



CROSSCHECK™ CC4 SERIES

SAFE CYLINDER CONTROL AND STOP

DOUBLE VALVES



INTEGRATION GUIDE

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Disclaimer:

Sample Logic and any and all related diagrams contained in ROSS Controls' Integration guide were developed and validated using dual channel electro-mechanical input signals in a laboratory environment and are provided to you for illustrative purposes only. Because of the many variables and unique requirements associated with any particular application, all persons responsible for installing and integrating ROSS products must satisfy themselves that the ROSS product is the correct product for the application and operates as intended. Because of the variability described above, ROSS Controls cannot assume responsibility or liability for actual use of its products based upon samples, examples and diagrams contained in its websites and documents.

Introduction

ROSS Controls offers a variety of safety valves for use in various safety functions such as safe exhaust, safe cylinder return, and safe cylinder control/stop (load holding). This document focuses specifically on ROSS Controls' 4/3 CC4 Series valves that are used for safe cylinder control/stop functions and utilize magnetic proximity sensors (PNP) to provide feedback to a safety control system for external monitoring.

Pulse Testing

In dual channel safety circuits, pulse testing is a method utilized to detect fault conditions that, otherwise, may be undetected. Pulse testing of the solenoids is required in dual channel circuits in order to reach performance level e (PL e). However, pulse testing of the feedback sensors is not required. Pulse testing of the solenoids will not affect the performance of the ROSS CC4 valve.

There are two methods of pulse testing outputs. The most common method is to use the native pulse testing instruction embedded by the manufacturer in Safety PLCs and Safety Relays. The other method is to use custom programming code generated by the user. We recommend the use of native pulse testing instructions of the respective manufacturers' safety Safety PLCs or Safety Relays because these instructions are fixed and cannot be tampered with. These instructions typically have a pulse period (cycle) of 400 ms to 600 ms and a pulse width of 0.4 ms to 0.8 ms. Pulse testing the outputs to the solenoids on the CC4 valve at this frequency and duration does not affect the performance of the valve but does provide a method to monitor for the occurrence of wiring faults in the output portion of the safety circuit controlling the valve solenoids.

Stopping Times for Safe Distance Calculations

When designing a safety circuit, the machine stopping time is a critical factor that determines the placement of guarding solutions. When using valves for a "safe cylinder control/stop" safety function, one factor in safe distance calculations is the response time of the valve. The faster your valve shifts, the quicker the cylinder can stop. The quicker the machine can stop, the closer your guarding solutions may be placed to the hazardous area. This can improve overall operating efficiency, ergonomics, and possibly allow the footprint of the machine to be smaller.

Unlike exhaust valves, the critical application time with blocking type valves is the parts movement time to block all ports (closing time) when switching from the energized condition to the de-energized condition. See the chart below for specific closing time intervals for the two sizes of CC4 valve.

Safe Distance calculations should be validated by testing.

Closing Time (time in ms from energized to all ports blocked)

Normal Response (not faulted)		
Valve Basic Size	From Port 2 Pressurized	From Port 4 Pressurized
0	70	80
2	90	100
Faulted Response		
Valve Basic Size	From Port 2 Pressurized	From Port 4 Pressurized
0	75	90
2	125	160

Note: Measured with supply pressure of 100 psig.

CC4 Wiring (Pinouts)

The CC4 wiring connections are made via two male M12 receptacles for the solenoids and one female M12 receptacle for the sensors. Pinouts are shown below. The M12 receptacles are wired such that if the solenoid cables are inadvertently swapped the valve will still operate the same as if they had not been swapped.

NOTE: The sensors must be wired with 24 volt (+) and 0 volt (-) connections in parallel with each other.

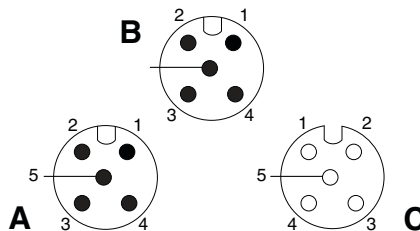
Valve Receptacle Arrangement

A & B - Solenoids

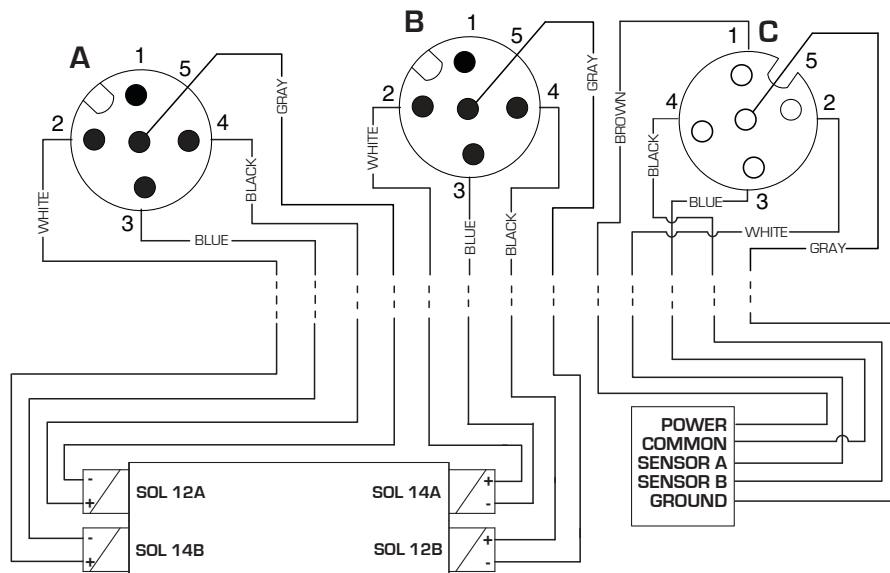
C - Sensor

IEC 61076-2-101

A CODED M12



Valve Wiring Diagram



Conversion to External Pilot Supply

The CC4 Series valve comes from the factory configured for internal pilot supply, which sources pilot supply air pressure internally from port 1 in the valve sub-base. However, the valve can be converted in the field to operate with external pilot supply through the X port in the valve sub-base. When this conversion to external pilot supply is made, the valve solenoid pilots will get their supply air from a source that is independent of the supply line connected to port 1.

