



HYDRAULIC DUAL BLOCK & STOP VALVES HDBH SERIES



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' HDBH Series valve system that is used for dual, safe hydraulic Block and Stop functions and utilizes 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 HDBH 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 HDBH 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

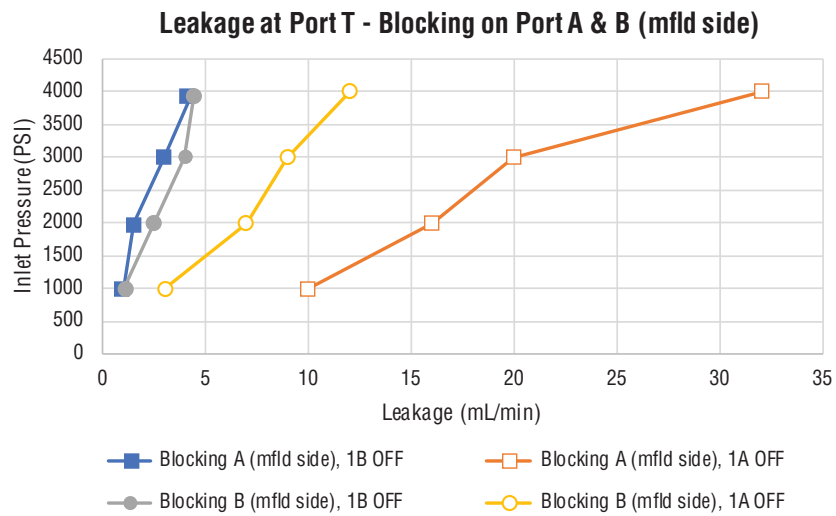
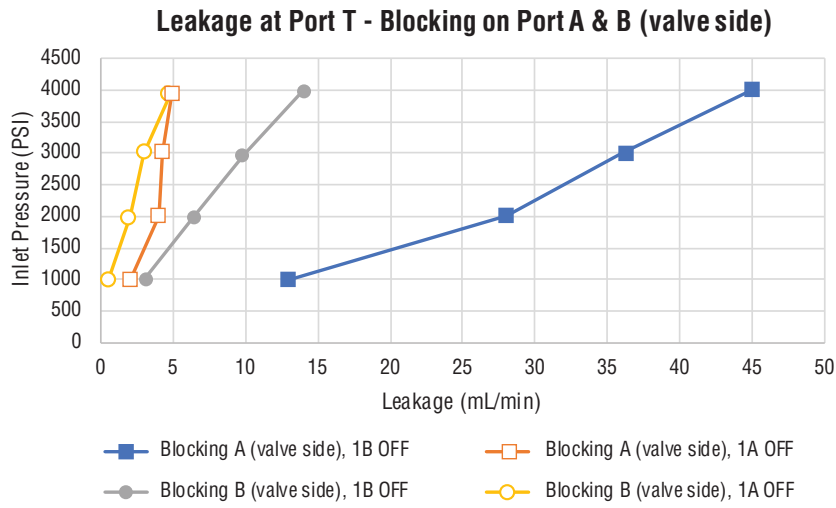
When designing a safety circuit, the machine stopping time is a critical factor that determines the placement of guarding solutions. When using valves for a "safe cylinder control/stop" safety function, one factor in safe distance calculations is the response time of the valve. The faster the valve shifts, 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.

The monitoring examples provided in this guide use 150 milliseconds as the maximum allowable de-actuation time for the HDBH. The normal response time of the HDBH is shorter than the 150 msec. However, safe distance calculations should be based on the the monitoring time of 150 msec. Safe Distance calculations should always be validated by testing.

Safe Distance calculations should be validated by testing.

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

Leakage at Port T (Faulted)



HDBH 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).



