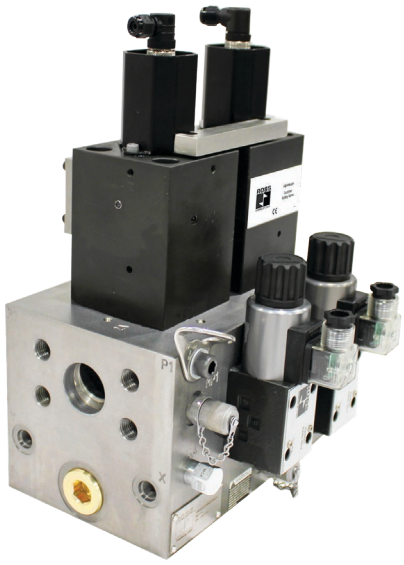
HBH Series

Hydraulic Block and Stop Safety Valve Systems



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

This document focuses specifically on ROSS Controls' HBH Series valve systems that are used for safe hydraulic Block and Stop functions and utilize inductive position switches (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 HBH Series valve system.

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 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 HBH valve system 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 the 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.

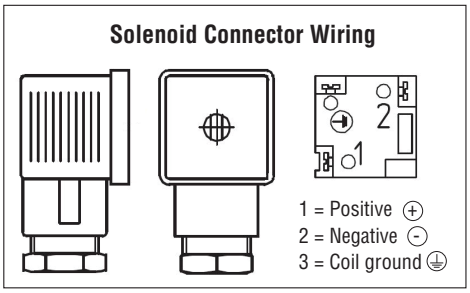
Unlike block and bleed valves, the critical application time with blocking type valves is the response time to block all ports (closing time) when switching from the ON condition (not blocking) to the OFF condition (blocking). Even more important is the "Faulted" response time. Faulted response time is the reaction time of the HBH system in its worst state. Double valves (redundant valve systems used for safety applications) will not close quite as quickly when there is an internal fault condition in the valve system, such as when one of the redundant valve components is de-actuated and the other one is not de-actuated. For this reason, safe distance calculations should always be done using faulted response times as the worst-case condition.

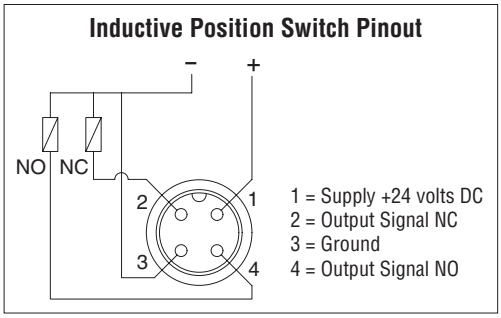
Safe Distance calculations should be validated by testing.

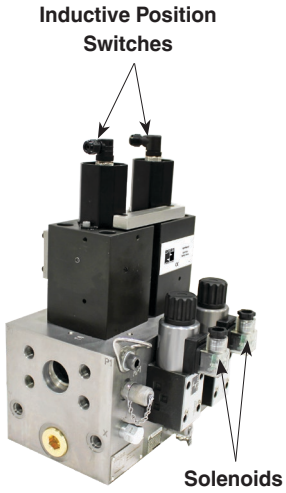
HBH Wiring (Pinouts)

Connection Type:
Solenoids: EN 175301-803, Form A
Switches: A-coded, male M12

Pinouts are shown below. Solenoid connectors (without cable) included with the valve. Cables with A-coded female M12 connectors are needed to connect to the switches (sold separately).

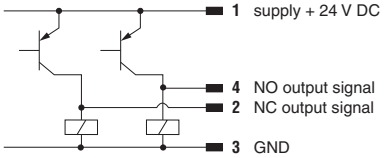






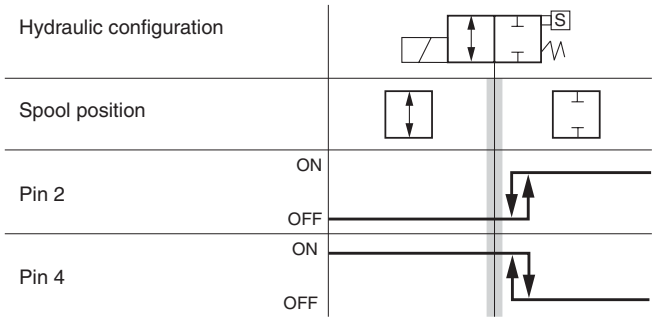
NOTE: The switches must be wired with 24 volt (+) and 0 volt (-) connections in parallel with each other.