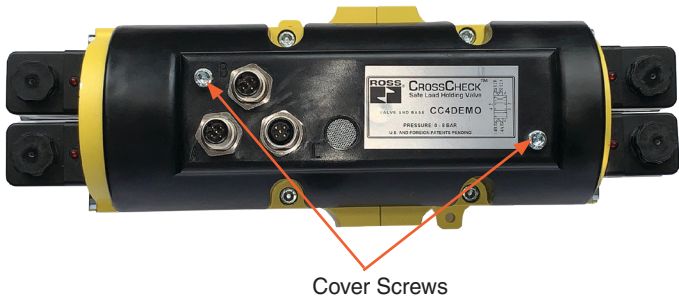
External pilot supply is typically used in applications where the normal supply pressure may be lower than the minimum operating pressure of the valve (60 psig (4 bar)). While external pilot supply may be a good alternative to internal pilot supply in certain applications, caution should be taken to avoid unsafe situations. For example, when using external pilot supply, a loss of pressure in port 1 while the valve is actuated could cause unexpected movement. In this situation, the valves will remain actuated by pressure from the external pilot source. This would allow both ports 2 and 4 to be exhausted, potentially causing unexpected motion. However, this situation can be detected through the addition of an upstream pressure switch or transducer in the main supply line to port 1. Once a fault is detected, the safety control system should turn off the outputs to all the valve solenoids. See Loss of Supply Pressure While Actuated on page 6.

WARNING: A loss of supply pressure to the valve and cylinder could cause unexpected cylinder movement.

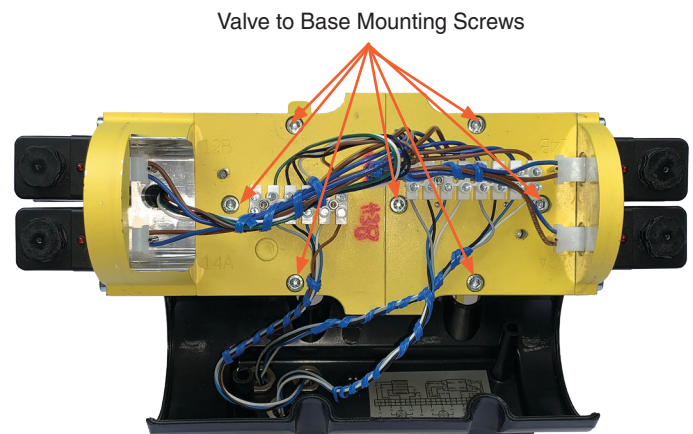
In order to convert the CC4 valve to external pilot supply:

- Shut-off and exhaust all pressure from the system and disconnect all electrical power from the valve.
- Remove the cover from the valve (2 screws). See photo below (left).
- Remove the valve from its sub-base (7 screws). See photo below (right).
- In the bottom of the valve, move the small pipe plug from the innermost hole to the outermost hole (max. torque 216 in-lbs (24.4 Nm)). See images below.
- Reinstall the valve on the sub-base (7 screws). See photo below (right).
Torque to: Port size 1/4 & 3/8: 49 in-lbs (5.5 Nm).
Port size 1/2 & 3/4: 216 in-lbs (24.4 Nm).
- Reinstall the cover (2 screws). Torque to 25 in-lb (2.8 Nm). See photo below (left).
- Remove the pipe plug from the X port in the sub-base.
- Install a new pilot supply line to the X port in the sub-base. The source for this external pilot supply line should be able to supply a minimum of 60 psig during system operation.

