. No gauge

2. Dial gauge

3. Digital gauge (NPT only)

4. Pressure Sensor



# Integration Guide for Pressure Sensors & Gauges

## Shipment of Product

The safety valve will be supplied with a plug inserted into the casting as shown. Gauge options ship with unit unassembled.



If the “G” Dial Gauge is ordered, part# K4515N18160 will ship with the safety valve.



If the “D” Digital Gauge (K4517N14160D) option is ordered, an adapter (part# 222P-4-2) is also provided to connect 1/8” port to 1/4” gauge.



+



(Not to scale)



# Integration Guide for Pressure Sensors & Gauges

## Pressure Sensor Option

The safety valve is available with option pressure sensor MPS-P34. The pressure sensor MPS-P34N-PCI is 1/8" NPT male with M8 Male electrical connection and mates directly to the valve.

### Features

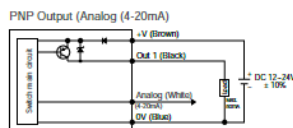
- Sensor output:
  - PNP Open collector
  - Transistor output, 30VDC, 125mA with
  - Analog output, 4 to 20mA
- Output response time less than 2.0 milliseconds
- RoHS
- Air and non-corrosive gases
- Sensor face includes icons to show sensor programming status



### MPS-34 Sensor Only Ordering Numbers

Pressure range	Electrical output	Electrical connection	Part number	
			1/8 NPSF male	1/8 BSPP male
0-145 PSI	(1) PNP with (1) 4-20ma	M8, 4 Pin	<b>MPS-P34N-PCI</b>	<b>MPS-P34G-PCI</b>

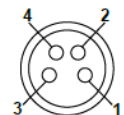
### Internal circuit for open collector and analog output wiring



### Sensor pin out with analog output

#### Pin #

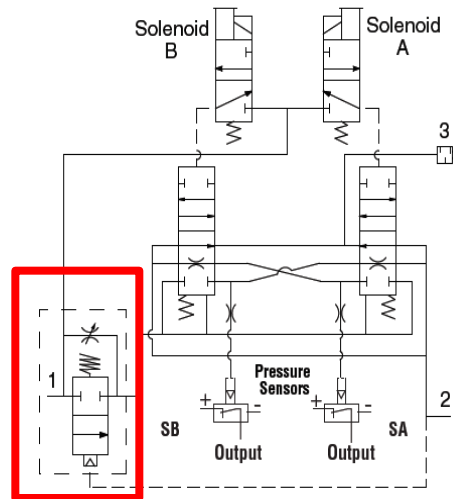
- 1 Brown: 24VDC
- 2 White: 4 to 20mA
- 3 Blue: 0VDC
- 4 Black: PNP Open Collector Output 1



# Integration Guide for General Operation & LED Status

## General Operation Guide (Schematics)

The Wilkerson E28/Q28 schematic shows patented cross flow technology. Solid state pressure sensors are used in this design (in place of mechanical switches). The red box highlights the optional soft start in the unit.

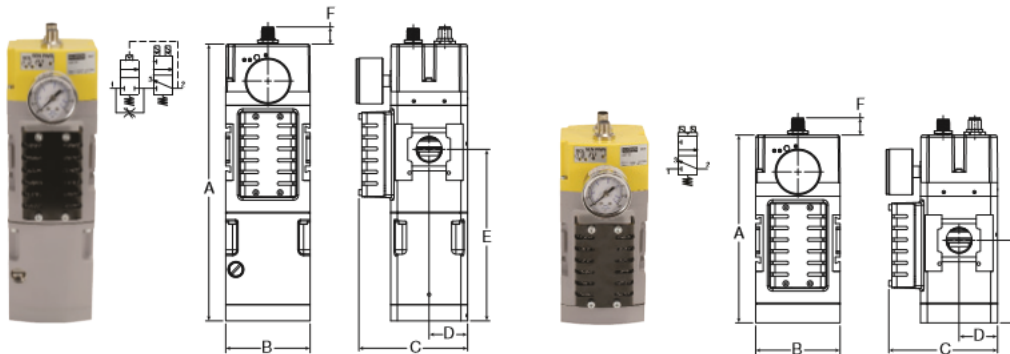


## General Operation Guide (Dimensions)

Standard nominal flow rate is based on 6 bar input pressure with  $\Delta P = 1$  bar

### Externally Monitored (with Soft Start) E28

### Externally Monitored (No Soft Start) Q28



### Dimensions

Ports	Standard nominal flow rate		A	B	C	D	E	F	
	1 → 2 L/min (SCFM)	2 → 3 L/min (SCFM)							
Externally Monitored with soft start E28	3/4"	4,100 (145)	7,500 (265)	10.31 (261.9)	3.15 (80)	4.30 (109.3)	1.44 (36.5)	6.39 (162.3)	0.64 (16.3)
Externally Monitored no soft start Q28	3/4"	4,300 (152)	7,500 (265)	7.03 (178.7)	3.15 (80)	4.30 (109.3)	1.44 (36.5)	3.11 (79.0)	0.64 (16.3)

# Integration Guide for General Operation & LED Status

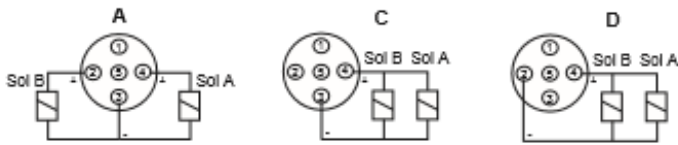
## General Operation Guide (Wiring)

The E28/Q28 valve is available with various wiring options for both the solenoid cable and the sensor cable. For example, the following model number is wired internally with the DB wiring option:

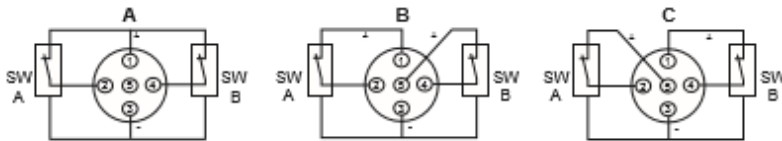
Model Number: E2806DBN

This means the valve in this example is wired with the D solenoid configuration and the B Sensor configuration. Use these diagrams to determine the proper pinouts for your valve.

### Solenoid M12 Pinouts



### Pressure Sensor M12 Pinouts



# Integration Guide for General Operation & LED Status

## General Operation Guide (Technical)

### General Technical Data

Valve type	Externally monitored, redundant, dual poppet
Soft start	Optional (E28 version)
Valve function	3/2 way, normally closed
Housing material	Cast aluminum
Seals	NBR
Fasteners	Stainless steel / brass
Silencer	Steel, non clog safety design
Weight lbs (kg)	6.5 (2.9) with soft start 4.2 (1.9) without soft start

In accordance with EN ISO 13849-1 this safety valve is suitable for use up to Category 4, Plc, sil 3. (Certification Pending)

### Specifications

Operating pressure PSIG (bar)	30 to 150 PSIG (2 to 10 bar)
Minimum operating pressure PSIG (bar)	30 PSIG (2 bar)
Ambient temperature °F (°C)	40° to 120°F (4° to 50°C)
Recommended filtration (μ)	40μ

The soft start opens to full flow at approximately 60% of input pressure.

### Electrical Specifications

Operating voltage	24V DC
Electrical connection	Two M12 connectors
Switching time 1-2 (ms)	23.3
Switching time 2-3 (ms)	42.7
Duty cycle (%)	100%
Operating voltage (DC)	21.6 to 26.4
Nominal power	
per solenoid coil at 24V DC (W) +/- 10%	1.2 W
per pressure sensor at 24V DC	1.2 W

Operating medium	Compressed air
Ingress protection class	IP65
B10 (mio)	10 million switching cycles
B10 <sub>d</sub> (mio)	20 million switching cycles
Allowable discordance	150ms

# Integration Guide for General Operation & LED Status

## General Operation Guide (LED Status Lights)

### FAULT (FLT):

**Flashing Red:** Sensors are in different States. The E28/Q28 unit will automatically fail to a mechanical safe state (no downstream pressure). The monitoring logic should automatically shut off power to both solenoids.

- If FLT light is flashing and either or both solenoid lights are ON it indicates the monitoring logic is not properly detecting this fault. The E28/Q28 unit should be powered down and monitoring logic reviewed and re-tested before putting into operation again.
- If FLT light is flashing and both solenoid lights are OFF it indicates the unit has an internal malfunction and should be replaced before continuing operation.

**OFF:** Sensors are in the same state – no issue.

### Solenoid Power (SOL 1/2):

**Green :** Power is properly applied to solenoid 1 and/or solenoid 2.

**OFF :** No power is applied to the solenoids. Check connection from Solenoid M12 to output device



### Sensor Power (SEN PWR):

**Green :** Power is properly applied to the sensors

**OFF :** No power to the sensors. Check connection from Sensor M12 to input device

# Integration Guide for Operation

## Operation & Monitoring Requirements

The intent of this document is to provide guidance on how to operate and monitor the E28/Q28 valve for safe operation. A test procedure is also provided for verification and validation of the user's external safety control monitoring system.

## Valve Operation

The E28/Q28 valve is a redundant safety exhaust (dump) valve. Its function is that of a 3/2, normally closed, single-solenoid valve. However, because the valve is redundant it has two operating solenoids that must be operated simultaneously in order to actuate the valve.

Actuating the valve will supply pressure from port 1 (supply) to port 2 (outlet) and close port 3 (exhaust).

De-actuating the valve will close port 1 (supply) and open port 2 (outlet) to port 3 (exhaust). De-actuation of the valve is accomplished by turning off both solenoids simultaneously.

## Valve Operation – Faulted Condition

In the event of a valve fault where one of the redundant valve components does not operate synchronously as commanded, the valve will perform its safety function which is to shut off supply and exhaust downstream pressure to atmosphere.

Synchronous operation occurs when both sets of valve internals shift within 150 msec of each other.

Failure of the valve to shift synchronously leads to a fault in the P33 valve. This could happen for a variety of reasons, such as:

- Defective piston seals
- Main valve elements experiencing a switching delay due to dirt, debris or resinous oil
- Insufficient electrical signals to valve solenoids; suitable voltage not available
- Receipt of signals at solenoids not synchronous
- Pilot valves experiencing a switching delay due to damaged components, dirt, debris or resinous oil
- Excessive water build-up in the valve

# Integration Guide for Monitoring Logic

## Monitoring of the Valve

The E28/Q28 valve is equipped with feedback pressure sensors that must be monitored by the user's external safety control monitoring system to detect any fault condition within the valve. Sensor feedback should always agree with the solenoid actuating signals.

Detection of any valve fault should disable the safety control outputs to the valve solenoids and prevent any subsequent attempts to actuate the valve until a safety control system reset is performed.

Refer to EN ISO13849-1 for cat 3 vs cat 4 monitoring.

**Automatic RESET is not recommended by WILKERSON**

## Actuation Fault Monitoring

Actuation fault monitoring should check for valve actuation synchronicity. After the safety control system outputs provide simultaneous actuation signals to both solenoids, both sensor outputs should switch off within 150 msec of each other. Dependent upon which sensor switches off first, the following faults should be detected.

1. "A" side fault detection – if sensor A does not switch off within 150 msec after sensor B switches off, this should be registered as a fault.
2. "B" side fault detection – if sensor B does not switch off within 150 msec after sensor A switches off, this should be registered as a fault.

## De-Actuation Fault Monitoring

De-Actuation fault monitoring should check for valve de-actuation synchronicity. After the safety control system simultaneously remove the actuation signals from both solenoids, both sensor outputs should switch on within 150 msec of each other. Dependent upon which sensor switches on first, the following faults should be detected.

1. "A" side fault detection - sensor A does not switch on within 150 msec after sensor B switches on, this should be registered as a fault.
2. "B" side fault detection – if sensor B does not switch on within 150 msec after sensor A switches on, this should be registered as a fault.



# Integration Guide for Validation

## Test Procedure for Valve Operation and External Monitoring Logic

*NOTE: This test procedure should only be performed with an E28/Q28 valve that is known to be functioning properly. If basic valve function is in question, please refer to Section 8 of the Product Operating Instructions for the Valve Test Procedure.*

### Valve Operation

1. Energize solenoids A & B simultaneously. Valve is on, air pressure is supplied downstream from supply port 1 through outlet port 2, and exhaust port 3 is shut off. Sensors A & B are off.
2. De-energize solenoids A & B simultaneously. Valve is off, supply port 1 is blocked, and downstream air is exhausted from outlet port 2 through exhaust port 3.
3. Sensors A & B are on.

## Test Procedure – Actuation Fault Monitoring (with Fault Latching)

*NOTE: These test procedures required fault simulation. It will be necessary to induce faults electrically by disabling one solenoid or the other at different times, which may require special test cabling in order to complete the test procedure. **Also, be aware that this would only be possible with solenoid wiring option A.** See product data sheet.*

3. Energize only solenoid A. This should result in a sensor A switching off while sensor B stays on. Your safety control monitoring system should detect this fault in the valve, where sensor A switches off and sensor B stays on more than 150 msec after sensor A switches off. This fault should trigger the safety outputs to switch off in order to de-energize both solenoids, A & B. The fault should be latched in by the safety control system logic until the system is reset. While the fault exists supply port 1 is blocked, and downstream air from outlet port 2 is open to exhaust port 3. Once the safety control system de-energizes the solenoids, sensors A and B should both be on.
4. Before attempting to reset the safety control system, attempt to energize both solenoids, A & B, simultaneously. Supply port 1 should remain blocked and downstream air from outlet port 2 should remain open to exhaust via exhaust port 3.
5. De-energize both solenoids A & B.
6. Reset the safety control system.