Solenoid Connector Wiring		<p>1 = Positive (+)</p> <p>2 = Negative (-)</p> <p>3 = Coil Ground (⊥)</p>
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Position Switch Connector Pinout		<p>1 = Supply +24 volts DC</p> <p>2 = Output Signal NC</p> <p>3 = Ground</p> <p>4 = Output Signal NO</p>	<p>NOTE: PNP (M12, 4-pin, A-coded, male); works with both 4-pin & 5-pin female cord sets</p>
			<p>NOTE: The switches must be wired with 24 volt (+) and 0 volt (-) connections in parallel with each other.</p>

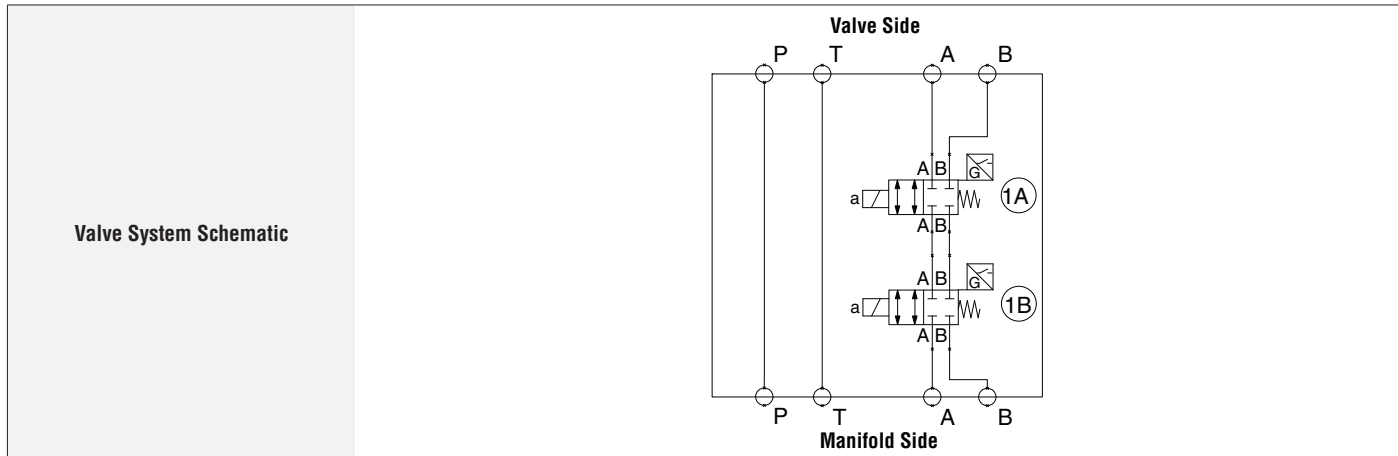
Technical Characteristics Of PNP Inductive Position Switch		OUTPUT SIGNAL STATUS FOR EACH VALVE IN THE HDBH SYSTEM	
Type Of Switch	Contactless inductive position switch with integrated amplifier	Hydraulic configuration	
Supply Voltage [V]	20-32 V DC	Spool position	
Ripple Max [%]	≤ 10	Pin 2	ON:
Max Current [mA]	400	Pin 4	ON:
Reaction Time [ms]	15		OFF:
Max Peak Pressure [bar]	400		
Mechanical Life	Virtually Infinite		
Switch Logic	PNP		
<p>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.</p> <p>■ = Intermediate spool position corresponding to the hydraulic configuration change.</p>			
<p>NOTE: PNP (M12, 4-pin, A-coded, male); works with both 4-pin and 5-pin female cord sets.</p>			

Direct Solenoid Operated

The HDBH Series valve system is direct solenoid-operated and does not require pilot pressure to actuate. However, there is a T (tank) port that should be piped back to the reservoir - whether sandwich mounted between a directional valve and manifold or in-line mounted with one of the available in-line mounting kits. If at least one of the T ports is not piped back to the reservoir the maximum operating pressure is reduced to 3000 psig (210 bar) instead of 5000 psig (350 bar).

Operation & Monitoring Requirements for HDBH Series Valve System

The intent of this section is to provide guidance on how to operate and monitor the HDBH 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.



WARNING: Risk of Injury! Do not replace individual valves in the HDBH valve system. The whole assembly should be replaced if necessary.