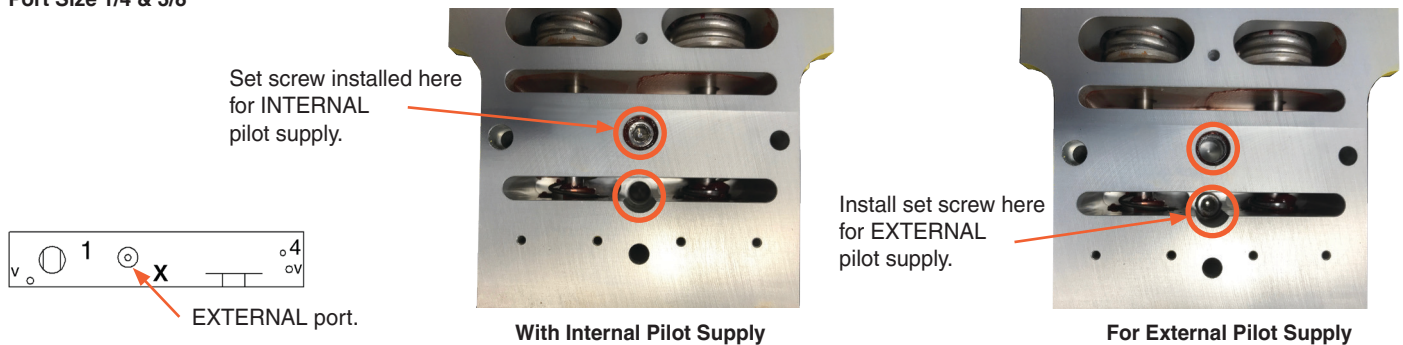
Top View



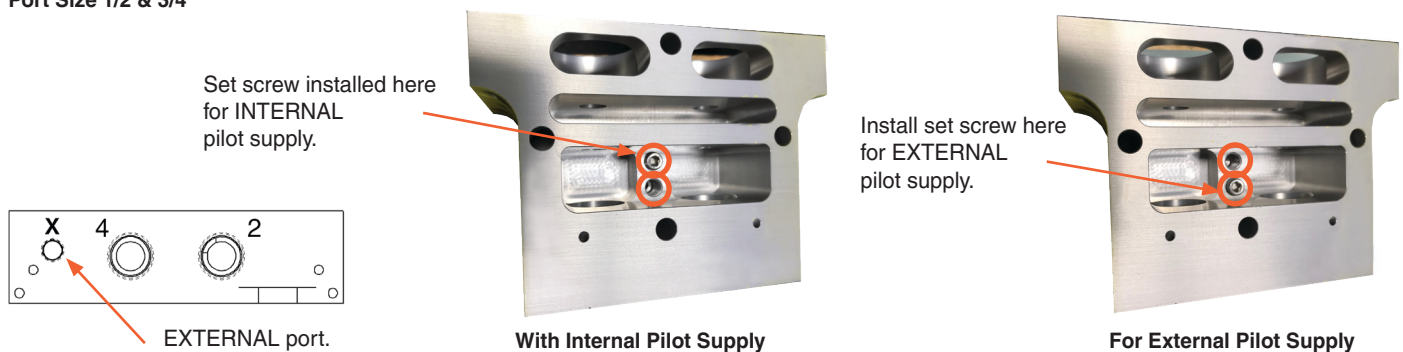
Top View - Open Cover



Port Size 1/4 & 3/8



Port Size 1/2 & 3/4

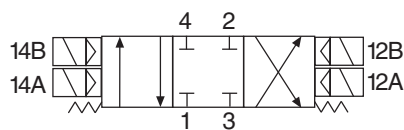


Operation & Monitoring Requirements for 4/3 CC4 Series Valves

The intent of this document is to provide guidance on how to operate and monitor the 4/3 CC4 valve for safe operation.

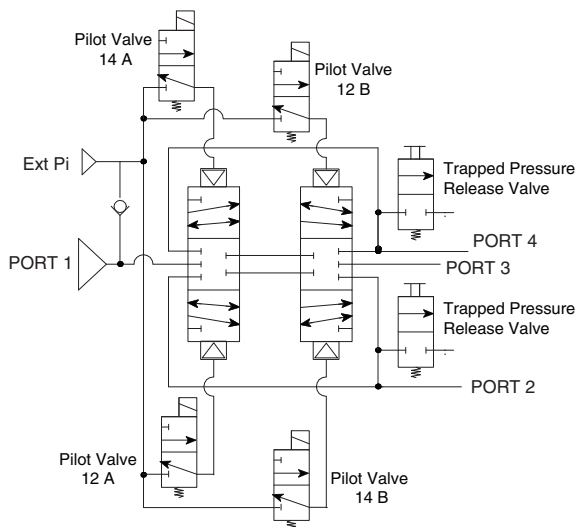
A test procedure is also provided for verification and validation of the user's external safety control monitoring system.

Simplified Valve Schematic



Valve Schematic

Schematics do not depict physical location of solenoids.



Valve Operation

The CC4 valve is a redundant, 4-port, 3-position, closed center valve. Its function is that of a 4/3, closed center, double-solenoid pilot-operated valve. However, because the valve is redundant it has four operating solenoids: two for extending a cylinder and two for retracting. When the valve is de-actuated, all 4 ports on the valve are closed (inlet port 1, outlet port 2, outlet port 4, & exhaust port 3).

In order to pressurize port 2 and exhaust port 4, both the 12A and 12B solenoids must be operated simultaneously. Conversely, in order to pressurize port 4 and exhaust port 2, both the 14A and 14B solenoids must be operated simultaneously. These pairs of solenoids must be operated by dual channel outputs from a safety control system.

NOTE: The 12A & 12B solenoids are physically located diagonally opposite each other on the valve, and the 14A & 14B solenoids are located at the other two opposite corners (diagonally).

De-actuating all of the solenoids returns the valve to the center, all-ports-closed position in order to trap air pressure in both cylinder lines to stop cylinder motion.

The CC4 valve is equipped with two sets of closed-center position, double-solenoid pilot valves that are integrated as a redundant and monitorable 4/3 closed-center-position directional valve that can be used to extend, retract, jog, and stop a cylinder. Each set of valves has a single, bi-directional magnetic proximity sensor that is wired as a PNP type sensor. When the valves are in the center position, the sensor outputs provide a voltage output signal to the inputs of the safety monitoring system. When the valves are actuated, the sensors switch off. Therefore, when both of the valves in the CC4 are in the center, de-actuated position, both sensors provide a 24 volts DC feedback signal, and when the valves are not in the center position (actuated), the sensors both provide a 0 volts DC feedback signal.

Normal operation occurs when both sets of valve internals shift within 150 msec of any change of the solenoid signals (12A & 12B or 14A & 14B). For example, when both the 12A & 12B solenoids are signaled to actuate, we would expect both proximity sensors to turn off within 150 msec of the application of the solenoid signals.

In the event of a valve fault where one of the redundant valve components does not operate normally, as commanded, the valve will perform its safety function which is to default to a condition where all ports are closed, including supply port 1, outlet port 2, outlet port 4, and exhaust port 3. The fault should be latched in by the safety monitoring system until a reset is performed.

Failure of the valve to shift normally leads to a fault in the CC4 valve. This could happen for a variety of reasons, such as:

- Compromised 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



Feedback Monitoring (General)

The CC4 valve is equipped with feedback proximity sensors that must be monitored by the user's external safety control & monitoring system to detect fault conditions within the valve. Sensor feedback should always be opposite the solenoid actuating signals. In other words, when the solenoids are energized, the sensor outputs should be off and when the solenoids are de-energized, the sensor outputs should be on.