# Integration Guide for Validation

## Test Procedure – Actuation Fault Monitoring (with Fault Latching) Continued

7. Energize only solenoid B. This should result in sensor A staying on while sensor B switches off. Your safety control monitoring system should detect this fault in the valve, where sensor B switches off and sensor A stays on more than 150 msec after sensor A switches off. This fault should trigger the safety outputs to switch off in order to de-energize both solenoids A & B. The fault should be latched in by the safety control system logic until the system is reset. While the fault exists, supply port 1 is blocked, and downstream air from outlet port 2 is open to exhaust port 3. Once the safety control system de-energizes the solenoids, sensors A and B should both be on.
8. Before attempting to reset the safety control system, attempt to energize both solenoids, A & B, simultaneously. Supply port 1 should remain blocked and downstream air from outlet port 2 should remain open to exhaust via exhaust port 3.
9. De-energize both solenoids A & B.
10. Reset the safety control system.

## Test Procedure – De-Actuation Fault Monitoring (with Fault Latching)

*NOTE: These test procedures required fault simulation. It will be necessary to induce faults electrically by disabling one solenoid or the other at different times, which may require special test cabling in order to complete the test procedure. **Also, be aware that this would only be possible with solenoid wiring option A.** See product data sheet.*

11. Energize solenoids A & B, simultaneously. This switches the valve on and should result in air pressure being supplied downstream from supply port 1 through outlet port 2, and exhaust port 3 being shut off. Sensors A & B should both switch off.
12. De-energize only solenoid A. The safety control system should detect the fault in the valve where sensor A switches on and sensor B stays off more than 150 msec after sensor A switches on. This fault should trigger the safety outputs to switch off in order to de-energize both solenoids A and B. The fault should be latched in by the safety control system logic until the system is reset. While the fault exists supply port 1 is blocked and downstream air from outlet port 2 is open to exhaust port 3. Once the safety control system de-energizes the solenoids sensors A and B should be both on.

## Test Procedure – De-Actuation Fault Monitoring (with Fault Latching) Continued

13. Before attempting to reset the safety control system, attempt to energize both solenoids A and B simultaneously. Supply port 1 should remain blocked and downstream air from outlet port 2 should remain open to exhaust via exhaust port 3.
14. De-energize both solenoids A & B.
15. Reset the safety control system.
16. Energize both solenoids, A & B simultaneously. This switches the valve on and should result in air pressure being supplied downstream from supply port 1 through outlet port 2, and exhaust port 3 being shut off. Sensors A & B should be both switched off.
17. De-energize only solenoid B. The safety control system should detect the fault in the valve where sensor B switches on and sensor A stays off more than 150 msec after sensor B switches on. This fault should trigger the safety outputs to switch off in order to de-energize both solenoids, A & B. The fault should be latched in by the safety control system logic until the system is reset. While the fault exists supply port 1 is blocked, and downstream air from outlet port 2 is open to exhaust port 3. Once the safety control system de-energizes the solenoids, sensors A and B should both be on.
18. Before attempting to reset the safety control system, attempt to energize solenoids, A & B simultaneously. Supply port 1 should remain blocked and downstream air from outlet port 2 should remain open to exhaust via exhaust port 3.
19. De-energize both solenoids A & B.
20. Reset the safety control

# Integration Guide for Validation

## Test Procedure for Loss of Supply Pressure While Actuated

1. Energize both solenoids, A & B, simultaneously. This switches the valve on and should result in air pressure being supplied downstream from supply port 1 through outlet port 2, and exhaust port 3 being shut off. Sensors A & B should both switch off.
2. Remove supply air from supply port 1. Sensors A & B should switch on. External monitoring should detect the fault in the valve where both solenoids are on, but both sensors are also switched on. This fault should trigger the safety outputs to switch off in order to de-energize both solenoids, A & B. The fault should be latched in by the safety control system logic until the system is reset. While the fault exists, supply port 1 is blocked, and downstream air from outlet port 2 is open to exhaust port 3. Sensors A and B should remain on.
3. Re-supply air to supply port 1. Supply port 1 is blocked and downstream air from outlet port 2 is open to exhaust via port 3. Sensors A & B should both be on. Re-supplying air while the fault is latched in the safety control system should not result in air being supplied from supply port 1 to outlet port 2.
4. Reset the safety control system.

# Integration Guide for Monitoring Logic

## **Monitoring of Supply Pressure**

### **Loss of Supply Pressure While Actuated**

The condition of loss of supply pressure while the valve is actuated must be detected by the safety control monitoring system. Loss of supply pressure while actuated should cause both sensors to switch on due to lack of pressure in both valves' outlet port even though the valve is still energized. This fault can be detected when the solenoids are high, and one or both sensors go from low (sensing pressure) to high (not sensing pressure).

### **No Supply Pressure Applied Before Actuation**

Monitoring of supply pressure may also be utilized if deemed beneficial for the application but is not required. If you choose to detect this condition it would require the addition of an upstream pressure switch or transducer. The condition of the pressure switch or transducer should be monitored to prevent actuation of the valve when supply pressure is insufficient.

### **Safety System Reset**

Any detected fault in the valve system should cause the safety control system to de-actuate the valve by removing power from both solenoids. A reset of the safety control system should only be possible after the valve sensors indicate that the valve is in the de-actuated state (both sensors switched on).

## Integration Guide (Safe Relay with Standard PLC) (for applications requiring Cat 3 PL d)

# Integration Guide for Rockwell 440R-D22S2

## Rockwell 440R-D22S2



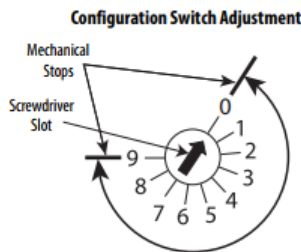
Part Number: 440R-D22S2

Functional Safety Rating: Cat 4, PL e

- Uses terminals
- Customer will have colored wires
- Can be wired with a PLC for sensors monitoring
- Examples include with and without pin outs and valve schematic

### Generic Connection Example (from Rockwell Catalog):

The DIS safety relay has two dual-channel inputs and four solid-state outputs. Two of the four solid-state outputs are designed to operate with high-capacitance loads. In addition, the DIS safety relay has SWS input and output. The DIS safety relay can be set for automatic or monitored manual reset by adjusting the switch on the front panel. The configuration switch also sets the AND/OR logic that is applied to the inputs.



DI and DIS Logic Switch

Position	Reset	Function
0	Not applicable	Start configuration
1	Monitored Manual	(IN1 OR IN2) OR L12
2		(IN1 AND IN2) OR L12
3		(IN1 OR IN2) AND L12
4		(IN1 AND IN2) AND L12
5	Automatic/Manual	(IN1 OR IN2) OR L12
6		(IN1 AND IN2) OR L12
7		(IN1 OR IN2) AND L12
8		(IN1 AND IN2) AND L12

Terminal	Function
A1	+24V Supply (+10%, -15%)
A2	24V Common
S11	Pulse Test Output for Channel 1
S21	Pulse Test Output for Channel 2
S12	Safety Input for IN1 Channel 1
S22	Safety Input for IN1 Channel 2
S32	Safety Input for IN2 Channel 1
S34	Reset Input
S42	Safety Input for IN2 Channel 2
Y32	Auxiliary Non-safety Output
L11	Single Wire Safety Output
L12	Single Wire Safety Input
14, 24	Safety Outputs - OSSD
34, 44	Safety Outputs - OSSD for capacitive loads



# Integration Guide for Rockwell 440R-D22S2

## Rockwell 440R-D22S2 Wiring

(Generic Wiring Examples from the Rockwell Catalog)

Figure 8 - Example Connections to 2 N.C. Mechanical Contacts

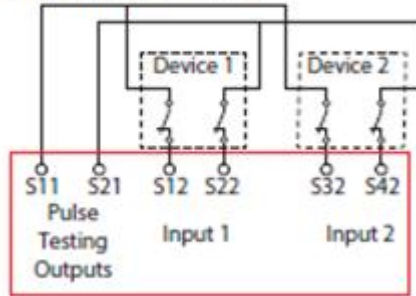


Figure 43 - Single Input, Monitored Reset

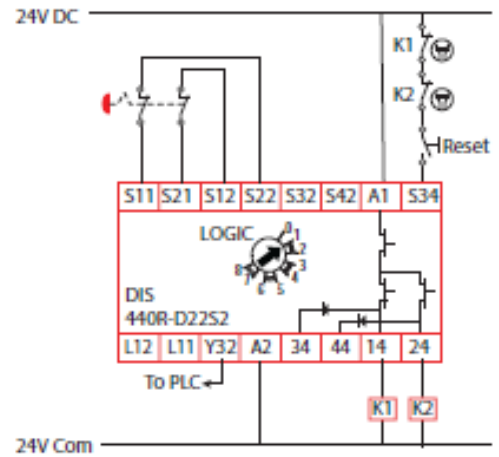
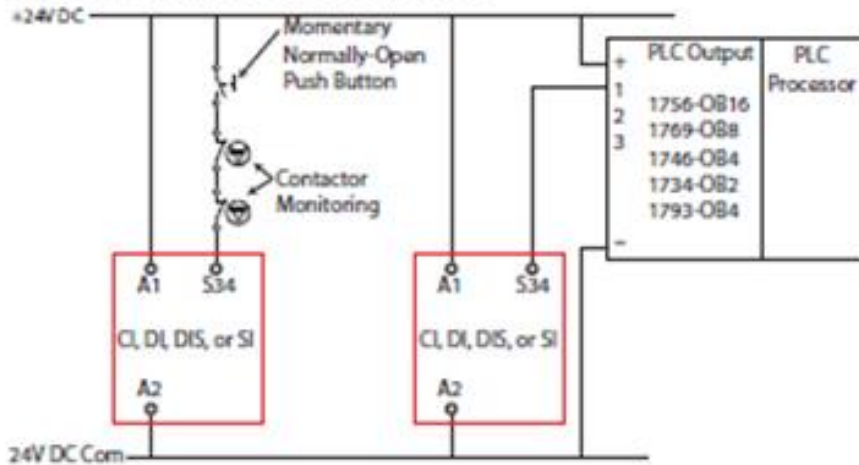
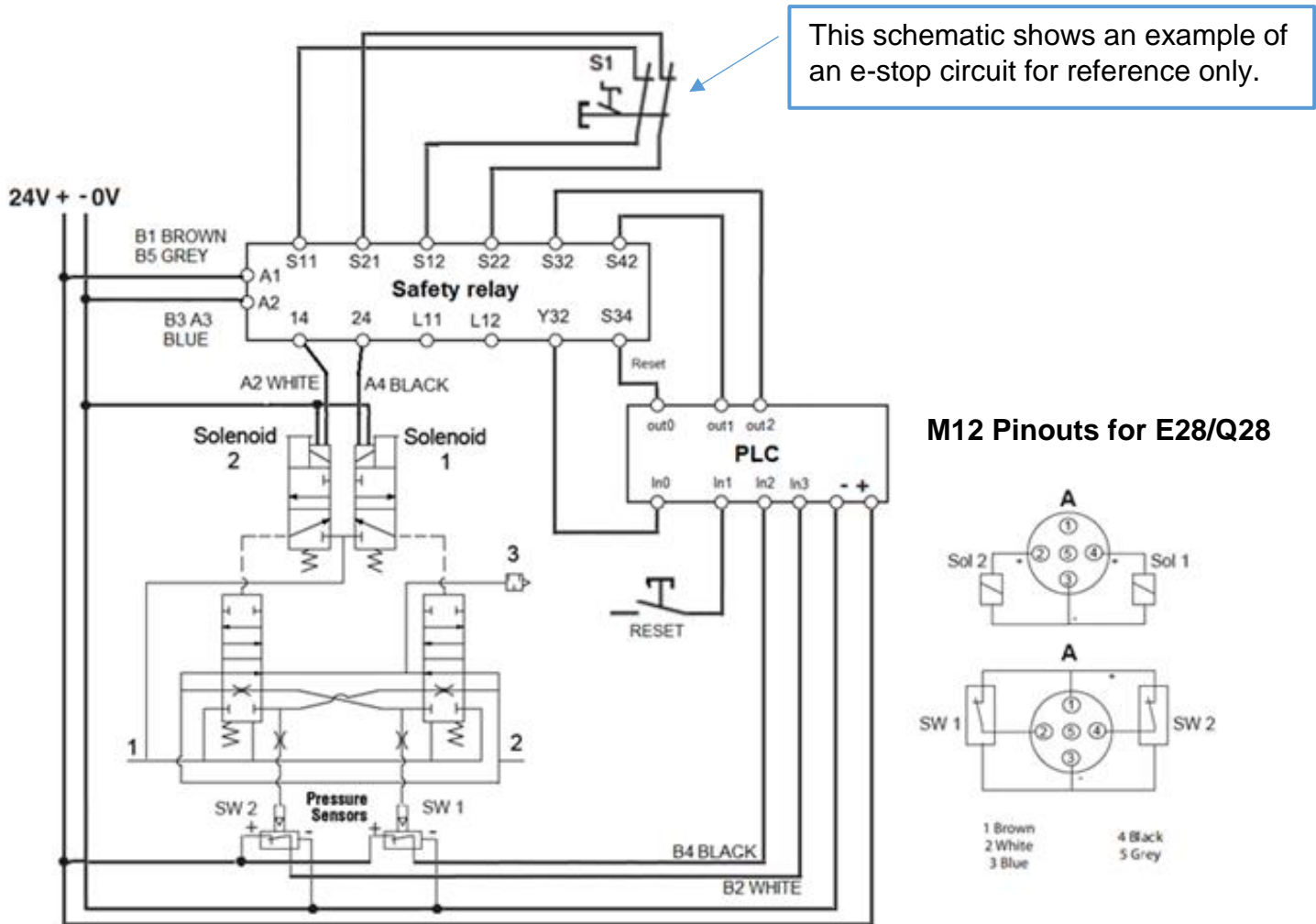


Figure 20 - Monitored Reset Connections



# Integration Guide for Rockwell 440R-D22S2

## Rockwell 440R-D22S2 Wiring Schematic with PLC to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to Cat 3 PL d if properly implemented.