Valve Operation

NOTE: Block and Stop functions are intended to momentarily stop an actuator (linear or rotary), but not to hold the actuator in place for an extended period. The HDBH valve is a spool type valve, and normal spool leakage will occur. The valve is to be used as a “permissive” safety device. Applications where long-term holding is necessary should also incorporate other components such as PO check, counterbalance, or mechanical locking devices. For further information regarding leakage see “Limitations Due to Leakage” below.

NOTE: HDBH valves are intended to be used only for tasks that are routine, repetitive, and integral to production. Maintenance tasks require following full lock-out/tag-out procedures to relieve hazardous energy and prevent unexpected startup.

The HDBH Series valve system is a sandwich-mount device that is designed to be installed directly between a manifold and a directional valve. The HDBH system allows or blocks flow between the directional valve and its associated cylinder (actuator) by opening both cylinder ports to allow movement or by closing both ports to stop movement as needed. Its function is that of a dual, 2/2, normally closed, single-solenoid 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 HDBH 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 outputs.

Another important characteristic to consider is the normal leakage of the valve in the OFF (blocking) condition. HDBH valves are spool-type valves and do have an inherent leak rate when in the off condition (around the spools). Although, this leakage is minor, as compared to the normal flow when the valve is switched ON, it must be considered for your application - especially in applications where the valve is oversized.

Careful consideration of the required safety function and how to achieve that goal is absolutely necessary.

NOTE: In applications where installation on a manifold is not practical, the In-line Mounting Kit can be used to facilitate installation of the HDBH valve in-line between a directional valve and actuator (cylinder).

NOTE: In applications where higher flows are needed, there is an optional Flow-doubling In-line Mounting Kit that can be

used to combine the flow through both the A & B ports to double the flow capacity of the valve. This doubling effect converts the HDBH valve to a single line blocking valve instead of blocking two lines.

Switching the valve on will allow flow between the Manifold Side and the Valve Side in both ports - A and B. Switching the valve ON is accomplished by energizing both solenoids simultaneously.

Switching the valve OFF will block flow in both ports - A and B. Switching the valve OFF is accomplished by turning off both solenoids simultaneously.

Normal operation occurs when both sets of valve internals shift within 150 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 150 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 in ports A and B.

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 HDBH 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

Feedback Monitoring (General)

The HDBH 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 HDBH 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 (pin 2) outputs of the inductive position switches.

NOTE: It is recommended to use the normally-closed switch outputs to avoid masking of unsafe conditions that could occur when using the normally-open outputs.

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.