Technical Characteristics Of PNP Inductive Position Switch	
Type Of Switch	Contactless inductive position switch with integrated amplifier
Supply Voltage [V]	20-32 V DC
Ripple Max [%]	≤ 10
Max Current [mA]	400
Reaction Time [ms]	15
Max Peak Pressure [bar]	400
Mechanical Life	Virtually Infinite
Switch Logic	PNP



Note: PNP Position Switch can be electrically wired by the consumer as NO or NC and then the status of the output signal will be in accordance to the selected configuration.
= Intermediate spool position corresponding to the hydraulic configuration change.

OUTPUT SIGNAL STATUS FOR EACH VALVE IN THE HBH SYSTEM



Pilot Supply Conversion

The HBH Series valve system is solenoid pilot-operated and requires pilot pressure to hold the valve in position. The HBH has a pilot supply system that utilizes an arrangement of internal check valves to enable the highest available pressure source within the manifold to be used for pilot pressure at any given time. This pilot pressure can be sourced internally (from Ports P1 or P2) or externally through one of the X ports in the manifold.

The HBH is shipped from the factory configured for internal pilot supply. In this configuration both X ports are blocked with a pipe plug.

In order to convert the HBH to external pilot supply, it is necessary to remove the plug from one of the X ports in the manifold (leave the other one plugged) and connect a hydraulic line from a separate source to that X port.

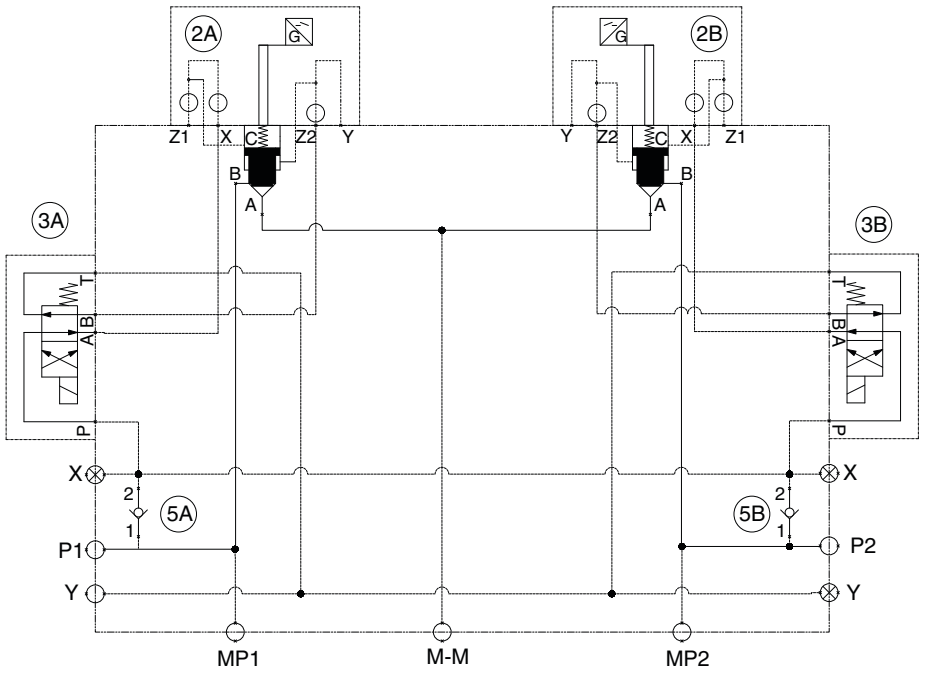
NOTE: It is recommended to install a check valve in the external pilot supply line to help prevent flow from port P2 to X when pressure in P2 is higher than the pressure in port X. Check valve shall be in accordance with Table C.4 of ISO 13849-2 for fault exclusion.