# Integration Guide for Rockwell 440R-D22S2

## Rockwell 440R-D22S2 Program\*

External monitoring program

- a) sensor error :  $In2 \neq In3$  after discrepancy time at 150 ms
- b) feedback error :  $In2 = In3 = In0$  after installation discrepancy time
- c) If error Reset Out 1 & Out 2

Reset error only after maintenance acknowledge

Reset function

- d) IF No "feedback error" &  $In1$   
Out0 = pulse of 2 s

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

# Integration Guide for Schmersal SRB-E-204ST

## Schmersal SRB-E-204ST



Part Number: SRB-E-20\*ST

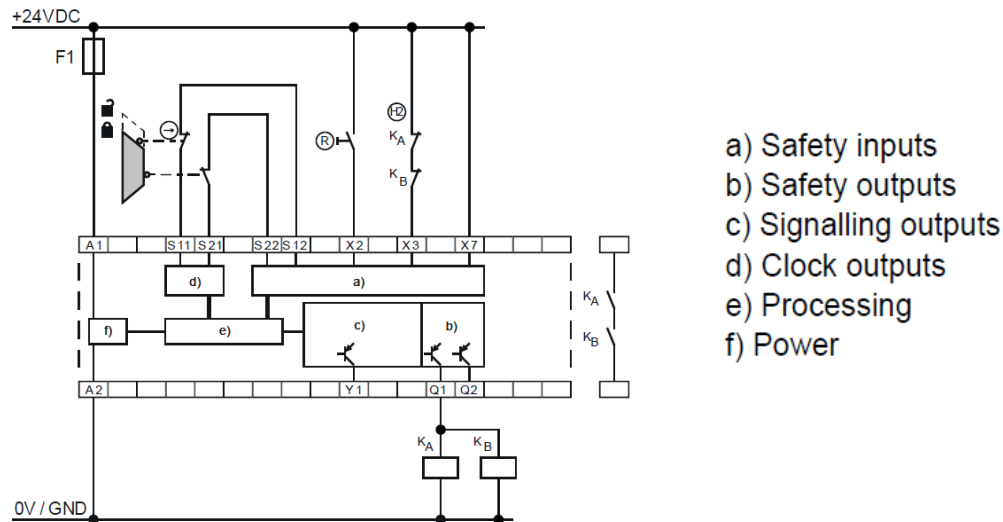
\*=1 or 4 double inputs

Functional Safety Rating: Cat 4, PL e

- Uses terminals
- Customer will have colored wires
- Can be wired with a PLC for sensor monitoring
- Examples include with and without pin outs and valve schematic

## Generic Connection Example for Schmersal SRB-E-201ST (from Schmersal Catalog):

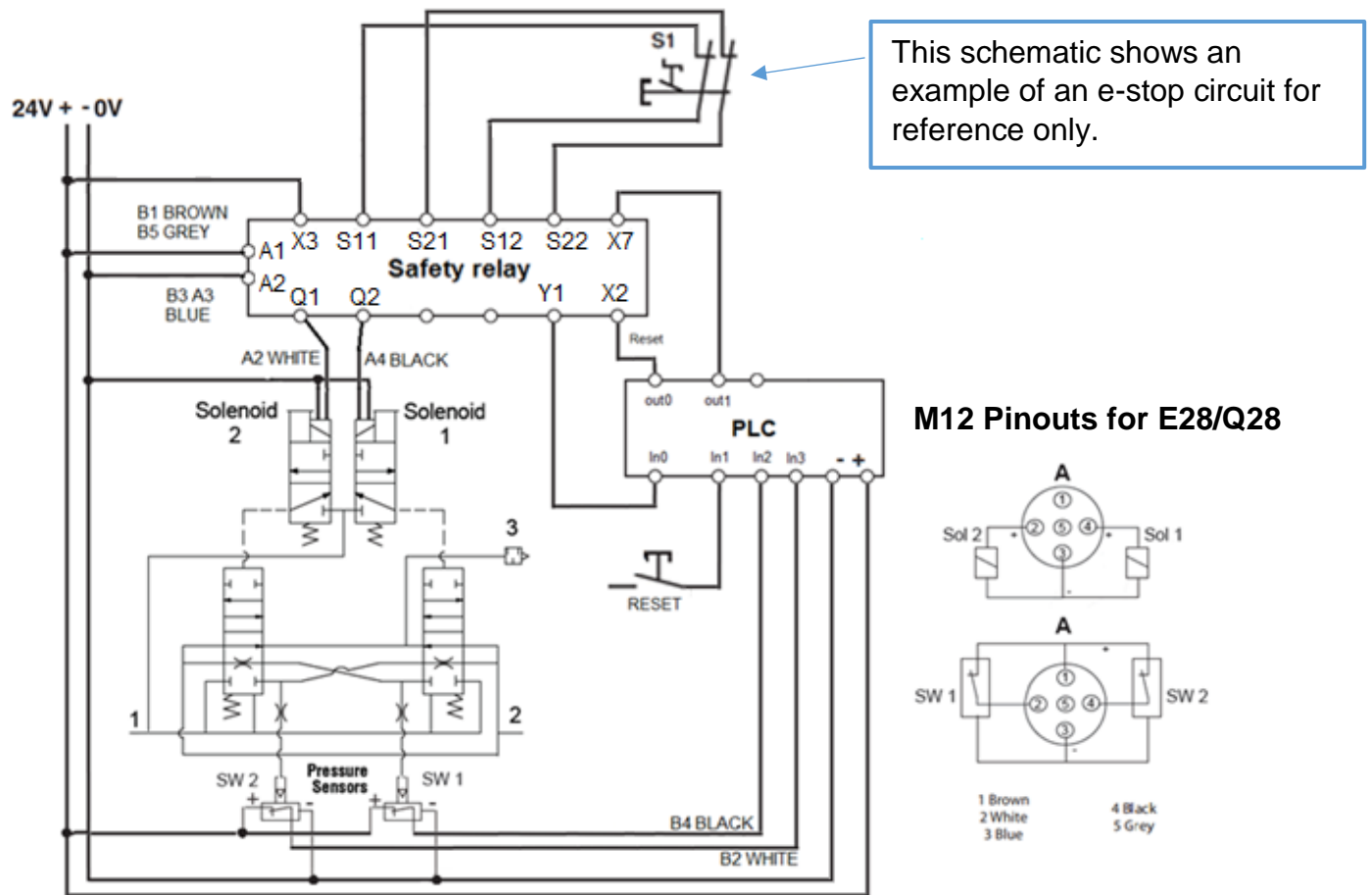
Wiring examples SRB-E-201ST and SRB-E-201LC



The same schematic is used, but with 4 dual inputs for P/N SRB-E-204ST

# Integration Guide for Schmersal SRB-E-204ST

## Schmersal Wiring Schematic for SRB-E-2014ST with PLC to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 3 PL d if properly implemented.

# Integration Guide for Schmersal SRB-E-204ST

## Schmersal - Program\*

### External monitoring program

- a) sensor error :  $In2 \neq In3$  after discrepancy time at 150 ms
- b) feedback error :  $In2 = In3 = In0$  after installation discrepancy time
- c) If error Reset Out 1 set error only after maintenance acknowledge

### Reset function

- d) IF No "feedback error" &  $In1$   
Out0 = pulse of 2 s

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

# Integration Guide for Siemens Sirius 3SK1112

## Siemens 3SK1112



Part Number: 3SK1112

Functional Safety Rating: Cat 4, PL e

- Uses terminals
- Customer will have colored wires
- Can be wired with a PLC for sensor monitoring
- Examples include with and without pin outs and valve schematic

### Safety Function Information (from Siemens Catalog):

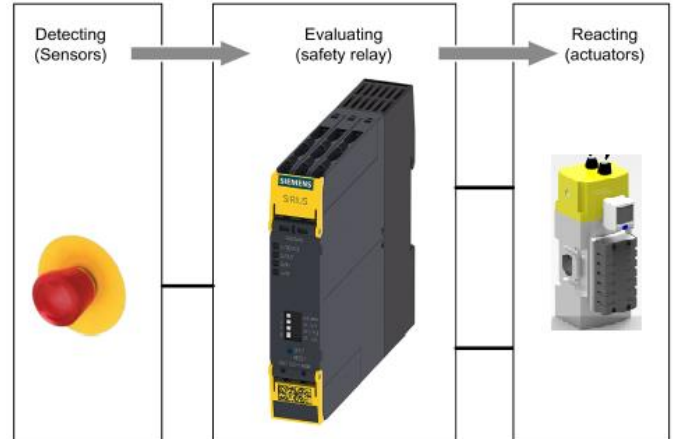
A safety function describes the reaction of a machine/plant to the occurrence of a specific event (e.g. opening of a protective door.) Execution of the safety function(s) is carried out by a safety-related control system. This usually comprises three subsystems, detecting, evaluating and reacting.

**Detecting (sensors):** Used to detect a safety requirement, eg: Emergency stop or a sensor for monitoring a hazardous area (light array, laser scanner etc) is operated.

**Evaluating (safety relay):** Detecting a safety requirement and safely initiating the reaction (eg. Switching off the safety related outputs). Monitoring the correct operation of sensors and actuators. Initiating a reaction upon detection of faults.

For the 3SKI products described in this guide, this concerns evaluation units for safety functions.

**Reacting (actuators):** Switching off the hazard by means of downstream actuators.





# Integration Guide for Siemens Sirius 3SK1112

## Generic Siemens Wiring Schematic for 3SK1112 (from Siemens Catalog)

Table 7- 14 Typical circuit 14:  
1NC/1NO sensor, with cross-circuit detection, with monitored start

<ul style="list-style-type: none"> <li>• Monitored start</li> <li>• With cross-circuit detection</li> <li>• 1 x two-channel</li> <li>• Jumper T1/PAR for NC/NO evaluation</li> <li>• Sensor: NC/NO sensor</li> <li>• 3SK112/3SK122 Advanced</li> </ul>			
DIP switch			
1	2	3	4
ON right	ON right	ON right	—
Up to PL in accordance with ISO 13849-1			e
Up to Safety Integrity Level (SILCL) to IEC 61508			3

# Integration Guide for Siemens Sirius 3SK1112

## Generic Siemens Wiring Schematic for 3SK1112 (from Siemens Catalog)

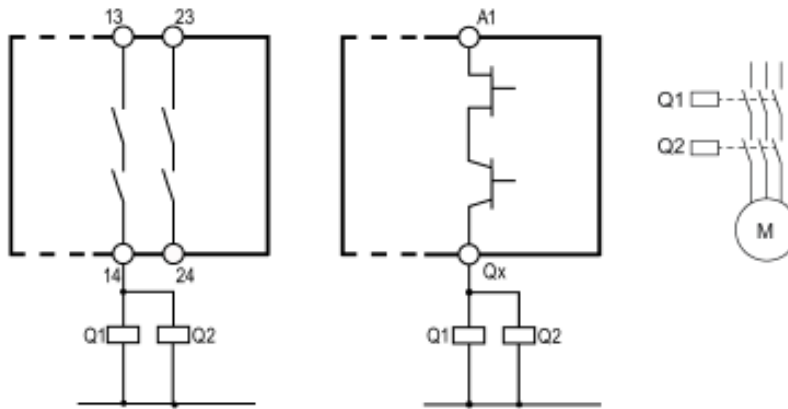


Figure 4-6 PL e/Cat. 4 in accordance with ISO 13849-1 or SILCL 3 in accordance with IEC 62061  
With units that have semiconductor outputs, this wiring is only possible from E02/V1.1.0.

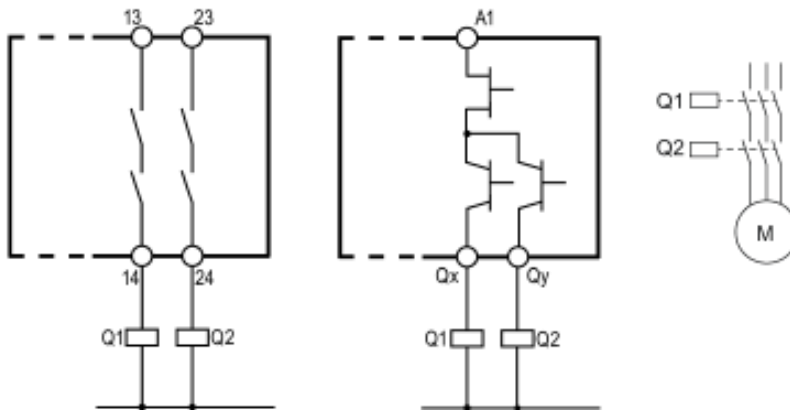
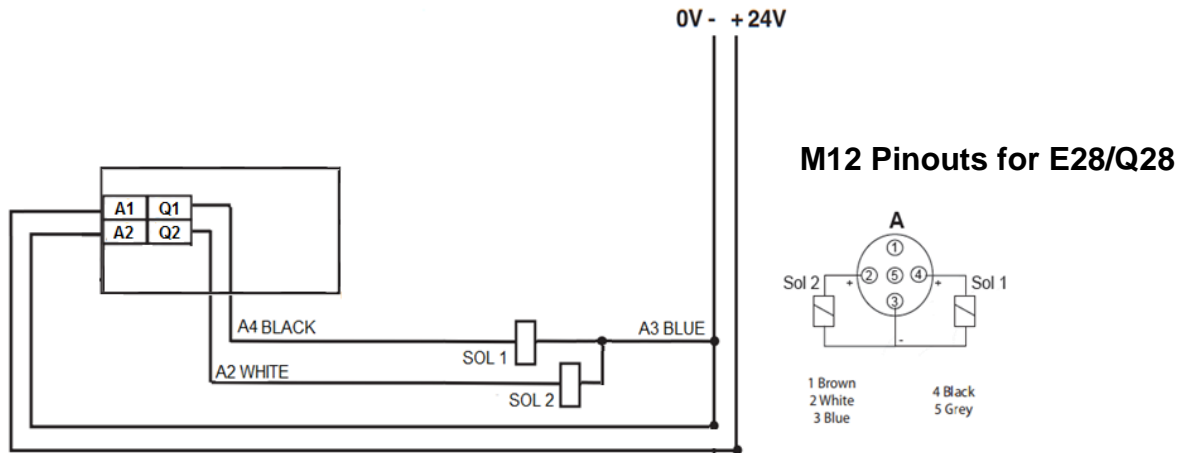