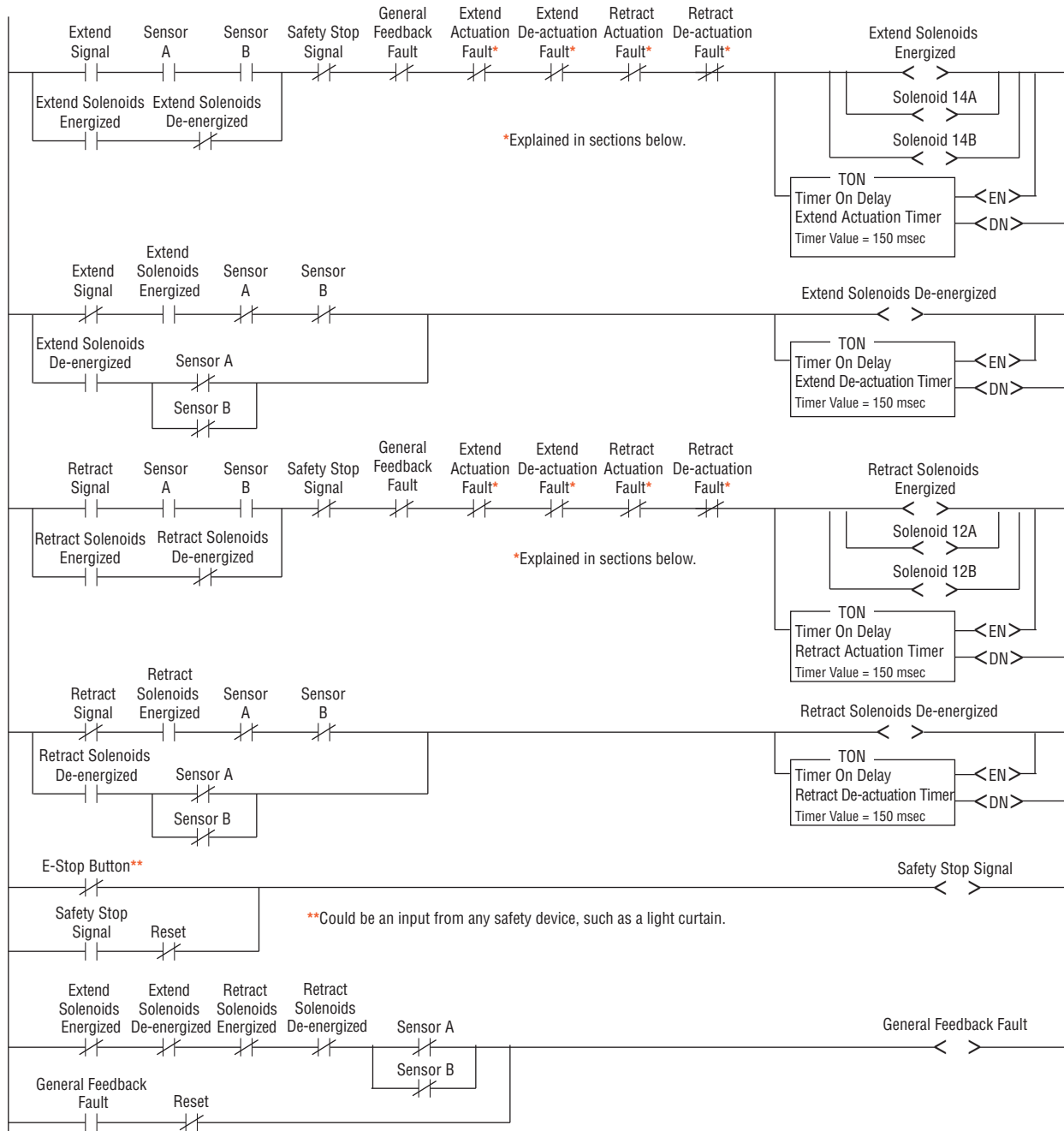
WARNING: It is possible to operate at a cycle rate that could result in non-monitored operation. To prevent exceeding this rate, ensure that the valve is de-actuated (both sensor outputs should be on) before attempting to energize the solenoids. Likewise, ensure that the valve is actuated (both sensor outputs should be off) before attempting to de-energize the solenoids.

NOTE: In the event of a stop signal from any safety system input, the safety system should immediately shut off the safety controller outputs to the valve solenoids (as required by the application) regardless of the condition of the feedback sensors.

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

Automatic RESET is not recommended by ROSS.

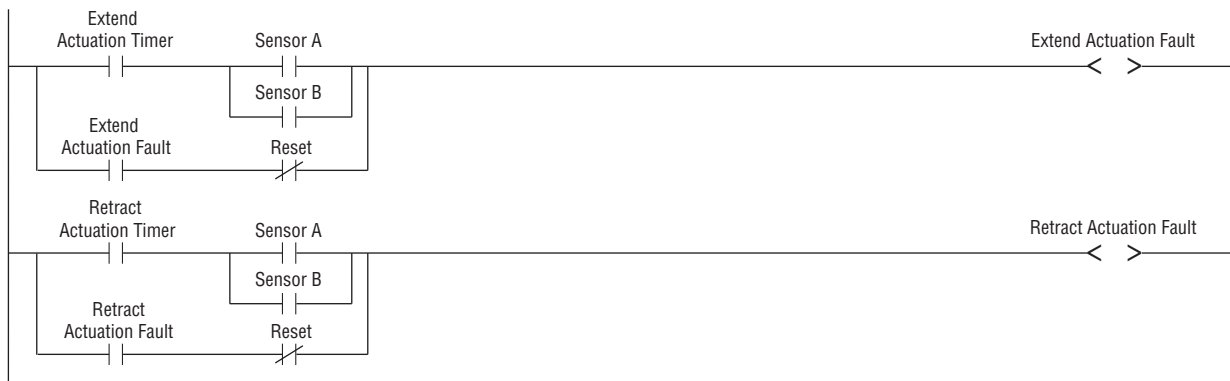
Valve Operation and General Feedback Monitoring Ladder Logic Example



Actuation Fault Monitoring

Actuation fault monitoring should check for actuation of both valves within 150 msec of the application of the actuation signal. After the safety control system simultaneously applies the actuation signal to both solenoids (12A & 12B or 14A & 14B), both sensor outputs should switch off within 150 msec. If both sensors have not changed state within the 150 msec time-frame, this should be registered as a valve fault.