WARNING: Unexpected movement could occur if one of the check valves in the pilot system, including any check installed in the external pilot supply line, were to fail open. A failure of one of these check valves could allow as much as 10 gpm flow from P1 to P2, P2 to P1 or P2 to X (external pilot port). The amount of flow could be higher from P2 to X when using external pilot supply depending on the flow capability of the check valve that the user installs in that line or, especially, if no check is installed in the external pilot line.

Operation & Monitoring Requirements for HBH Series Valve System

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

Valve System Schematic



Valve Operation

The HBH Series valve system is a redundant safety block and stop valve system. Its function is that of a 2/2, normally closed, single-solenoid pilot valve. However, because the system is redundant it has two solenoids that must be operated simultaneously in order to actuate. In addition, each valve element within the HBH system has a single, inductive position switch that is wired as a PNP type switch for position sensing. Each position switch is supplied with both NC and NO contacts.

Actuating the valve will allow flow between ports P1 and P2 in either direction.

De-actuating the valve will block flow, in either direction, between port P1 and port P2. De-actuation of the valve is accomplished by turning off both solenoids simultaneously.

Normal operation occurs when both sets of valve internals shift within 350 msec of the change of the solenoid signals. For example, when both solenoids are signaled to energize, we would expect both position switches to turn off within 350 msec of application of the solenoid signals. Each switch only reacts to its associated solenoid.

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 block flow in either direction between ports P1 and P2.

The fault should be latched in by the safety monitoring system until a reset is performed.

Failure of one of the valves to shift normally leads to a fault in the HBH Series valve system. This could happen for a variety of reasons, such as:

- Compromised 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

Feedback Monitoring (General)

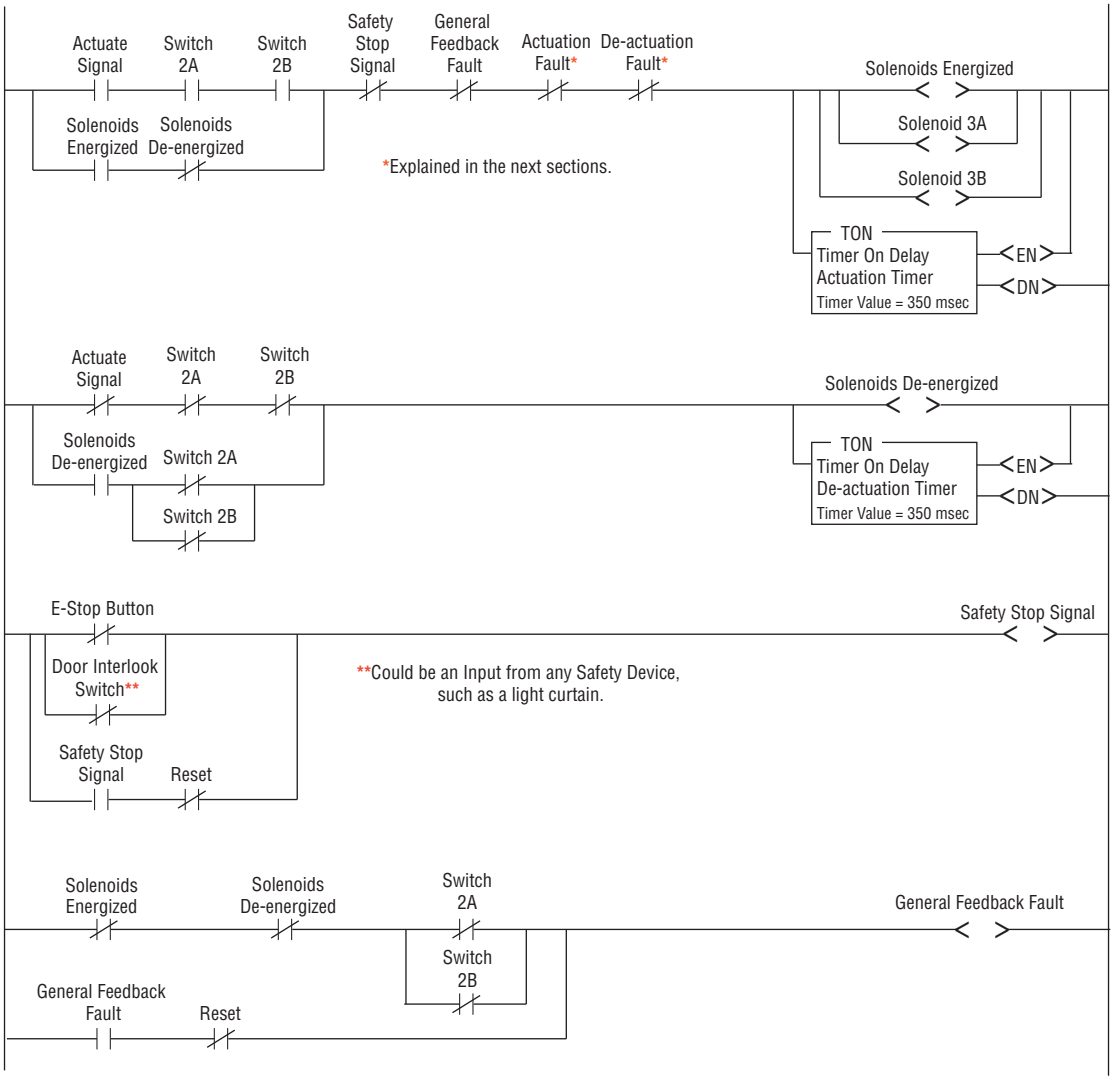
The HBH Series valve system is equipped with feedback inductive position switches that must be monitored by the user's external safety control & monitoring system to detect any fault condition within the HBH valve system. The position switches are provided with both NC and NO outputs. If using the NC outputs, switch feedback should always be opposite the solenoid actuating signals. The ladder logic examples below were created with reference to the NC outputs of the inductive position switches.