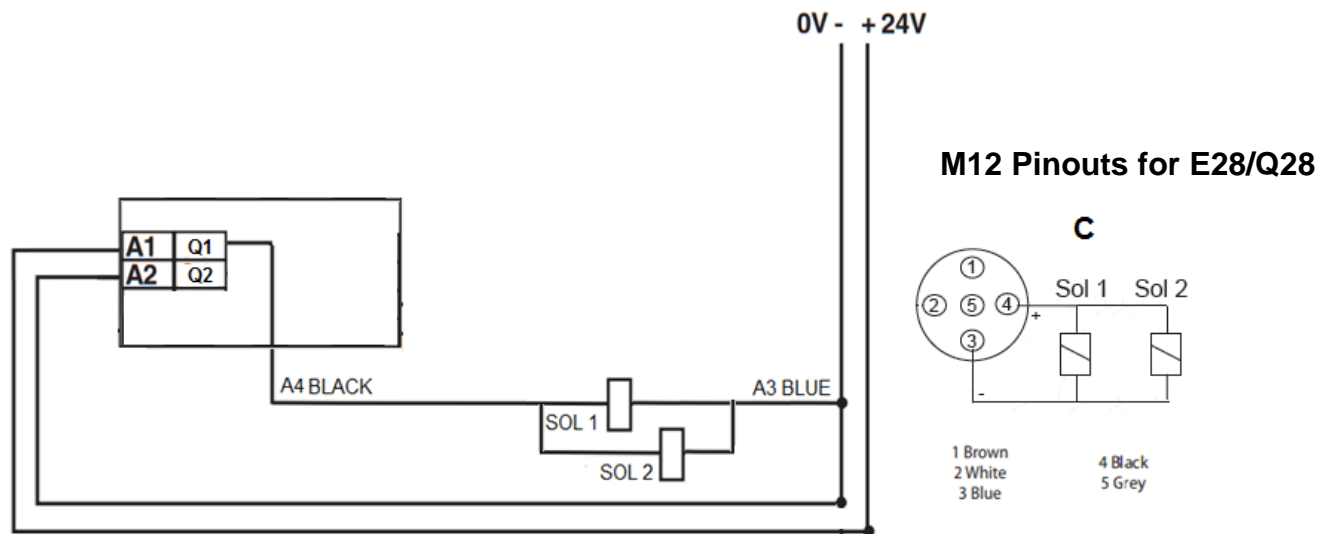
Figure 4-7 PL e / Cat. 4 in accordance with ISO 13849-1 or SILCL 3 in accordance with IEC 62061

# Integration Guide for Siemens Sirius 3SK1112

## Siemens Wiring Schematic with Dual Output to Interface to Safety Exhaust Valve

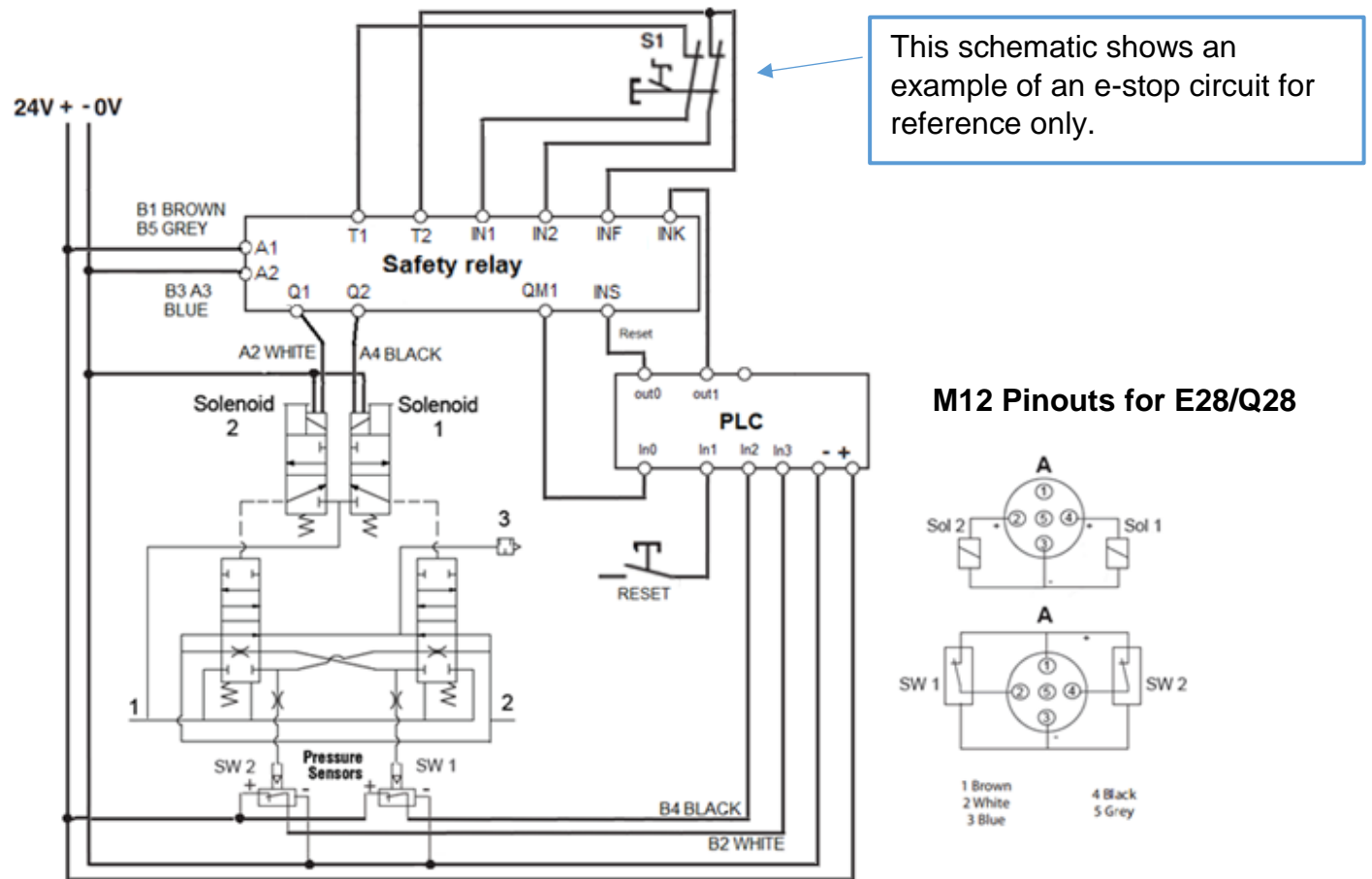


## Siemens Wiring Schematic with One Safe Output to Interface to Safety Exhaust Valve



# Integration Guide for Siemens Sirius 3SK1112

## Siemens Wiring Schematic for 3SK1112-1BB40 with PLC to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 3 PL d if properly implemented.

# Integration Guide for Siemens Sirius 3SK1112

## Siemens- Program\*

### External monitoring program

- a) sensor error :  $In2 \neq In3$  after discrepancy time at 150 ms
- b) feedback error :  $In2 = In3 = In0$  after installation discrepancy time
- c) If error Reset Out 1 set error only after maintenance acknowledge

### Reset function

- d) IF No “feedback error” &  $In1$   
Out0 = pulse of 2 s

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

## Integration Guide (Programmable Safe Relay) (for applications requiring Cat 4 PL e)

# Integration Guide for Pilz PNOZ

## Pilz PNOZ



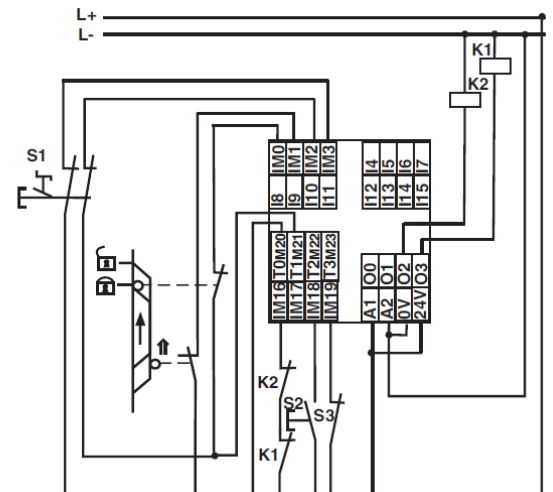
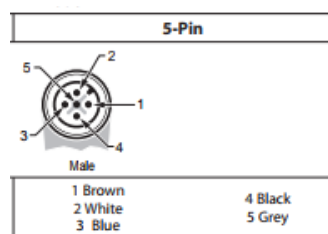
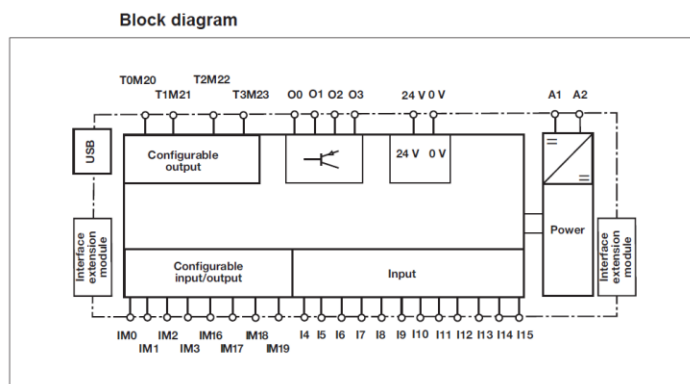
Part Number: 772100 Pnoz m B0

Functional Safety Rating: Cat 4, PL e

- Uses terminals
- Customer will have colored wires
- Can be wired with and without test pulses on the sensors
- Examples include with and without pin outs and valve schematic

### Generic Connection Example (from Pilz Catalog):

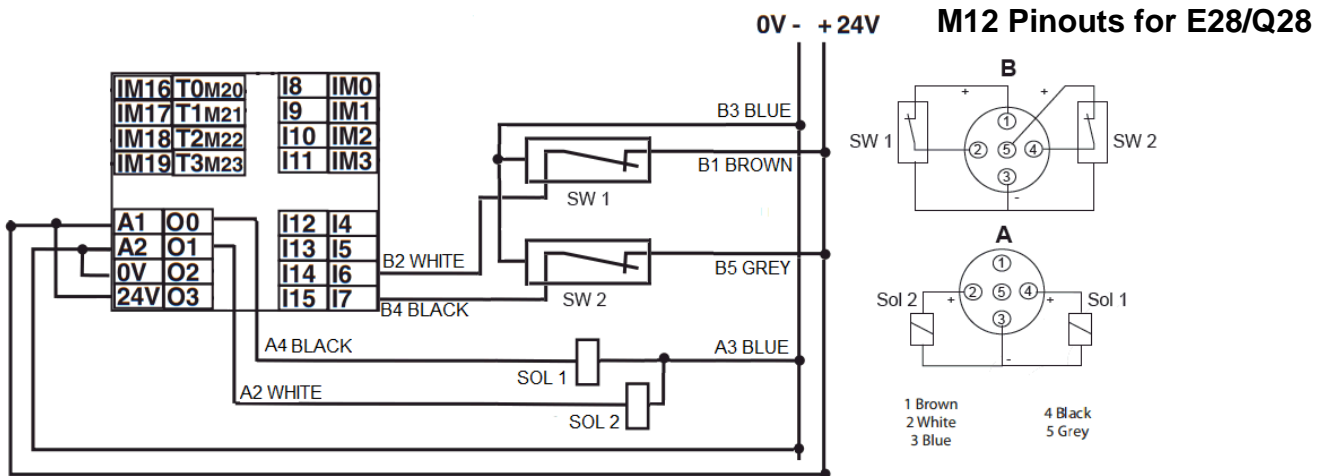
Dual-channel E-STOP and safety gate wiring, monitored start and feedback loop.