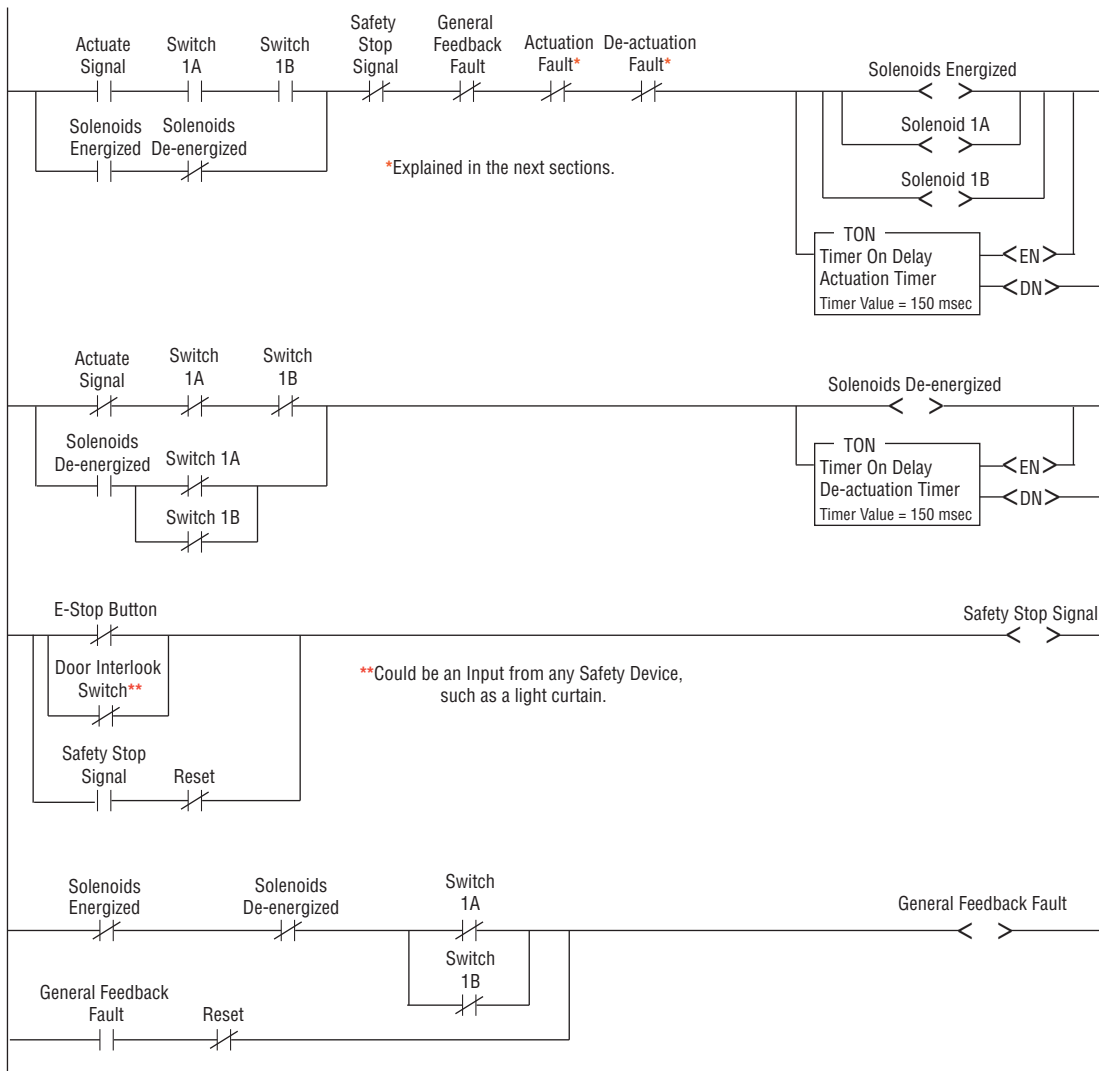
NOTE: In the event of a stop signal from any safety system input, the safety system should immediately shut off the safety controller outputs to the valve solenoids (as required by the application) regardless of the condition of the feedback switches.

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

Automatic RESET of the safety system is not recommended by ROSS.

The HDBH must be integrated to meet the Category and/or Performance Level requirements of the safety system, as determined by the risk assessment of the machine.

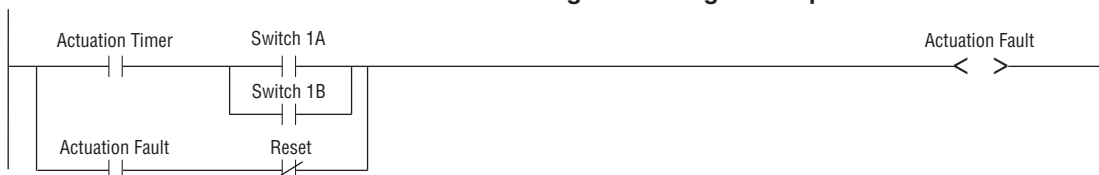
HDBH Valve System Operation and General Feedback Monitoring Ladder Logic Example