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 switch outputs should be on) before attempting to energize the solenoids. Likewise, ensure that the valve is actuated (both switch 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 switches.

Automatic RESET is not recommended by ROSS.

HBH Valve System Operation and General Feedback Monitoring Ladder Logic Example



Actuation Fault Monitoring

Actuation fault monitoring should check for actuation of both valves within 350 msec of the actuation signal. After the safety control system outputs provide simultaneous actuation signals to both solenoids, both NC switch outputs should switch off within 350 msec. If both switches have not changed state within the 350 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 350 msec of the removal of the actuation signal. After the safety control system simultaneously removes the actuation signals from both solenoids, both NC switch outputs should switch on within 350 msec. If both switches have not changed state within the 350 msec time frame, this should be registered as a valve fault.

De-actuation Fault Monitoring Ladder Logic Example

Loss of Supply While Actuated

The condition of loss of supply to port P1 while the valve system is actuated must be detected by the safety control monitoring system. If using INTERNAL pilot supply, the logic supplied above will detect the condition, but only after all pressure in the system has decayed due to the loss of supply pressure.

NOTE: This is only possible when using INTERNAL pilot supply on HBH valve systems where loss of supply pressure should cause both valves to de-actuate due to lack of pilot pressure; thus, causing both NC switches to switch on even though the solenoids are still energized. Therefore, this fault can be detected when the solenoids are energized and one or both NC switches switch from off (sensing the actuated position) to on (not sensing the actuated position).

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

NOTE: Unexpected movement could occur until the fault is detected by the Actuation Fault Monitoring logic.

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 both 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 switches indicate that the valve is in the de-actuated state (both NC switch outputs are closed). The valve solenoids must be de-energized during Reset.