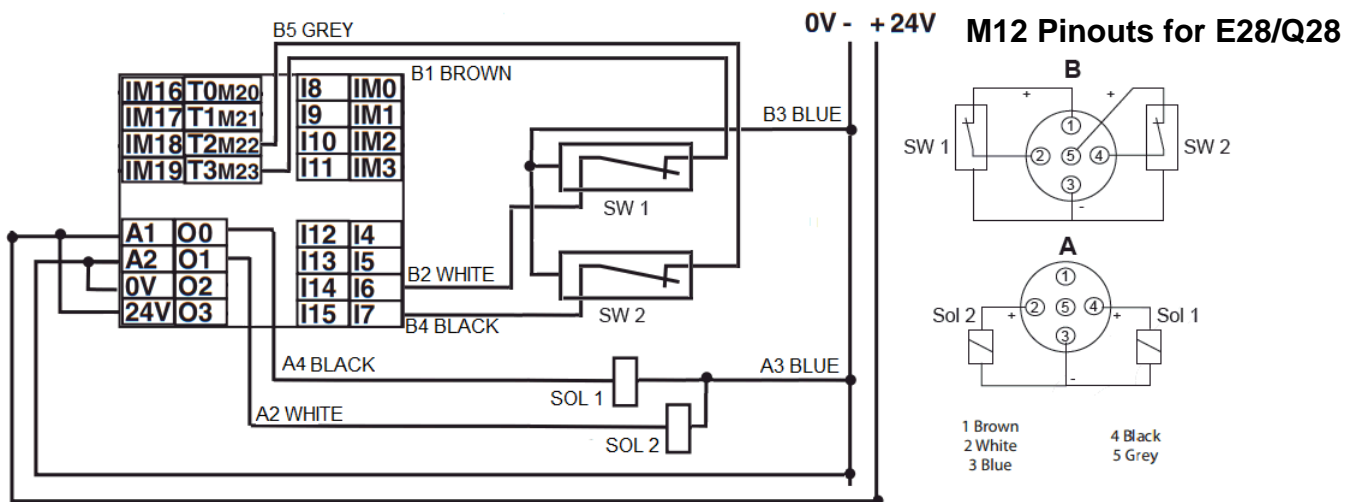
# Integration Guide for Pilz PNOZ

## Pilz Wiring Schematic (without sensor test pulse) to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

## Pilz Wiring Schematic (with sensor test pulse) to interface to Safety Exhaust Valve

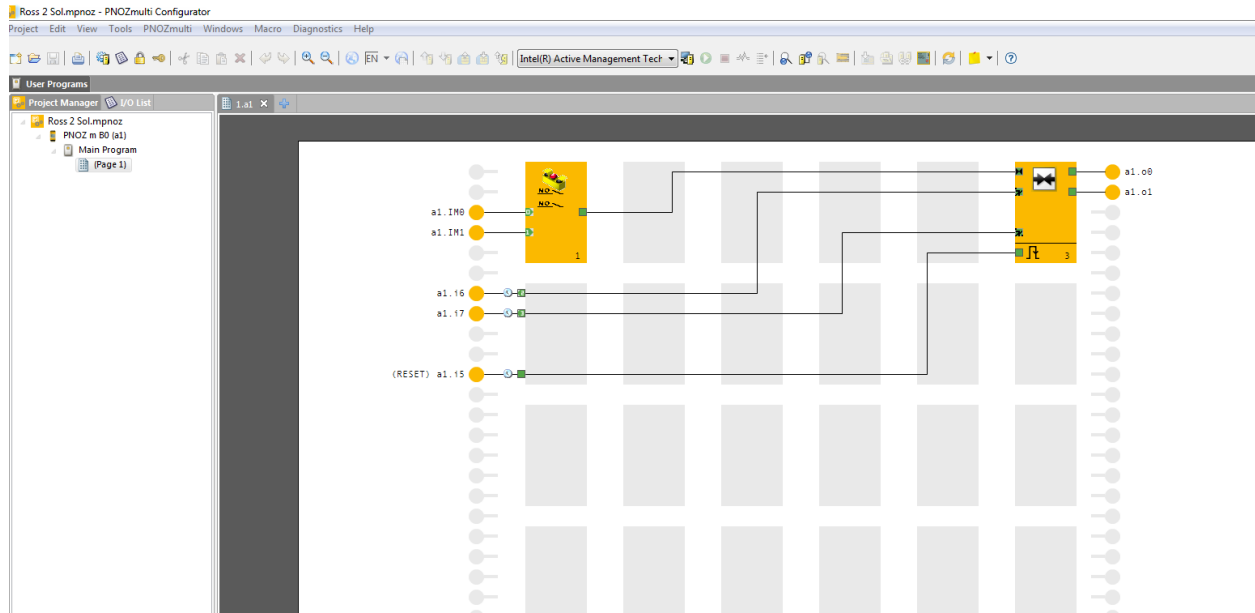


With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Pilz PNOZ

## Pilz - Program\*

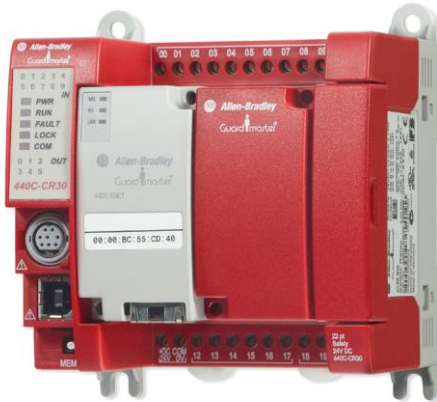
Contains pinouts; these can vary based on wiring  
ie feedback listed as I6 & I7, could be I4, I5, I6, or I7



\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

# Integration Guide for Rockwell 440C-CR30

## Rockwell 440C-CR30



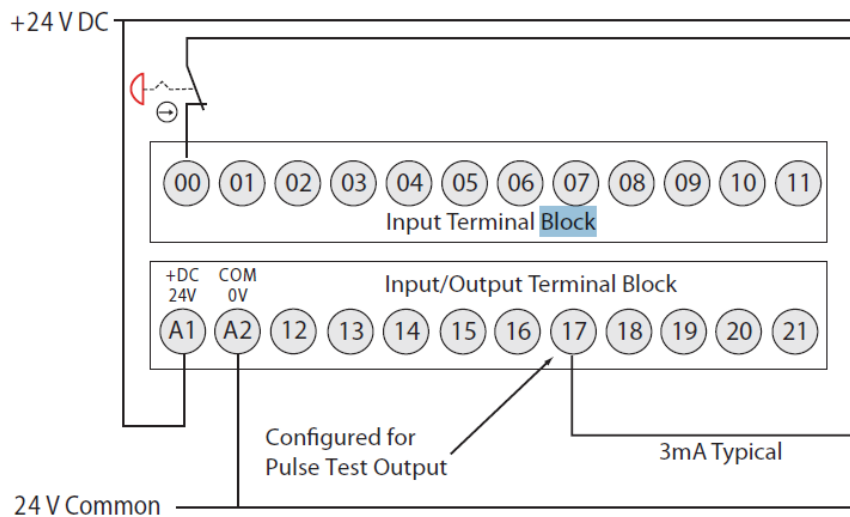
Part Number: 440C-CR30-22BBB

Functional Safety Rating: Cat 4, PL e

- Software configured safety relay
- 22 safety I/O with embedded serial port
- USB programming port
- 2 plug-in slots
- 24 V DC

## Generic Connection Example (from Rockwell Catalog):

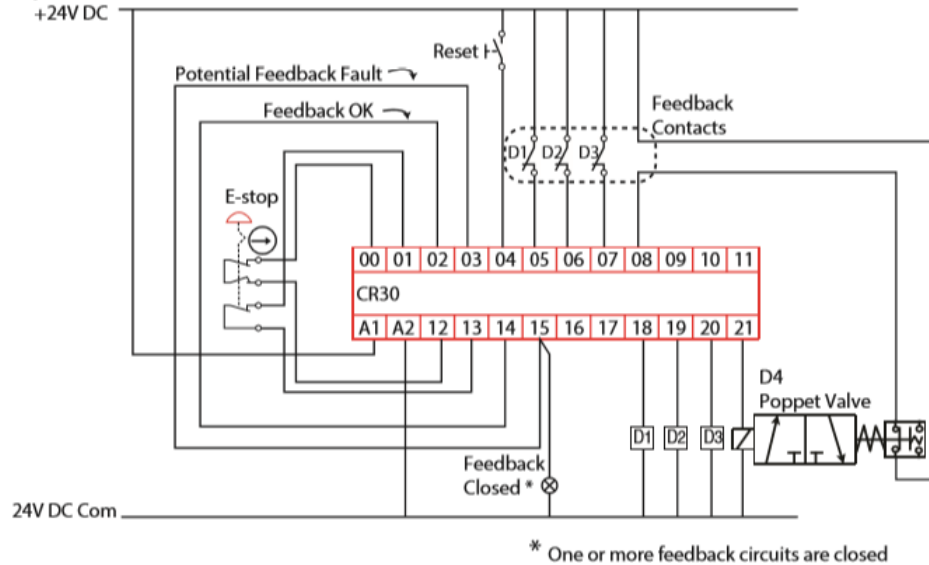
Figure 9 - Input Devices with Mechanical Contacts



# Integration Guide for Rockwell 440C-CR30

## Generic Rockwell Wiring Schematic for 440C-CR30 (from the Rockwell Catalog)

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.

### 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.

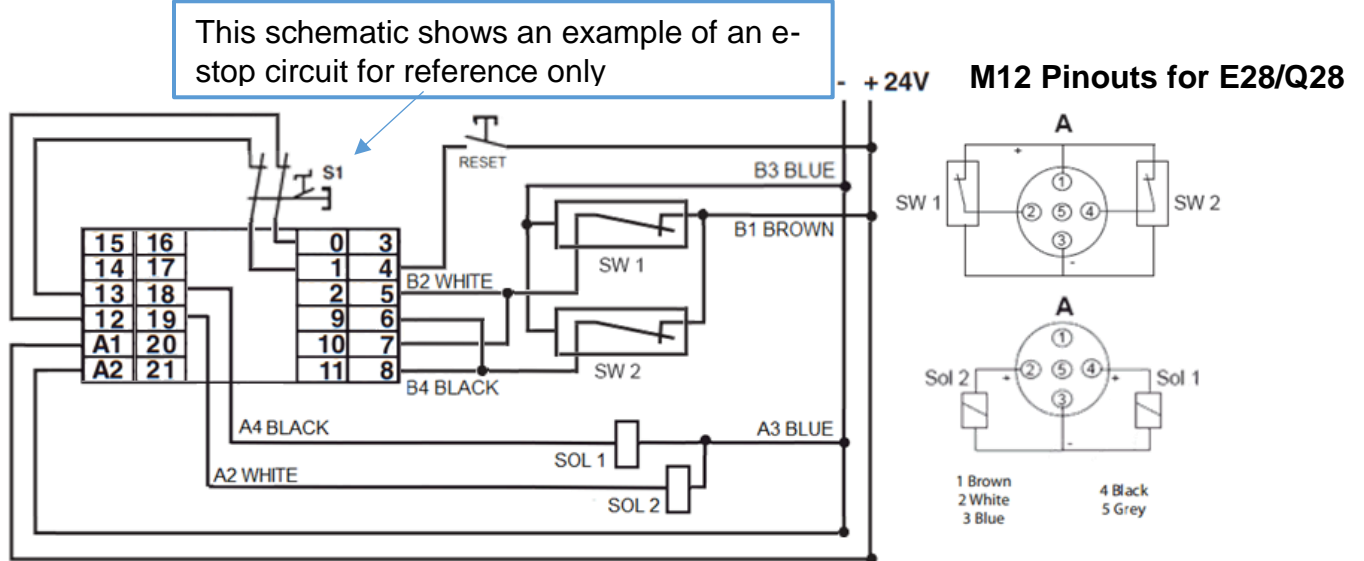
With a short circuit across one of the output device contacts:

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.

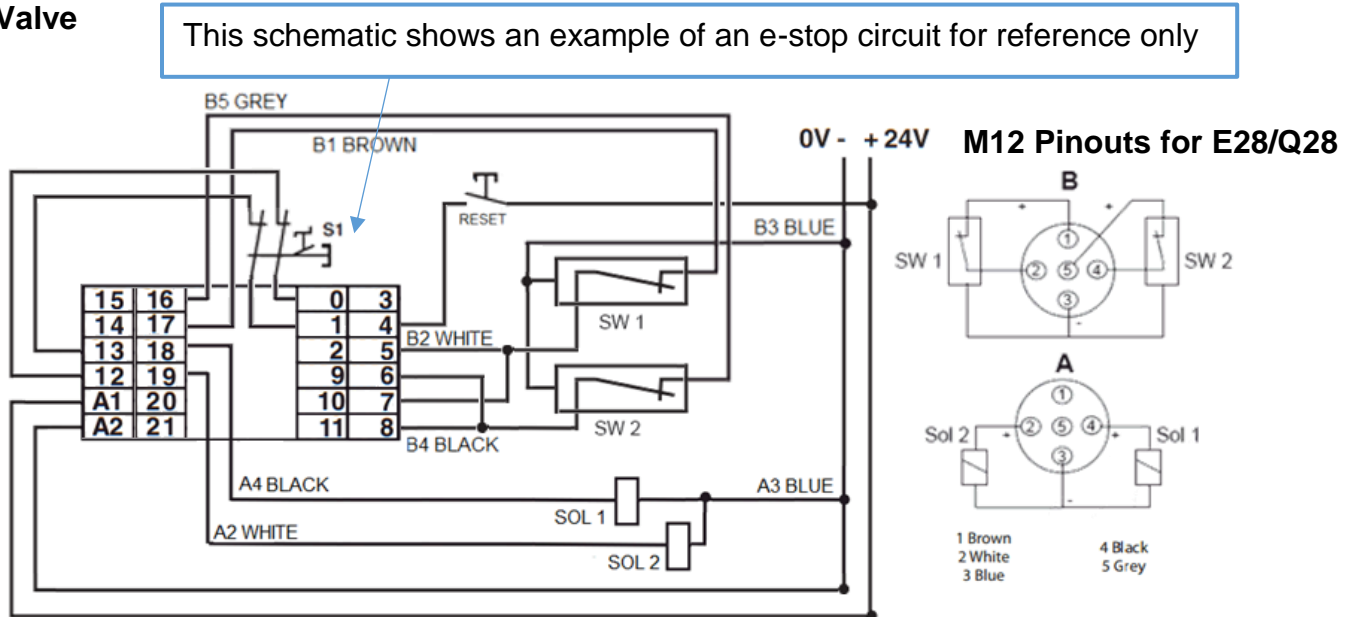
# Integration Guide for Rockwell 440C-CR30

## Rockwell Wiring Schematic (without sensor test pulse) to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

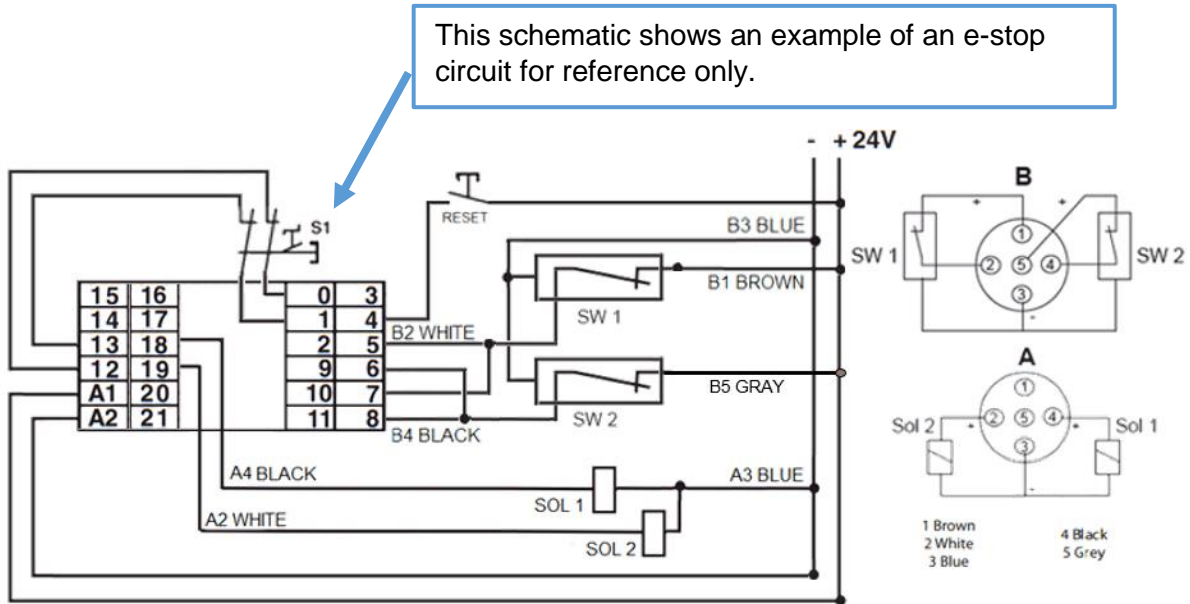
## Rockwell Wiring Schematic (with sensor test pulse) to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Rockwell 440C-CR30