Actuation Fault Monitoring

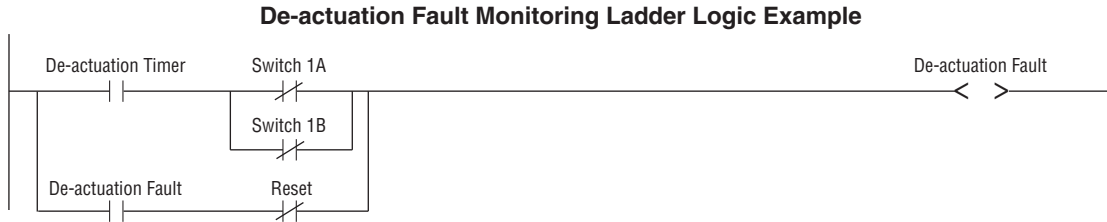
Actuation fault monitoring should check for actuation of both valves within 150 msec of the actuation signal. After the safety control system outputs provide simultaneous actuation signals to both solenoids, both NC switch outputs should switch off within 150 msec. If both switches have not changed state within the 150 msec time frame, this should be registered as a valve fault.

Actuation Fault Monitoring Ladder Logic Example



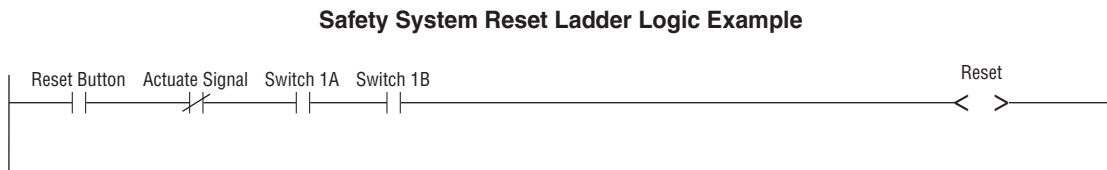
De-Actuation Fault Monitoring

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, both NC switch outputs should switch on within 150 msec. If both switches have not changed state within the 150 msec time frame, this should be registered as a valve fault.



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.



Limitations Due to System Leakage

Even though the HDBH is designed to redundantly block flow, it is important to periodically test for leakage within the HDBH and the system it controls, as any leak within the HDBH 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 HDBH itself, it is necessary to check for actuator (cylinder) movement when the HDBH 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.

See Faulted Leakage charts on page 4.

- A) fully de-energized (both solenoids 1A & 1B de-energized)
- B) solenoid 1A energized with solenoid 1B de-energized
- C) solenoid 1A de-energized with solenoid 1B energized.

Depending on the application, it may be necessary to preposition actuators and/or other valves such that energizing the HDBH would allow motion to occur. This sets up the circuit so that the HDBH 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 HDBH 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.

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

NOTE 1:	This validation test procedure should only be performed with an HDBH 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:	“-“ indicates no change from previous step.
NOTE 4:	Actuate Signal is the signal to switch on the solenoids either from a physical input switch or a software signal.
NOTE 5:	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 1A	Sol 1B	Flow Conditions (All Ports A & B)	Switch Conditions		Fault ?	Pass/Fail (P/F)
		Sol 1A & Sol 1B				Switch 1A	Switch 1B		
1	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	No	
2	De-energize solenoids 1A & 1B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	
3	Disconnect solenoid cable from solenoid 1B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	No	
4	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	Yes*	
5	Reconnect solenoid 1B	-	-	-	-	-	-	-	
6	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
7	Reset the safety control system	-	-	-	-	-	-	No	
8	Disconnect solenoid cable from solenoid 1A	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	No	
9	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	Yes*	
10	Reconnect solenoid 1A	-	-	-	-	-	-	-	
11	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
12	Reset the safety control system	-	-	-	-	-	-	No	
13	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	No	
14	Disconnect solenoid cable from solenoid 1A	-	OFF	OFF	CLOSED	CLOSED	CLOSED	Yes**	
15	Reconnect solenoid cable to solenoid 1A	-	-	-	-	-	-	-	
16	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
17	Reset the safety control system	-	-	-	-	-	-	No	
18	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	No	
19	Disconnect solenoid cable from solenoid 1B	-	OFF	OFF	CLOSED	CLOSED	CLOSED	Yes**	
20	Reconnect solenoid cable to solenoid 1B	-	-	-	-	-	-	-	
21	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
22	Reset the safety control system	-	-	-	-	-	-	No	
23	Disconnect switch cable from switch 1A	OFF	OFF	OFF	CLOSED	OPEN	CLOSED	Yes**	
24	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
25	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
26	Reconnect switch cable to switch 1A	-	-	-	-	CLOSED	-	-	
27	Reset the safety control system	-	-	-	-	-	-	No	

* Fault should be detected within 150 msec.