Safety System Reset Ladder Logic Example

Limitations Due to System Leakage

Even though the HBH is designed to redundantly block flow, it is important to periodically test for leakage within the HBH and the system it controls, as any leak within the HBH itself, interconnecting hoses, connectors, cylinders or other actuators, or even other valves in the circuit may cause unexpected movement. In order to test for leakage within the HBH itself, it is necessary to check for actuator (cylinder) movement when the HBH is in each of the following conditions:

WARNING: Performing this test could cause injury or damage to equipment due to unexpected or uncontrolled movement. Take all necessary precautions to ensure worker safety prior to initiating this test.

A) Fully de-energized (both solenoids 3A & 3B de-energized)

B) Solenoid 3A energized with solenoid 3B de-energized

C) Solenoid 3A de-energized with solenoid 3B energized.

Depending on the application, it may be necessary to preposition actuators and/or other valves such that energizing the HBH would allow motion to occur. This sets up the circuit so that the HBH valve is the sole motion-controlling device during testing. For example, if a cylinder is fully retracted, a leak that normally allows retract motion to occur could be masked because the cylinder is already fully retracted.

This test helps to troubleshoot leaks within the HBH system. Other leaks within the associated system can affect the outcome of this test.

WARNING: If any leakage is discovered within the system, measures should be taken to eliminate the leak(s) as failing to do so could limit the ability of the safety system to safely stop motion when required.

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

WARNING: Unexpected movement could occur if one of the check valves in the pilot system, including any check valve installed in the external pilot supply line, were to fail open. A failure of one of these check valves could allow as much as 10 gpm flow from P1 to P2, P2 to P1 or P2 to X (external pilot port). The amount of flow could be higher from P2 to X when using external pilot supply depending on the flow capability of the check valve that the user installs in that line or, especially, if no check is installed in the external pilot line.

HBH System Validation Test Procedure for Valve System Operation and External Monitoring Logic

NOTE 1:	This validation test procedure should only be performed with an HBH Series valve system 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 switch at different times. This will be most easily done by disconnecting solenoid or switch cables at the valve.
NOTE 3:	Hydraulic supply will need to be supplied to port X if using external pilot supply.
NOTE 4:	"-" indicates no change from previous step.
NOTE 5:	Actuate Signal is the signal to switch on the solenoids either from a physical input switch or a software signal.
NOTE 6:	The switches are supplied with both NC and NO outputs. The statements below only refer to the condition of the NC switch outputs.

Step	Action	Actuate Signal	Sol 3A	Sol 3B	Flow Conditions (P1 to P2)	Switch Conditions		Fault ?	Pass/Fail
		Sol 3A & Sol 3B				Switch 2A	Switch 2B		(P/F)
1	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	No	
2	De-energize solenoids 3A & 3B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	
3	Disconnect solenoid cable from solenoid 3B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	No	
4	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	Yes*	
5	Reconnect solenoid 3B	-	-	-	-	-	-	-	
6	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
7	Reset the safety control system	-	-	-	-	-	-	No	
8	Disconnect solenoid cable from solenoid 3A	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	No	
9	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	Yes*	
10	Reconnect solenoid 3A	-	-	-	-	-	-	-	
11	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
12	Reset the safety control system	-	-	-	-	-	-	No	
13	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	No	
14	Disconnect solenoid cable from solenoid 3A	-	OFF	OFF	CLOSED	CLOSED	CLOSED	Yes**	
15	Reconnect solenoid cable to solenoid 3A	-	-	-	-	-	-	-	
16	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
17	Reset the safety control system	-	-	-	-	-	-	No	
18	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	No	
19	Disconnect solenoid cable from solenoid 3B	-	OFF	OFF	CLOSED	CLOSED	CLOSED	Yes**	
20	Reconnect solenoid cable to solenoid 3B	-	-	-	-	-	-	-	
21	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
22	Reset the safety control system	-	-	-	-	-	-	No	
23	Disconnect switch cable from switch 2A	OFF	OFF	OFF	CLOSED	OPEN	CLOSED	Yes**	
24	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
25	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
26	Reconnect switch cable to switch 2A	-	-	-	-	CLOSED	-	-	
27	Reset the safety control system	-	-	-	-	-	-	No	