## Rockwell Wiring Schematic (without sensor test pulse) to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Rockwell 440C-CR30

## Rockwell - Program\*

External monitoring program

- a) IF I.5 = I.6 = I.4 THEN set O.18 = O.19 = 1
- b) Sensor discrepancy error: I.5 <> I.6 (max. discrepancy time = 150 msec)
- c) Loss of pressure error: I.7 = I.8 = 0 AND O.18 = O.19=1 followed by  
I.7=I.8=O.18=O.19=1
- d) IF sensor discrepancy error OR loss of pressure error THEN reset O.18 = O.19  
=0

Errors must be reset only after maintenance acknowledgement

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

## Integration Guide (Safe PLC I/O) (for applications requiring Cat 4 PL e)



# Integration Guide for Rockwell 1732ES-IB8X0B8

## Rockwell 1732ES-IBX0B8



Part Number: 1732ES-IB8X0B8

Functional Safety Rating: Cat 4, PL e

- Uses M12
- Direct M12 cable
- Central or IO modules
- Dual output

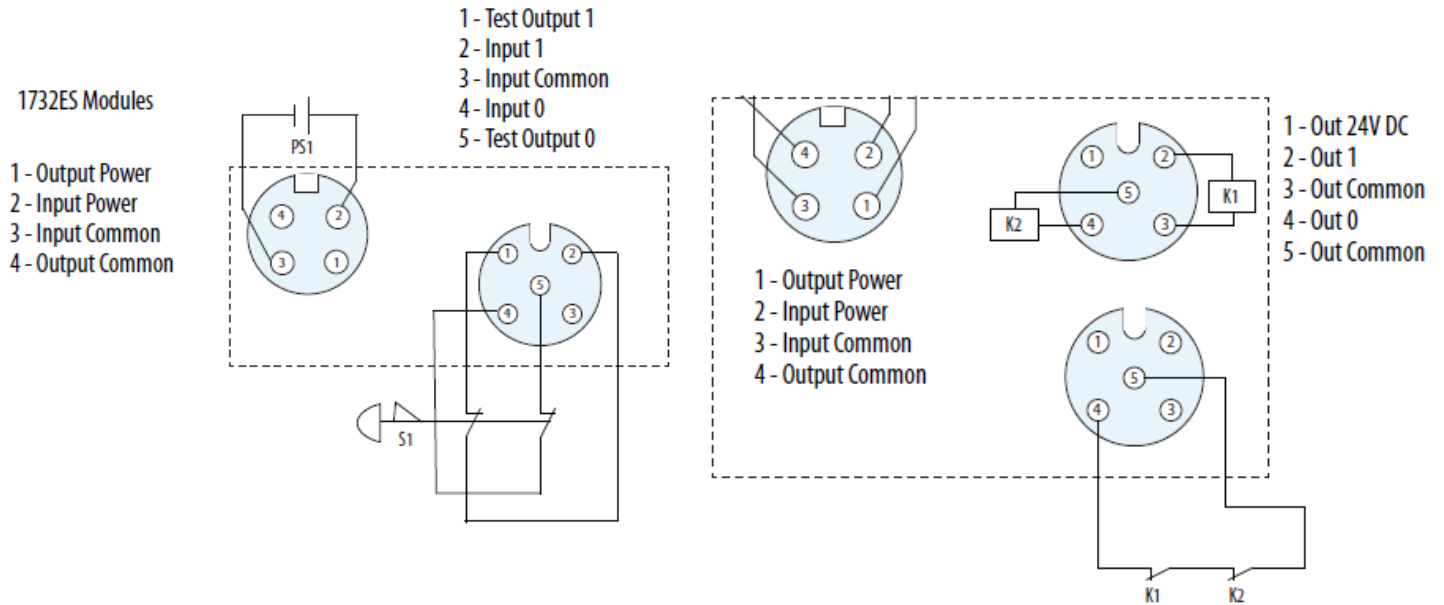
The Guard I/O modules implement the CIP Safety™ protocol extensions over EtherNet/IP networks and provide various features for a safety system.

Use the modules to construct a safety-control network system that meets the following requirements, up to and including:

- Safety Integrity Level Claim Limit 3 (SIL CL 3), as defined in IEC 61508
- Category 4 (CAT. 4), Performance Level e (PLe), as defined in ISO 13849-1

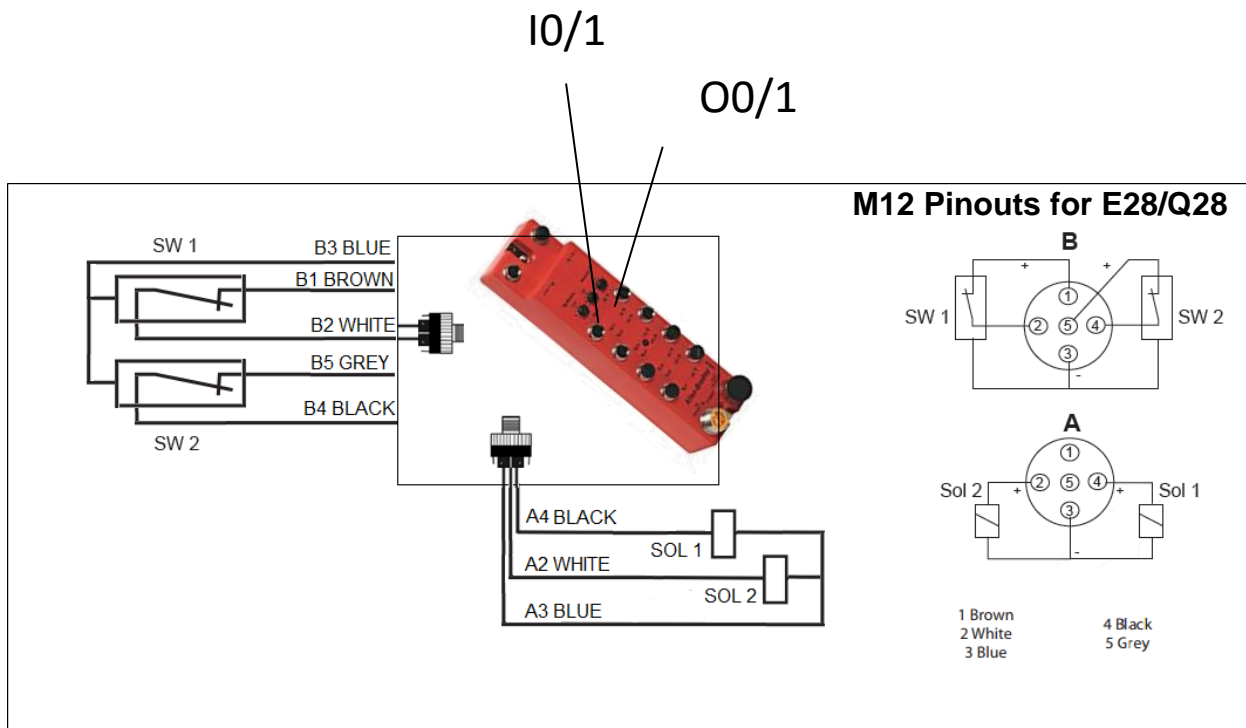
# Integration Guide for Rockwell 1732ES-IB8XOB8

## Generic Rockwell 1732ES-IB8XOB8 Wiring (from Rockwell Catalog)



# Integration Guide for Rockwell 1732ES-IB8X0B8

## Rockwell 1732ES-IB8X0B8 Wiring Schematic (from Rockwell Catalog) to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to Cat 4 PL e if properly implemented.

# Integration Guide for Rockwell 1732ES-IB8XOB8

## Rockwell - Program\*

### External monitoring program

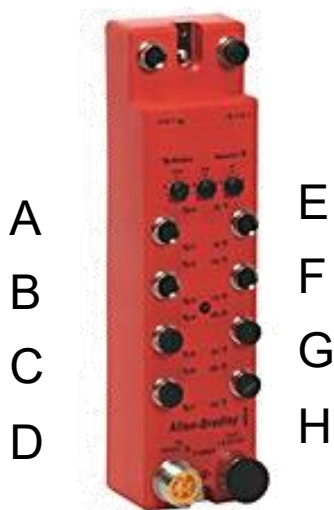
- a) IF I.0 = I.1 = 1 THEN set O.0 = O.1 = 1 when commanded
- b) Sensor discrepancy error: I.0 <> I.1 (max. discrepancy time = 150 msec)
- c) Loss of pressure error: I.0 = I.1 = 0 AND O.0 = O.1=1 followed by  
I.0=I.1=O.0=O.1=1
- d) IF sensor discrepancy error OR loss of pressure error THEN reset O.0 = O.1=0

Errors must be reset only after maintenance acknowledgement

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

# Integration Guide for Rockwell 1732ES-IB8XOBV4

## Rockwell 1732ES-IB8XOBV4



Part Number: 1732ES-IB9X0BV4

Functional Safety Rating: Cat 4, PL e

- Uses M12
- Direct M12 cable
- Central or IO modules
- Safe output

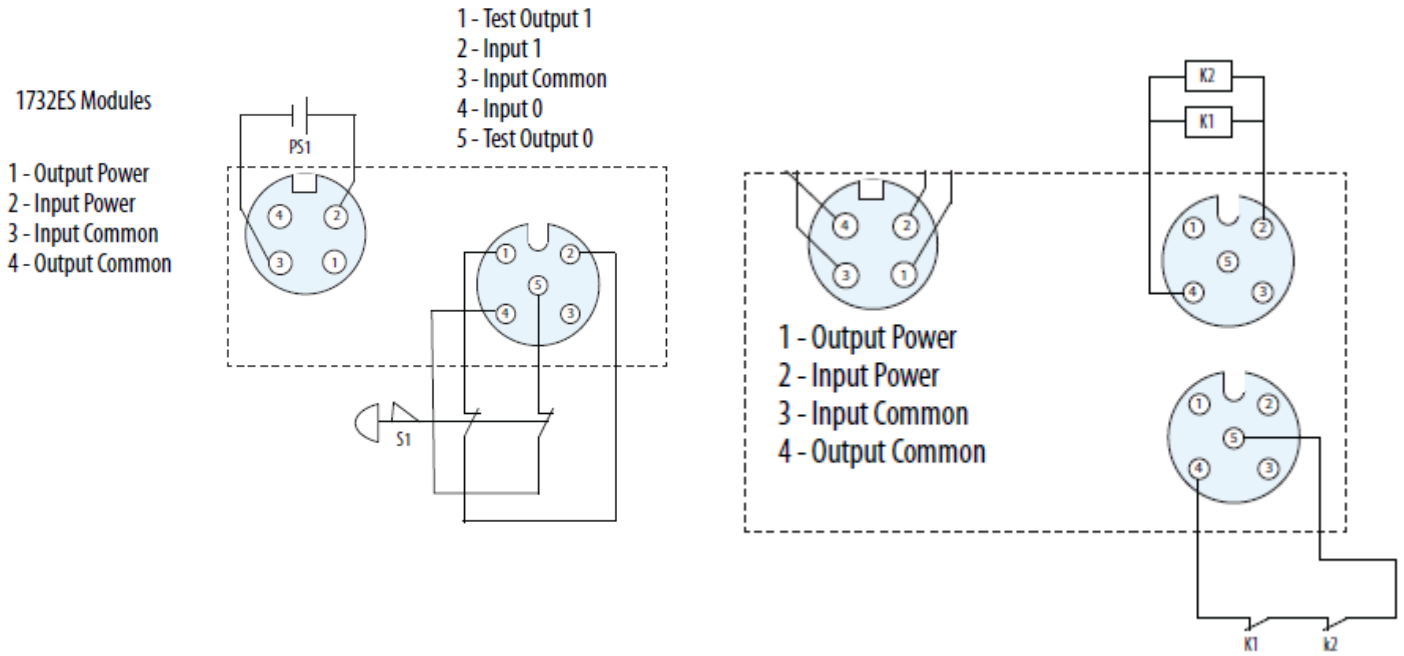
The Guard I/O modules implement the CIP Safety™ protocol extensions over EtherNet/IP networks and provide various features for a safety system.