** Fault should occur immediately.

Step	Action	Actuate Signal	Sol 1A	Sol 1B	Flow Conditions (All Ports A & B)	Switch Conditions		Fault ?	Pass/Fail
		Sol 1A & Sol 1B				Switch 1A	Switch 1B		(P/F)
28	Disconnect switch cable from switch 1B	OFF	OFF	OFF	CLOSED	CLOSED	OPEN	Yes**	
29	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
30	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
31	Reconnect switch cable to switch 1B	-	-	-	-	-	CLOSED	-	
32	Reset the safety control system	-	-	-	-	-	-	No	
33	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	No	
34	Disconnect switch cable from switch 1A	-	-	-	-	-	-	-	
35	De-energize solenoids 1A & 1B	OFF	OFF	OFF	CLOSED	-	CLOSED	Yes*	
36	Reconnect switch cable to switch 1A	-	-	-	-	CLOSED	-	-	
37	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
38	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
39	Reset the safety control system	-	-	-	-	-	-	No	
40	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	No	
41	Disconnect switch cable from switch 1B	-	-	-	-	-	-	-	
42	De-energize solenoids 1A & 1B	OFF	OFF	OFF	CLOSED	CLOSED	-	Yes*	
43	Reconnect switch cable to switch 1B	-	-	-	-	-	CLOSED	-	
44	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
45	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
46	Reset the safety control system	-	-	-	-	-	-	No	
47	Disconnect switch cable from switch 1A	OFF	OFF	OFF	CLOSED	OPEN	CLOSED	Yes**	
48	Attempt to reset the safety control system	-	-	-	-	-	-	-	
49	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
50	Reconnect the switch cable to switch 1A	-	-	-	-	CLOSED	-	-	
51	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
52	Reset the safety control system	-	-	-	-	-	-	No	
53	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	-	
54	De-energize solenoids 1A & 1B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	
55	Disconnect switch cable from switch 1B	OFF	OFF	OFF	CLOSED	CLOSED	OPEN	Yes**	
56	Attempt to reset the safety control system	-	-	-	-	-	-	-	
57	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
58	Reconnect the switch cable to switch 1B	-	-	-	-	-	CLOSED	-	
59	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
60	Reset the safety control system	-	-	-	-	-	-	No	
61	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	-	
62	De-energize solenoids 1A & 1B	OFF	OFF	OFF	CLOSED	CLOSED	CLOSED	-	

* Fault should be detected within 150 msec.

** Fault should occur immediately.

Step	Action	Actuate Signal	Sol 1A	Sol 1B	Flow Conditions (All Ports A & B)	Switch Conditions		Fault ?	Pass/Fail
		Sol 1A & Sol 1B				Switch 1A	Switch 1B		(P/F)
<i>Items 63 through 70 could also be done with Switch 1B instead of Switch 1A.</i>									
63	Disconnect switch cable from switch 1A	OFF	OFF	OFF	CLOSED	OPEN	CLOSED	Yes**	
64	Reconnect the switch cable to switch 1A	-	-	-	-	CLOSED	-	-	
65	Attempt to energize solenoids 1A & 1B	ON	-	-	-	-	-	-	
66	Attempt to reset the safety control system	-	-	-	-	-	-	-	
67	De-energize solenoids 1A & 1B	OFF	-	-	-	-	-	-	
68	Reset the safety control system	-	-	-	-	-	-	No	
69	Energize solenoids 1A & 1B	ON	ON	ON	OPEN	OPEN	OPEN	-	
70	De-energize solenoids 1A & 1B	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.

STANDARD WARRANTY

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

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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