*** Fault should be detected within 350 msec.**
**** Fault should occur immediately.**

Step	Action	Actuate Signal	Sol 3A	Sol 3B	Flow Conditions (P1 to P2)	Switch Conditions		Fault ?	Pass/Fail
		Sol 3A & Sol 3B				Switch 2A	Switch 2B		(P/F)
28	Disconnect switch cable from switch 2B	OFF	OFF	OFF	CLOSED	CLOSED	OPEN	Yes**	
29	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
30	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
31	Reconnect switch cable to switch 2B	-	-	-	-	-	CLOSED	-	
32	Reset the safety control system	-	-	-	-	-	-	No	
33	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	No	
34	Disconnect switch cable from switch 2A	-	-	-	-	-	-	-	
35	De-energize solenoids 3A & 3B	OFF	OFF	OFF	CLOSED	-	CLOSED	Yes*	
36	Reconnect switch cable to switch 2A	-	-	-	-	CLOSED	-	-	
37	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
38	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
39	Reset the safety control system	-	-	-	-	-	-	No	
40	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	No	
41	Disconnect switch cable from switch 2B	-	-	-	-	-	-	-	
42	De-energize solenoids 3A & 3B	OFF	OFF	OFF	CLOSED	CLOSED	-	Yes*	
43	Reconnect switch cable to switch 2B	-	-	-	-	-	CLOSED	-	
44	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
45	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
46	Reset the safety control system	-	-	-	-	-	-	No	
47	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	No	
48	Turn off and bleed supply to port P1	-	OFF	OFF	CLOSED	CLOSED	CLOSED	Yes**	
49	Turn supply back on to port P1	-	-	-	-	-	-	-	
50	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
51	Reset the safety control system	-	-	-	-	-	-	No	
52	Disconnect switch cable from switch 2A	OFF	OFF	OFF	CLOSED	OPEN	CLOSED	Yes**	
53	Attempt to reset the safety control system	-	-	-	-	-	-	-	
54	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
55	Reconnect the switch cable to switch 2A	-	-	-	-	CLOSED	-	-	
56	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
57	Reset the safety control system	-	-	-	-	-	-	No	
58	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	-	
59	De-energize solenoids 3A & 3B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	
60	Disconnect switch cable from switch 2B	OFF	OFF	OFF	CLOSED	CLOSED	OPEN	Yes**	
61	Attempt to reset the safety control system	-	-	-	-	-	-	-	
62	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
63	Reconnect the switch cable to switch 2B	-	-	-	-	-	CLOSED	-	
64	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
65	Reset the safety control system	-	-	-	-	-	-	No	
66	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	-	
67	De-energize solenoids 3A & 3B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	

*** Fault should be detected within 350 msec.**
**** Fault should occur immediately.**

Step	Action	Actuate Signal	Sol 3A	Sol 3B	Flow Conditions (P1 to P2)	Switch Conditions		Fault ?	Pass/Fail
		Sol 3A & Sol 3B				Switch 2A	Switch 2B		(P/F)
Items 68 through 75 could also be done with Switch 2B instead of Switch 2A.									
68	Disconnect switch cable from switch 2A	OFF	OFF	OFF	CLOSED	OPEN	CLOSED	Yes**	
69	Reconnect the switch cable to switch 2A	-	-	-	-	CLOSED	-	-	
70	Attempt to energize solenoids 3A & 3B	ON	-	-	-	-	-	-	
71	Attempt to reset the safety control system	-	-	-	-	-	-	-	
72	De-energize solenoids 3A & 3B	OFF	-	-	-	-	-	-	
73	Reset the safety control system	-	-	-	-	-	-	No	
74	Energize solenoids 3A & 3B	ON	ON	ON	OPEN	OPEN	OPEN	-	
75	De-energize solenoids 3A & 3B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	

** **Fault should occur immediately.**

CAUTIONS, WARNINGS

Additional technical documentation, cautions and warnings information is available at www.rosscontrols.com, Support and Downloads.

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950 Woodward Heights, Ferndale, Michigan 48220 US

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