Use the modules to construct a safety-control network system that meets the following requirements, up to and including:

- Safety Integrity Level Claim Limit 3 (SIL CL 3), as defined in IEC 61508
- Category 4 (CAT. 4), Performance Level e (PLe), as defined in ISO 13849-1

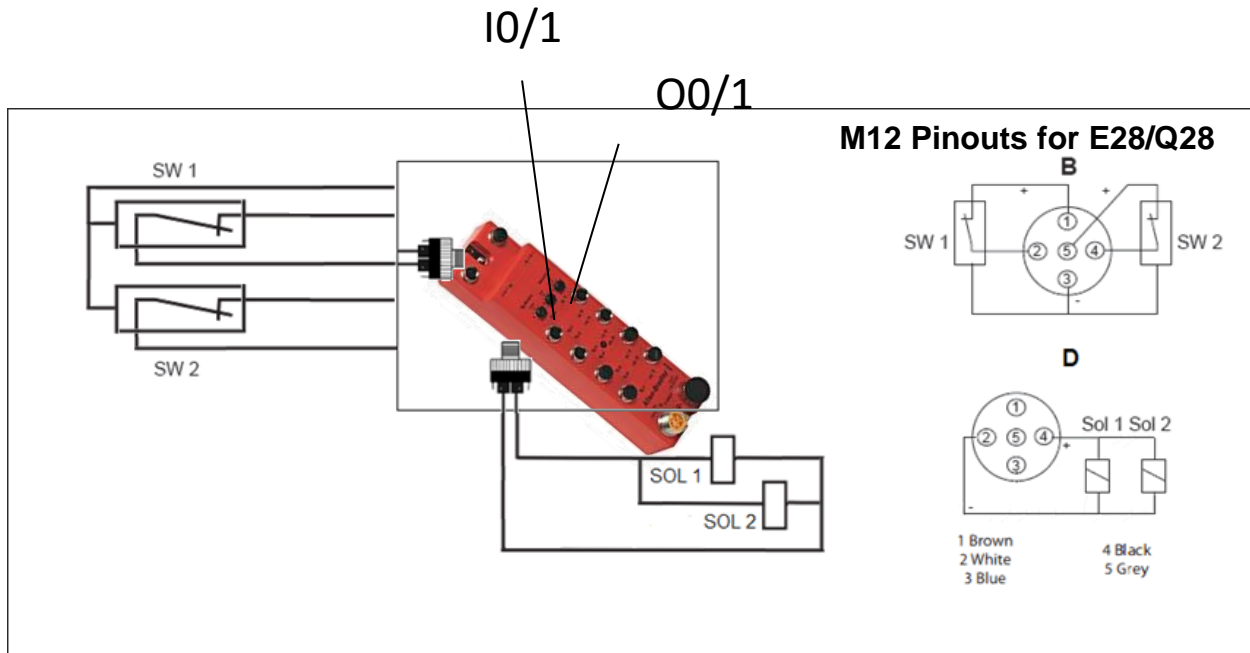
# Integration Guide for Rockwell 1732ES-IB8XOBV4

## Generic Rockwell 1732ES-IB8XOBV4 Wiring (from Rockwell Catalog)



# Integration Guide for Rockwell 1732ES-IB8X0BV4

## Rockwell 1732ES-IB8X0BV4 Wiring Schematic (from Rockwell Catalog) to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to Cat 4 PL e if properly implemented.

# Integration Guide for Rockwell 1732ES-IB8XOBV4

## Rockwell - Program\*

### External monitoring program

- a) IF I.0 = I.1 = 1 THEN set O.0 = O.1 = 1 when commanded
- b) Sensor discrepancy error: I.0 <> I.1 (max. discrepancy time = 150 msec)
- c) Loss of pressure error: I.0 = I.1 = 0 AND O.0 = O.1=1 followed by  
I.0=I.1=O.0=O.1=1
- d) IF sensor discrepancy error OR loss of pressure error THEN reset O.0 = O.1=0

Errors must be reset only after maintenance acknowledgement

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.



# Integration Guide for Siemens ET200PRO Safe

## Siemens ET200PRO Safe



Part Number: ET200PRO Safe

Functional Safety Rating: Cat 4, PL e

- Uses M12
- Direct M12 Cable
- Central or IO modules
- Examples include with and without pin outs and valve schematic

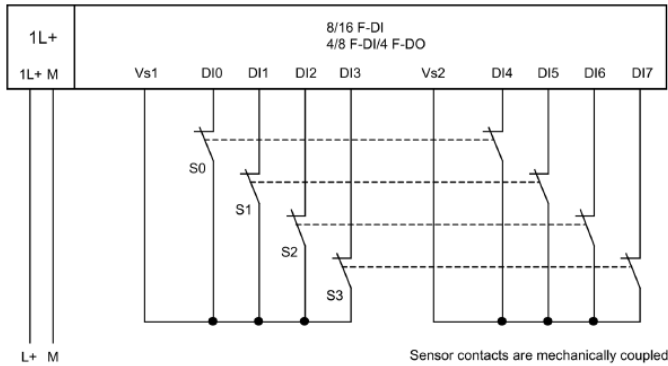
## Generic Connection Example (from Siemens Catalog):

### Wiring Diagram – Connecting One Two-Channel Sensor Via Two Channels

One two-channel sensor is connected via two channels to two inputs of the F-module for each process signal (1oo2 evaluation).

The wiring is carried out at the appropriate connection module.

The figures below illustrate an example wiring diagram for channel groups 1 and 2.



### Wiring Two Loads in Parallel to Each Digital Output

Avoiding/Managing Cross Circuits:

To protect against cross circuits between P- and M-switches of a fail-safe digital output, we recommend the following wiring schemes:

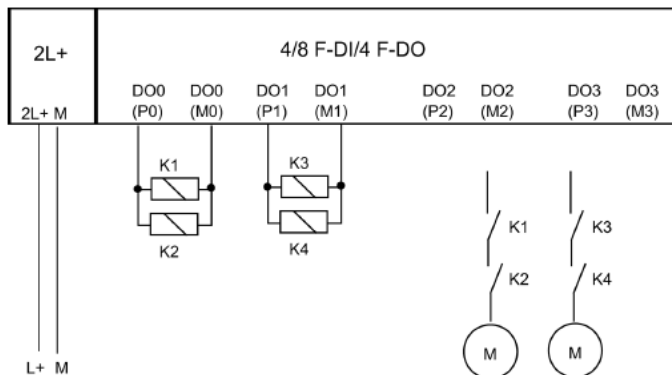
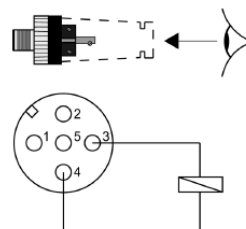
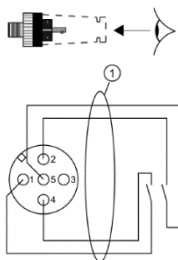
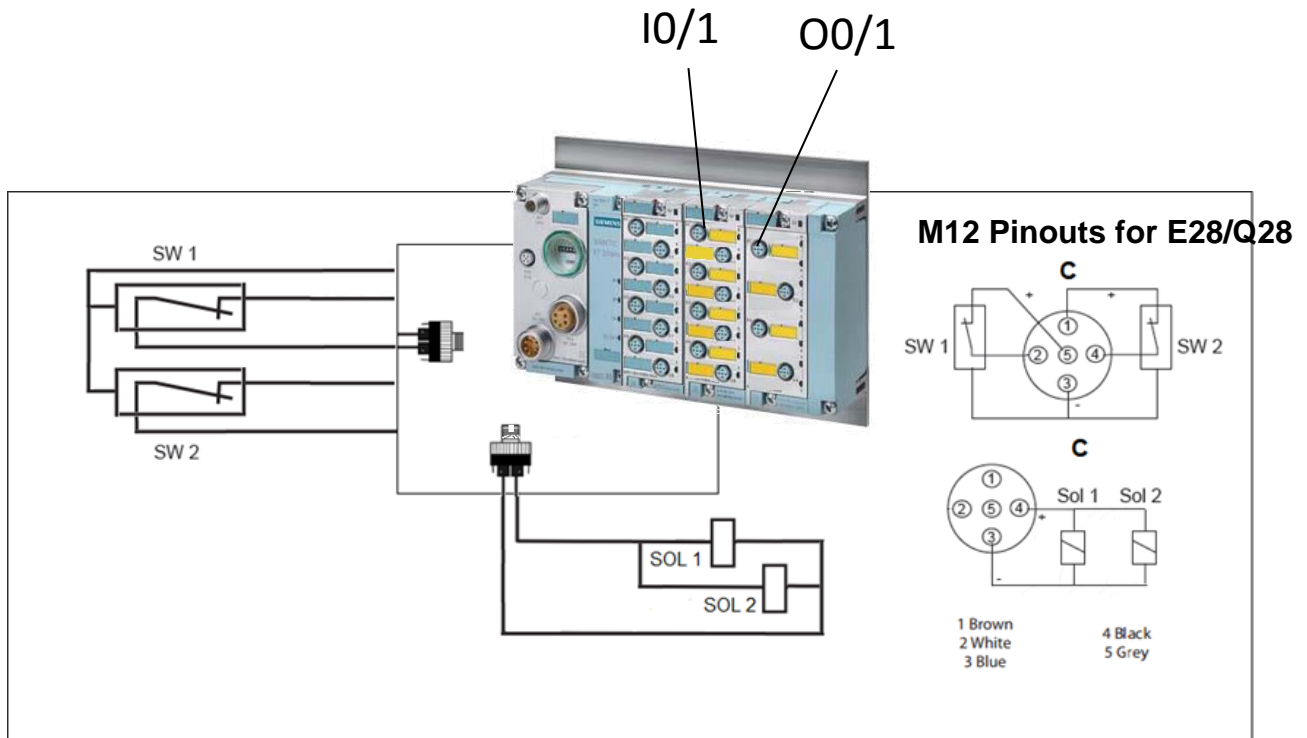


Figure 8-20 Wiring Diagram for Each of Two Relays Parallel at One F-DO of the 4/8 F-DI/4 F-DO DC24V/2A PROFIsafe Electronic Module



# Integration Guide for Siemens ET200PRO Safe

## Siemens Wiring Schematic for ET200PRO Safe to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Siemens ET200PRO Safe

## Siemens - Program\*

External monitoring program

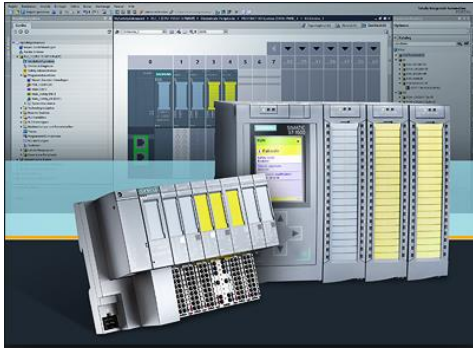
- a) sensor error : I.0 <> I.1
  - Adjust discrepancy time at 150 ms
- c) feedback error : I.0 = I.1 = Out 0
  - Adjust discrepancy time
- d) IF feedback or sensor error THEN reset Out 0

Errors must be reset only after maintenance acknowledgement

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.

# Integration Guide for Siemens Simatic S7

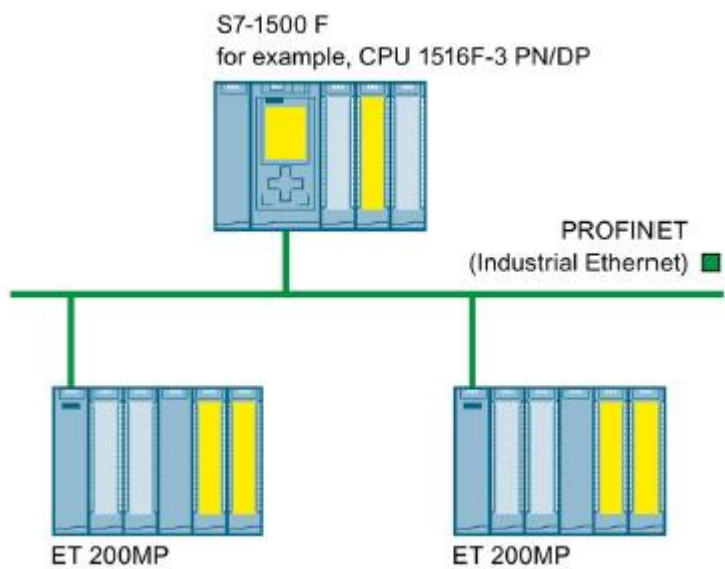
## Siemens Simatic S7



Part Number: Simatic S7

Functional Safety Rating: Cat 4, PL e

- Uses Terminals
- Customer will have colored wires
- Central or IO modules
- Examples include with and without pin outs and valve schematic



# Integration Guide for Siemens Simatic S7

## Generic Siemens Wiring Examples for S7 1200F (from Siemens Catalog):

4.1.4 Applications 5 and 6: 1oo2 evaluation of independent equivalent sensors  
S0 and S8 can be dual contacts of a single sensor.

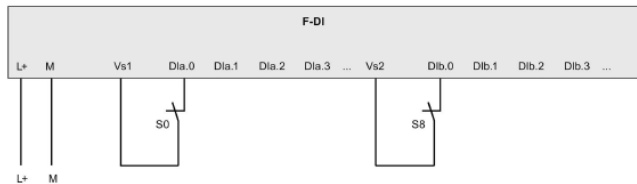


Figure 4-5 F-DI Application mode 5: Internal sensor supply

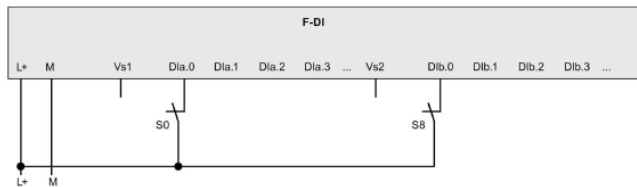
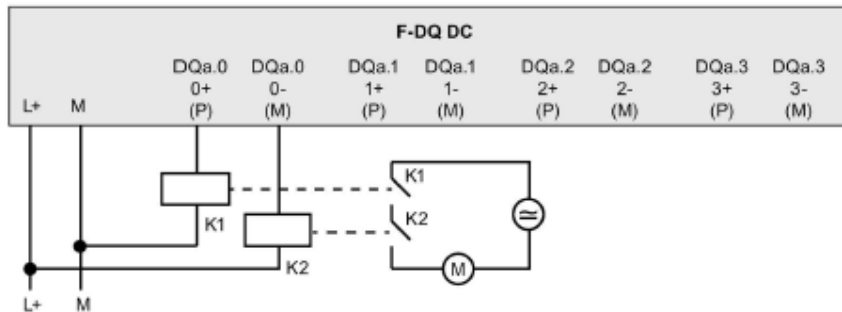


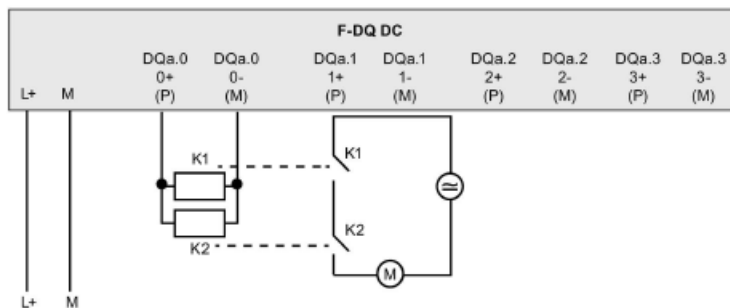
Figure 4-6 F-DI Application mode 6: External sensor supply

### Application 2: Wiring external contactors: Separate P and M controlled contactors

A short-circuit between the P and the M output can immediately lead to dangerous failure. You must prevent this failure mode by proper separation and protection of conductors.