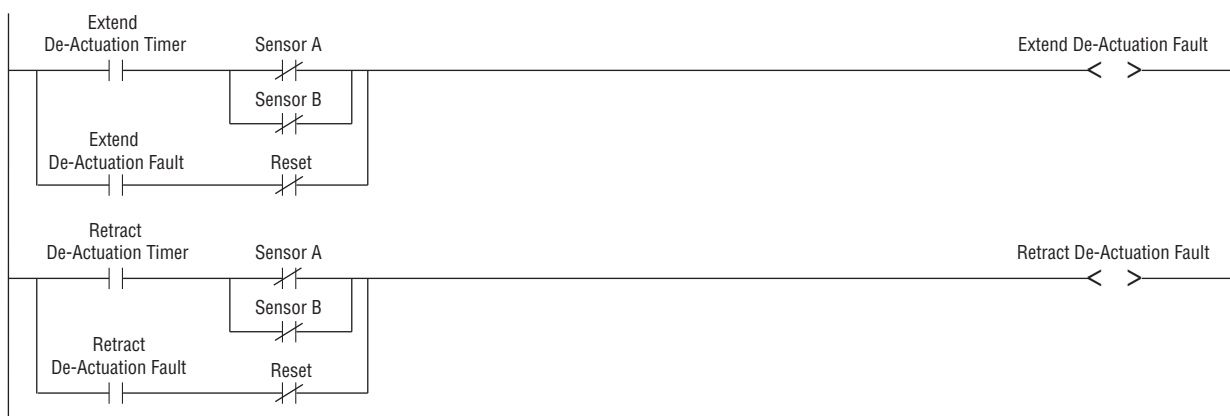
Actuation Fault Monitoring Ladder Logic Example



De-Actuation Fault Monitoring

De-Actuation fault monitoring should check for de-actuation of both valves within 150 msec of the removal of the actuation signal. After the safety control system simultaneously removes the actuation signals from both solenoids (12A & 12B or 14A & 14B), both sensor outputs should switch on within 150 msec. If both sensors have not changed state within the 150 msec timeframe, this should be registered as a valve fault.

De-actuation Fault Monitoring Ladder Logic Example



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.

NOTE: The safety function of the CC4 valve is to close all ports when the valve is switched off and/or when the valve is in a fault condition.

Using INTERNAL Pilot Supply (Standard configuration):

When operating the CC4 valve with INTERNAL pilot pressure (supplied internally from supply port 1), loss of supply pressure while actuated will cause both valves to de-actuate due to lack of pilot pressure; thus, causing all ports to close (trapping pressure in both cylinder lines downstream of outlet ports 2 & 4) and also causing both sensors to switch on. Therefore, this fault can be detected where the solenoids are energized, and one or both sensors go from off (not sensing the center, de-actuated position) to on (sensing the center, de-actuated position). This condition should be registered as a valve fault.

NOTE: No additional ladder logic is required for Loss of Supply Pressure While Actuated because this fault is detected by the Actuation Fault Monitoring logic.

WARNING: Valve does not close due to loss of supply pressure until the supply pressure drops below 60 psig (4 bar) which could result in unexpected cylinder movement.

Operation & Monitoring – Loss of Supply Pressure While Actuated (continued)

Using EXTERNAL Pilot Supply (Optional configuration):

When operating the CC4 valve with EXTERNAL pilot pressure (supplied externally from a separate source through the X port), a loss of supply pressure in supply port 1, but not in external pilot supply port X, will allow the valves to remain actuated; thus, potentially causing unexpected cylinder movement. This fault where both valves remain actuated while the main supply pressure is lost can be detected through the addition of an upstream pressure switch or transducer in the main supply line to port 1. This additional pressure switch or transducer must be monitored by the safety monitoring system to detect a fault where supply pressure in port 1 is too low. This condition should be registered as a valve fault by the safety control monitoring system, which should remove power from all solenoids on the CC4 valve. Thus, stopping any further cylinder movement.

WARNING: When utilizing EXTERNAL pilot supply from a source that is independent of the main valve supply, loss of pressure in the main valve supply could cause unexpected cylinder movement.

NOTE: No ladder logic example provided for additional equipment.

No Supply Pressure Applied Before Actuation

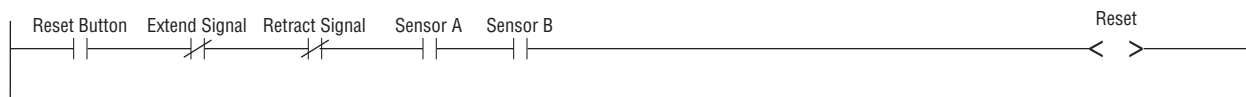
Monitoring of supply pressure may also be utilized if deemed beneficial for the application but is not required (unless using external pilot supply). If you choose to detect this condition it would require the addition of an upstream pressure switch or transducer in the main supply line to port 1. The condition of the pressure switch or transducer should be monitored to prevent actuation of the valve when supply pressure is insufficient. However, this becomes essential when external pilot pressure is being used. See above information on Loss of Supply Pressure While Actuated.

NOTE: No sample ladder logic provided for additional equipment.

Valve Fault & 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 all solenoids. Any fault should be latched in by the safety monitoring system until a reset is performed. A reset of the safety control system should only be possible after the valve sensors indicate that both valves in the CC4 are in the center, de-actuated position (both sensors switched on).

Safety System Reset Ladder Logic Example



Limitations of Load Holding Due to System Leakage

Leakage in a safe cylinder stop/load holding application has the potential to create unexpected motion regardless of whether the leakage occurs in the valve, hoses, connections or the cylinder. The CC4 series valves are equipped with valve position sensors for external monitoring to meet diagnostic coverage requirements. However, position sensing does not detect leakage. The CC4 series valves are designed to have redundant valve elements that are interconnected in such a manner that any single point of leakage within the valve will not cause unexpected movement. Therefore, periodic leakage testing of the system may be necessary depending on the risk assessment specific to the machine or application. If leakage is discovered, measures should be taken to eliminate the leak.

WARNING: Continued operation of the system without periodic leakage inspections can lead to unexpected movement.

Refer to steps 1 - 9 below to help identify valve/system leakage.

Valve/System Leakage Test Procedure

Step #	Fault Conditions Procedures	Sol 12A	Sol 12B	Sol 14A	Sol 14B	Outlet Pressure		Sensor Condition		Expected Cylinder Action	Notes	Results
						Port 2	Port 4	Sensor A	Sensor B			
NOTE: Prior to step 1 the cylinder needs to be positioned near mid-stroke.												
1	Momentarily energize solenoids 12A & 12B	On then off	On then off	Off	Off	Line	Line	Off then On	Off then On	Partial retract	Energize only long enough for a partial stroke.	
2	Energize solenoid 12A	On	Off	Off	Off	Line	Line	Off	On	None	Fault	
3	De-energize solenoid 12A	Off	Off	Off	Off	Line	Line	On	On	None	No fault	
4	Energize solenoid 12B	Off	On	Off	Off	Line	Line	On	Off	None	Fault	
5	De-energize solenoid 12B	Off	Off	Off	Off	Line	Line	On	On	None	No fault	
6	Energize solenoid 14A	Off	Off	On	Off	Line	Line	Off	On	None	Fault	
7	De-energize solenoid 14A	Off	Off	Off	Off	Line	Line	On	On	None	No fault	
8	Energize solenoid 14B	Off	Off	Off	On	Line	Line	On	Off	None	Fault	
9	De-energize solenoid 14B	Off	Off	Off	Off	Line	Line	On	On	None	No fault	

CC4 Validation Test Procedure for Valve Operation and External Monitoring Logic

NOTE 1:	This validation test procedure should only be performed with a CC4 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.
NOTE 2:	These procedures require fault simulation. It will be necessary to induce faults electrically by disabling a different solenoid or sensor at different times. This will be most easily done by disconnecting solenoid or sensor wires at the safety controller.
NOTE 3:	Ports 2 and 4 should be connected to a cylinder with a gauge or pressure sensor teed into each line. Or, just a gauge in each outlet port, 2 and 4.
NOTE 4:	Supply pressure will need to be supplied to inlet port 1.
NOTE 5:	Power for the sensor board needs to be maintained throughout the entire procedure. Pins 1 and 3 must remain connected at all times during this validation test.
NOTE 6:	This procedure pertains to internal pilot configuration only.
NOTE 7:	"-" indicates no change from previous step.
NOTE 8:	Retract Signal and Extend Signal are the signals to switch on the solenoids either from physical input switches or software signals.

Step	Action	Retract Signal (12A & 12B)	Extend Signal (14A & 14B)	Sol 12A	Sol 12B	Sol 14A	Sol 14B	Port Conditions	Outlet Condition at End of Stroke		Sensor Conditions Sensor A Sensor B	Cylinder Action	Fault ?	Pass/Fail (P/F)
									Port 2	Port 4				
1	Energize solenoids 12A & 12B	ON	OFF	ON	ON	OFF	OFF	1 to 2 4 to 3	Pressure	None	OFF	Retract	No	
2	De-energize solenoids 12A & 12B	OFF	-	OFF	OFF	-	-	All closed	-	-	ON	Stop	-	
3	Energize solenoids 14A & 14B	-	ON	-	-	ON	ON	1 to 4 2 to 3	None	Pressure	OFF	Extend	-	
4	De-energize solenoids 14A & 14B	-	OFF	-	-	OFF	OFF	All closed	-	-	ON	Stop	-	
5	Disconnect solenoid signal wire from solenoid 12B	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	ON	Stop	No	
6	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	Yes*	
7	Reconnect solenoid 12B	-	-	-	-	-	-	-	-	-	-	-	-	
8	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	
9	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	No	
10	Disconnect solenoid signal wire from solenoid 12A	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	ON	Stop	No	
11	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	Yes*	
12	Reconnect solenoid 12A	-	-	-	-	-	-	-	-	-	-	-	-	
13	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	
14	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	No	

* Fault should be detected within 150 msec.

Step	Action	Retract Signal (12A & 12B) (14A & 14B)		Sol 12A	Sol 12B	Sol 14A	Sol 14B	Port Conditions	Outlet Condition at End of Stroke		Sensor Conditions		Cylinder Action	Fault ?	Pass/Fail (P/F)
		(12A & 12B)	Extend Signal (14A & 14B)						Port 2	Port 4	Sensor A	Sensor B			
15	Disconnect solenoid signal wire from solenoid 14B	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	ON	ON	Stop	No	
16	Attempt to energize solenoids 14A & 14B	-	ON	-	-	-	-	-	-	-	-	-	-	Yes*	
17	Reconnect solenoid 14B	-	-	-	-	-	-	-	-	-	-	-	-	-	
18	De-energize solenoids 14A & 14B	-	OFF	-	-	-	-	-	-	-	-	-	-	-	
19	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	No	
20	Disconnect solenoid signal wire from solenoid 14A	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	ON	ON	Stop	No	
21	Attempt to energize solenoids 14A & 14B	-	ON	-	-	-	-	-	-	-	-	-	-	Yes*	
22	Reconnect solenoid 14A	-	-	-	-	-	-	-	-	-	-	-	-	-	
23	De-energize solenoids 14A & 14B	-	OFF	-	-	-	-	-	-	-	-	-	-	-	
24	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	No	
25	Energize solenoids 12A & 12B	ON	OFF	ON	ON	OFF	OFF	1 to 2 4 to 3	Pressure	None	OFF	OFF	Retract	No	
26	Disconnect solenoid signal wire from solenoid 12A	-	-	OFF	OFF	-	-	All closed	-	-	ON	ON	Stop	Yes**	
27	Reconnect solenoid signal wire to solenoid 12A	-	-	-	-	-	-	-	-	-	-	-	-	-	
28	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	
29	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	No	
30	Energize solenoids 12A & 12B	ON	OFF	ON	ON	OFF	OFF	1 to 2 4 to 3	Pressure	None	OFF	OFF	Retract	No	
31	Disconnect solenoid signal wire from solenoid 12B	-	-	OFF	OFF	-	-	All closed	-	-	ON	ON	Stop	Yes**	
32	Reconnect solenoid signal wire to solenoid 12B	-	-	-	-	-	-	-	-	-	-	-	-	-	
33	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	
34	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	No	
35	Energize solenoids 14A & 14B	OFF	ON	OFF	OFF	ON	ON	1 to 4 2 to 3	None	Pressure	OFF	OFF	Extend	No	
36	Disconnect solenoid signal wire from solenoid 14A	-	-	-	-	OFF	OFF	All closed	-	-	ON	ON	Stop	Yes**	
37	Reconnect solenoid signal wire to solenoid 14A	-	-	-	-	-	-	-	-	-	-	-	-	-	
38	De-energize solenoids 14A & 14B	-	OFF	-	-	-	-	-	-	-	-	-	-	-	
39	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	No	

* Fault should be detected within 150 msec. ** Fault should occur immediately.