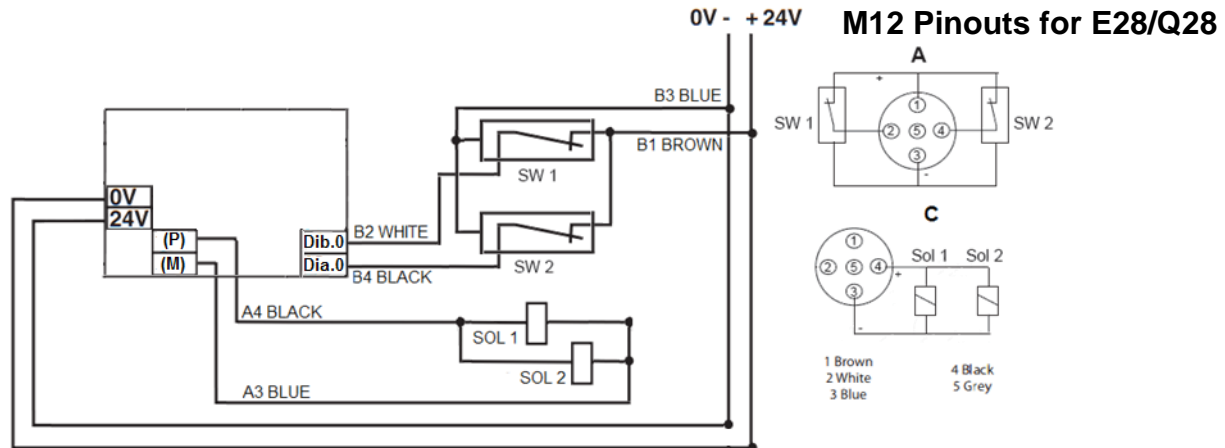


### Application 3: Wiring external contactors: Parallel connected between P and M



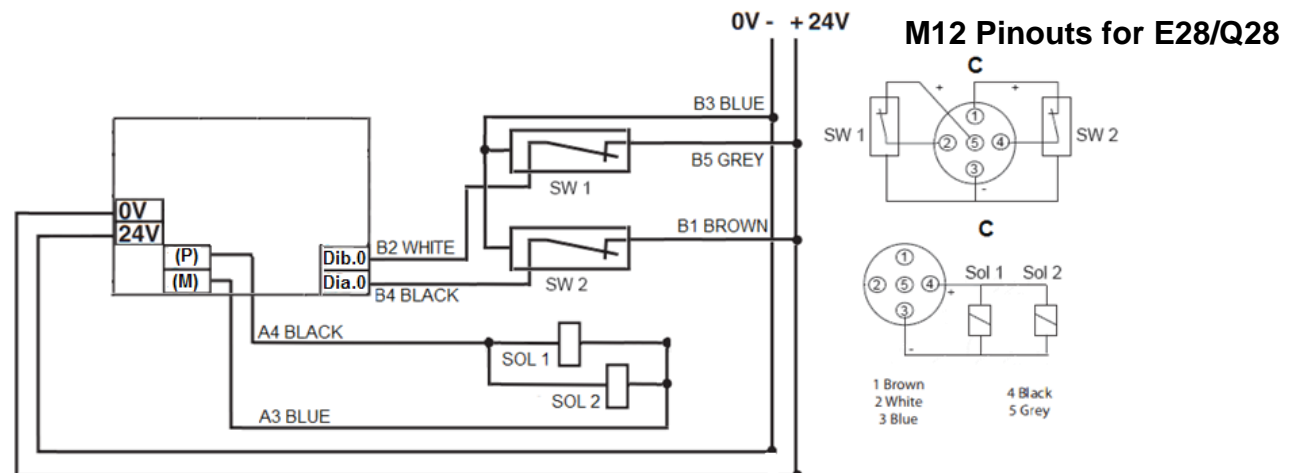
# Integration Guide for Siemens Simatic S7

## Siemens Wiring Schematic Safe Output without Sensor Test Pulse Version AC to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

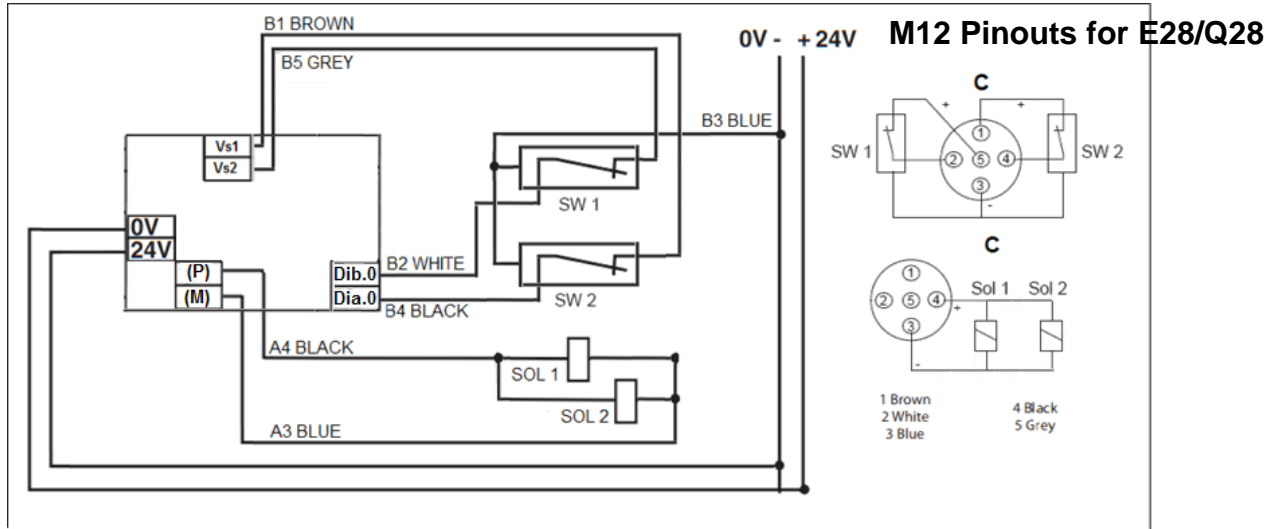
## Siemens Wiring Schematic Safe Output without Sensor Test Pulse Version CC to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Siemens Simatic S7

## Siemens Wiring Schematic Safe Output with Sensor Test Pulse to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Siemens Simatic S7

## Siemens - Program\*

External monitoring program

a) sensor error : Dia.0 <> Dib.0

Adjust discrepancy time at 150 ms

b) feedback error : Dia.0 = Dib.0 = Out 0

- Adjust discrepancy time

c) IF feedback or sensor error THEN reset Out 0

- Errors must be reset only after maintenance acknowledgement

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.



# Integration Guide for Turck TBPN-L1-FDIO1-2IOL

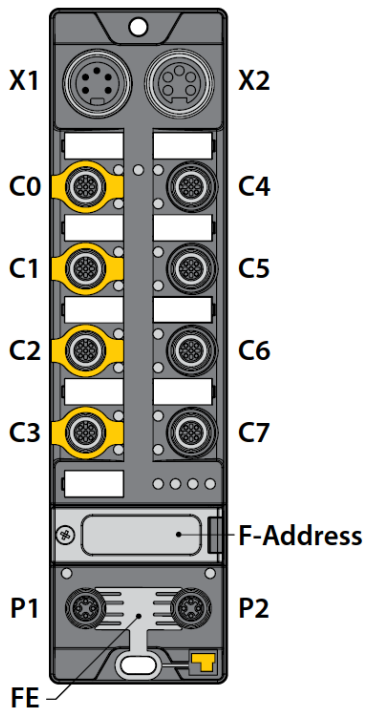
## Turck TBPN-L1-FDIO1-2IOL



Functional Safety Rating: Cat 4, PL e

- Uses M12 connections
- Direct M12 cables
- Central or IO modules

### Generic Connection Example (from Turck Catalog):



Meaning	Power IN
X2	Power OUT
C0	FDI0/1, safety input
C1	FDI2/3, safety input
C2	FDX4/5, safety in-/output
C3	FDX6/7, safety in-/output
C4	DXP8/9, standard in-/outputs (safe shutdown via FSO0)
C5	DXP10/11, standard in-/outputs (safe shutdown via FSO0 possible)
C6	IOL, IO-Link port1
C7	IOL, IO-Link port2 (safe shutdown via FSO1 possible)
F-Address	Rotary coding switch for address setting for PROFI-safe (F-address setting)
P1	Ethernet 1
P2	Ethernet 2
FE	Functional earth

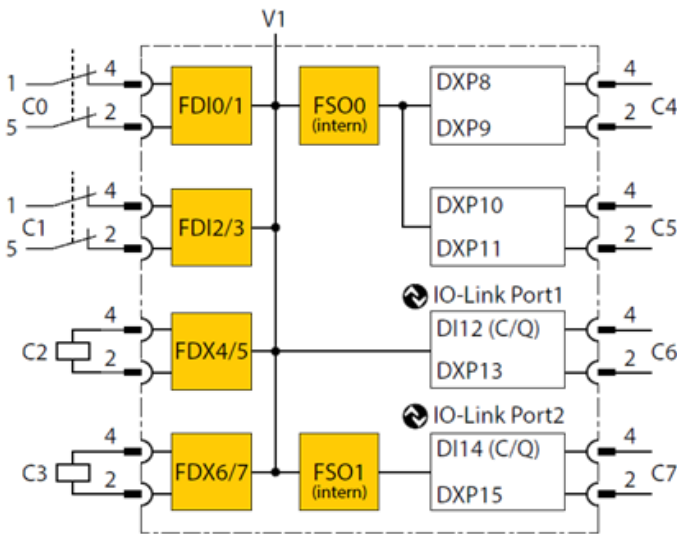
# Integration Guide for Turck TBPN-L1-FDIO1-2IOL

## Generic Turck Wiring Schematic (from Turck Catalog):

Safety Integrity Level/Performance Level/Category

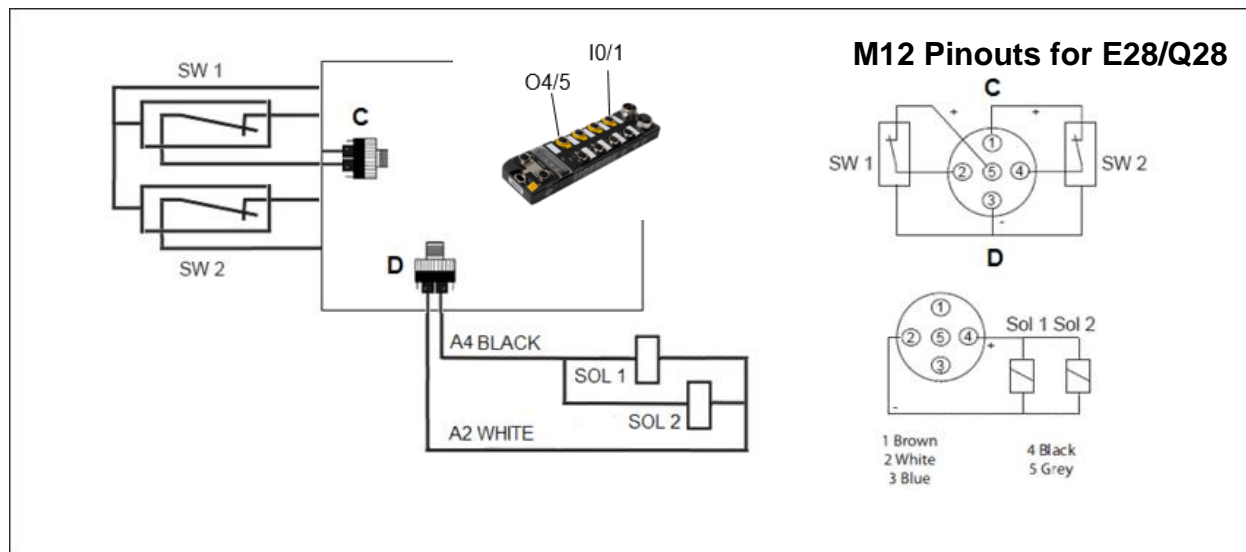
The devices are rated for applications up to:

- SIL3 according to EN/IEC/ 61508 and EN/EC 62061
- Category 4 / PL e according to EN ISO 13849-1



# Integration Guide for Turck TBPN-L1-FDIO1-2IOL

## Turck Wiring Schematic TBPN-L1-FDIO1-2IOL to Interface to Safety Exhaust Valve



With this schematic it is possible to achieve up to category 4 PL e if properly implemented.

# Integration Guide for Turck TBPN-L1-FDIO1-2IOL

## Turck TBPN - Program\*

External monitoring program

- a) sensor error : I.0 <> I.1
    - Adjust discrepancy time at 150 ms
  - b) feedback error : I.0 = I.1 = Out 4
    - Adjust discrepancy time
  - c) IF feedback or sensor error THEN reset Out 4
- Errors must be reset only after maintenance acknowledgement

\*Programs provided in this integration guide are for reference only. These programs have not been certified or tested unless stated otherwise.