Step	Action	Retract Signal (12A & 12B)		Extend Signal (14A & 14B)	Sol 12A		Sol 12B	Sol 14A	Sol 14B	Port Conditions	Outlet Condition at End of Stroke		Sensor Conditions		Cylinder Action	Fault ?	Pass/Fail (P/F)
		(12A & 12B)	(12A & 12B)								Port 2	Port 4	Sensor A	Sensor B			
40	Energize solenoids 14A & 14B	OFF	OFF	ON	OFF	OFF	OFF	ON	ON	1 to 4 2 to 3	None	Pressure	OFF	OFF	Extend	No	
41	Disconnect solenoid signal wire from solenoid 14B	-	-	-	-	-	-	OFF	OFF	All closed	-	-	ON	ON	Stop	Yes**	
42	Reconnect solenoid signal wire to solenoid 14B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
43	De-energize solenoids 14A & 14B	-	-	OFF	-	-	-	-	-	-	-	-	-	-	-	-	
44	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
45	Disconnect sensor output wire from sensor A	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	OFF	OFF	Stop	Yes**	
46	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
47	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
48	Reconnect sensor output wire to sensor A	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	-	
49	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
50	Disconnect sensor output wire from sensor B	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	ON	OFF	Stop	Yes**	
51	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
52	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
53	Reconnect sensor output wire to sensor B	-	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	
54	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
55	Energize solenoids 12A & 12B	ON	OFF	ON	ON	ON	ON	OFF	OFF	1 to 2 4 to 3	Pressure	None	OFF	OFF	Retract	No	
56	Disconnect sensor output wire from sensor A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
57	De-energize solenoids 12A & 12B	OFF	-	OFF	OFF	OFF	OFF	-	-	All closed	-	-	-	ON	Stop	Yes*	
58	Reconnect sensor output wire to sensor A	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	-	
59	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
60	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
61	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	

* Fault should be detected within 150 msec.

** Fault should occur immediately.

Step	Action	Retract Signal (12A & 12B)		Extend Signal (14A & 14B)	Sol 12A	Sol 12B	Sol 14A	Sol 14B	Port Conditions	Outlet Condition at End of Stroke			Sensor Conditions		Cylinder Action	Fault ?	Pass/Fail (P/F)
										Port 2	Port 4	Port 4	Sensor A	Sensor B			
62	Energize solenoids 12A & 12B	ON	OFF	OFF	ON	ON	OFF	OFF	1 to 2 4 to 3	Pressure	None	None	OFF	OFF	Retract	No	
63	Disconnect sensor output wire from sensor B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
64	De-energize solenoids 12A & 12B	OFF	-	OFF	OFF	OFF	-	-	All closed	-	-	-	ON	-	Stop	Yes*	
65	Reconnect sensor output wire to sensor B	-	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	
66	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
67	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
68	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
69	Energize solenoids 12A & 12B	ON	OFF	OFF	ON	ON	OFF	OFF	1 to 2 4 to 3	Pressure	None	None	OFF	OFF	Retract	No	
70	Remove supply air from port 1	-	-	OFF	OFF	OFF	-	-	All closed	-	-	-	ON	ON	Stop	Yes**	
71	Resupply air to port 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
72	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
73	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
74	Energize solenoids 14A & 14B	OFF	ON	ON	OFF	OFF	ON	ON	1 to 4 2 to 3	None	Pressure	None	OFF	OFF	Extend	No	
75	Remove supply air from port 1	-	-	-	-	-	OFF	OFF	All closed	-	-	-	ON	ON	Stop	Yes**	
76	Resupply air to port 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
77	De-energize solenoids 14A & 14B	-	OFF	OFF	-	-	-	-	-	-	-	-	-	-	-	-	
78	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
79	Disconnect sensor output wire from sensor A	OFF	OFF	OFF	OFF	OFF	OFF	OFF	All closed	None	Pressure	None	OFF	ON	Stop	Yes**	
80	Attempt to reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
81	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
82	Reconnect the sensor output wire to sensor A	-	-	-	-	-	-	-	-	-	-	-	ON	ON	-	-	
83	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
84	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
85	Energize solenoids 12A & 12B	ON	-	ON	ON	ON	-	-	1 to 2 4 to 3	Pressure	None	None	OFF	OFF	Retract	-	
86	De-energize solenoids 12A & 12B	OFF	-	OFF	OFF	OFF	-	-	All closed	-	-	-	ON	ON	Stop	-	

* Fault should be detected within 150 msec. ** Fault should occur immediately.

Step	Action	Retract Signal (12A & 12B)		Extend Signal (14A & 14B)		Sol 12A	Sol 12B	Sol 14A	Sol 14B	Port Conditions	Outlet Condition at End of Stroke			Sensor Conditions		Cylinder Action	Fault ?	Pass/Fail (P/F)
											Port 2	Port 4	Port 4	Sensor A	Sensor B			
87	Disconnect sensor output wire from sensor B	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	All closed	Pressure	None	None	ON	OFF	Stop	Yes**	
88	Attempt to reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
89	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
90	Reconnect the sensor output wire to sensor B	-	-	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	
91	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
92	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
93	Energize solenoids 12A & 12B	ON	-	ON	ON	ON	ON	-	-	1 to 2 4 to 3	-	-	-	OFF	OFF	Retract	-	
94	De-energize solenoids 12A & 12B	OFF	-	OFF	OFF	OFF	OFF	-	-	All closed	-	-	-	ON	ON	Stop	-	
95	Disconnect sensor output wire from sensor A	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	All closed	Pressure	None	None	OFF	ON	Stop	Yes**	
96	Reconnect the sensor output wire to sensor A	-	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	-	
97	Attempt to energize solenoids 12A & 12B	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
98	Attempt to reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
99	De-energize solenoids 12A & 12B	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
102	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
103	Energize solenoids 12A & 12B	ON	-	-	ON	ON	ON	-	-	1 to 2 4 to 3	-	-	-	OFF	OFF	Retract	-	
104	De-energize solenoids 12A & 12B	OFF	-	OFF	OFF	OFF	OFF	-	-	All closed	-	-	-	ON	ON	Stop	-	
Items 105 through 114 could also be done with Sensor B instead of Sensor A.																		
105	Disconnect sensor output wire from sensor A	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	All closed	Pressure	None	None	OFF	ON	Stop	Yes**	
106	Reconnect the sensor output wire to sensor A	-	-	-	-	-	-	-	-	-	-	-	-	ON	-	-	-	
107	Attempt to energize solenoids 14A & 14B	-	ON	ON	-	-	-	-	-	-	-	-	-	-	-	-	-	
108	Attempt to reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
109	De-energize solenoids 14A & 14B	-	OFF	OFF	-	-	-	-	-	-	-	-	-	-	-	-	-	
112	Reset the safety control system	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No	
113	Energize solenoids 14A & 14B	-	ON	ON	-	-	ON	ON	ON	1 to 4 2 to 3	None	Pressure	Pressure	OFF	OFF	Extend	-	
114	De-energize solenoids 14A & 14B	-	OFF	OFF	-	-	OFF	OFF	OFF	All closed	-	-	-	ON	ON	Stop	-	

** Fault should occur immediately.

CAUTIONS, WARNINGS And STANDARD WARRANTY

ROSS OPERATING VALVE, ROSS CONTROLS®, ROSS DECCO®, and AUTOMATIC VALVE INDUSTRIAL, collectively the “ROSS Group”.

PRE-INSTALLATION or SERVICE

1. Before servicing a valve or other pneumatic component, be sure all sources of energy are turned off, the entire pneumatic system is shut down and exhausted, and all power sources are locked out (ref: OSHA 1910.147, EN 1037).
2. All ROSS Group Products, including service kits and parts, should be installed and/or serviced only by persons having training and experience with pneumatic equipment. Because any product can be tampered with and/or need servicing after installation, persons responsible for the safety of others or the care of equipment must check ROSS Group Products on a regular basis and perform all necessary maintenance to ensure safe operating conditions.
3. All applicable instructions should be read and complied with before using any fluid power system to prevent harm to persons or equipment. In addition, overhauled or serviced valves must be functionally tested prior to installation and use. If you have any questions, call your nearest ROSS Group location.
4. Each ROSS Group Product should be used within its specification limits. In addition, use only ROSS Group components to repair ROSS Group Products.

WARNINGS:

Failure to follow these instructions can result in personal injury and/or property damage.

FILTRATION and LUBRICATION

1. Dirt, scale, moisture, etc., are present in virtually every air system. Although some valves are more tolerant of these contaminants than others, best performance will be realized if a filter is installed to clean the air supply, thus preventing contaminants from interfering with the proper performance of the equipment. The ROSS Group recommends a filter with a 5-micron rating for normal applications.
2. All standard ROSS Group filters and lubricators with polycarbonate plastic bowls are designed for compressed air applications only. Use the metal bowl guard, where provided, to minimize danger from high pressure fragmentation in the event of bowl failure. Do not expose these products to certain fluids, such as alcohol or liquefied petroleum gas, as they can cause bowls to rupture, creating a combustible condition and hazardous leakage. Immediately replace crazed, cracked, or deteriorated bowls.
3. Only use lubricants which are compatible with materials used in the valves and other components in the system. Normally, compatible lubricants are petroleum base oils with oxidation inhibitors, an aniline point between 180°F (82°C) and 220°F (104°C), and an ISO 32, or lighter, viscosity. Avoid oils with phosphate

type additives which can harm polyurethane components, potentially leading to valve failure which risks personal injury, and/or damage to property.

WARNINGS:

Failure to follow these instructions can result in personal injury and/or property damage.

AVOID INTAKE/EXHAUST RESTRICTION

1. Do not restrict air flow in the supply line. To do so could reduce the pressure of the supply air below minimum requirements for the valve and thereby causing erratic action.
2. Do not restrict a valve's exhaust port as this can adversely affect its operation. Exhaust silencers must be resistant to clogging and must have flow capacities at least as great as the exhaust capacities of the valves. Contamination of the silencer can result in reduced flow and increased back pressure.

WARNINGS: *Failure to follow these instructions can result in personal injury and/or property damage.*

SAFETY APPLICATIONS

1. Mechanical Power Presses and other potentially hazardous machinery using a pneumatically controlled clutch and brake mechanism must use a press control double valve with a monitoring device. A double valve without a self-contained monitoring device should be used only in conjunction with a control system which assures monitoring of the valve. All double valve installations involving hazardous applications should incorporate a monitoring system which inhibits further operation of the valve and machine in the event of a failure within the valve mechanism.
2. Safe Exhaust (dump) valves without a self-contained monitoring device should be used only in conjunction with a control system which assures monitoring of the valve. All Safe Exhaust valve installations should incorporate a monitoring system which inhibits further operation of the valve and machine in the event of a failure within the valve mechanism.
3. Per specifications and regulations, the ROSS L-O-X® and L-O-X® with EEZ-ON®, N06 and N16 Series operation products are defined as energy isolation devices, NOT AS EMERGENCY STOP DEVICES.

WARNINGS:

Failure to follow these instructions can result in personal injury and/or property damage.

STANDARD WARRANTY

All products sold by the ROSS Group are warranted for a one-year period [with the exception of Filters, Regulators and Lubricators (“FRLs”) which are warranted for a period of seven (7) years] from the date of purchase. All products are, during their respective warranty periods, warranted to be free of defects in material and workmanship. The ROSS Group's obligation under this warranty is limited to repair, replacement or refund of the purchase price paid for products which the ROSS Group has determined, in its sole discretion, are defective. All warranties become void if a product has been subject to misuse, misapplication, improper maintenance, modification or tampering. Products for which warranty protection is sought must be returned to the ROSS Group freight prepaid.

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