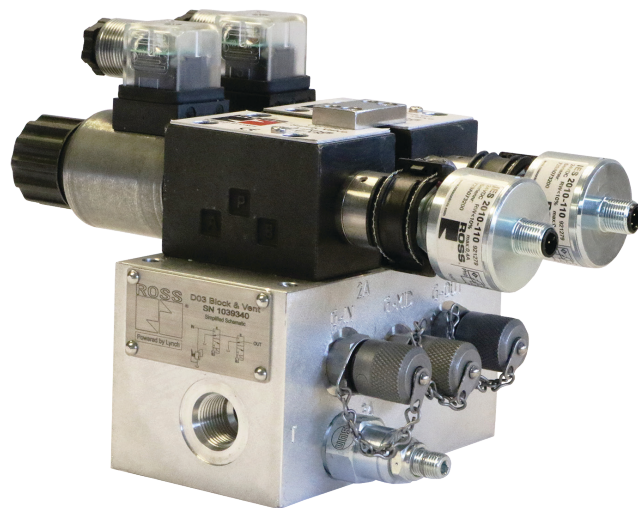




HBB SERIES REDUNDANT VALVE SYSTEMS

HYDRAULIC BLOCK AND BLEED



INTEGRATION GUIDE

Table of Contents

Integration Guide – HBB Series Hydraulic Block and Bleed Safety Valve Systems	
	Page
General Information	
Introduction	3
Pulse Testing	
Bleed Flow Rates and Faulted Bleed Flow Rates	3 - 4
HBB Wiring (Pinouts)	5
Pilot Supply Conversion	6
Operation & Monitoring Requirements for HBB Series Valve Systems	7
Valve Operation	7
Feedback Monitoring (General)	8
Actuation Fault Monitoring	9
De-Actuation Fault Monitoring	10
Loss of Supply Pressure While Actuated	
No Supply Pressure Applied Before Actuation	
Valve Fault & Safety System Reset	11 - 13
Validation Test Procedure for Valve Operation and External Monitoring Logic	
Cautions, Warnings and Standard Warranty	Cover
Global Locations	

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' HBB Series valve systems that are used for safe hydraulic Block and Bleed 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 HBB 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 HBB 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.

Bleed Flow Rates and Faulted Bleed Flow Rates

When designing a safety circuit, the machine stopping time is a critical factor that determines the placement of guarding solutions. One factor in safe distance calculations is the bleed time of the valve system that is responsible for blocking and bleeding the hydraulic energy from the machine. The faster the block and bleed valve bleeds off downstream energy, the quicker the machine can stop and the closer your safety devices 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.

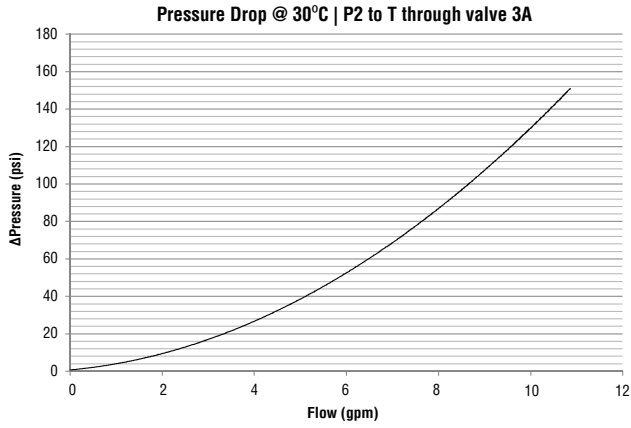
Even more important than bleed flow rate is the "Faulted bleed flow rate." Faulted bleed flow rate is the bleed rate of the valve system in its worst state. Double valves (redundant valve systems used for safety applications) will not bleed quite as quickly when there is an internal fault condition in the valve system, such as when one of the redundant valve components is actuated and the other one is not actuated. For this reason, double valve systems used in safety circuits should always be sized using faulted flow rates as the worst-case condition. In the case of HBB valves, this situation occurs when the 3A valve (the downstream element) is faulted and bleed flow must go through both the 3A and 2A valves to get to the T (tank) port. Normal and faulted bleed flow rates are shown on page 4.

Stop time testing should be done for your application with the HBB in the circuit to determine how your machinery reacts with the valve installed. Data obtained from these tests should be used to determine safe distances for guarding. Be certain to test for reaction times with both normal and faulted valve conditions.

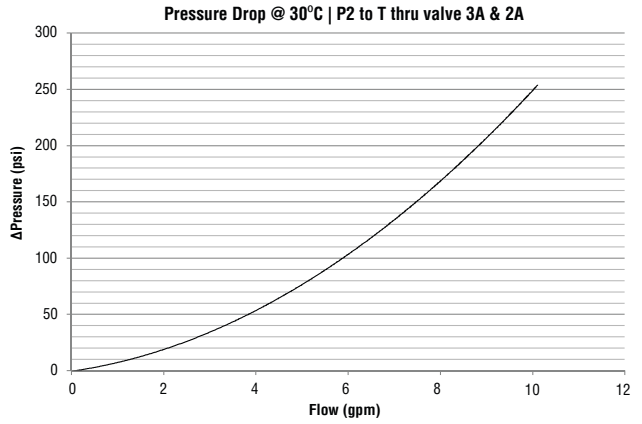
BLEED FLOW RATES (Normal & Faulted)

Size D03

Normal

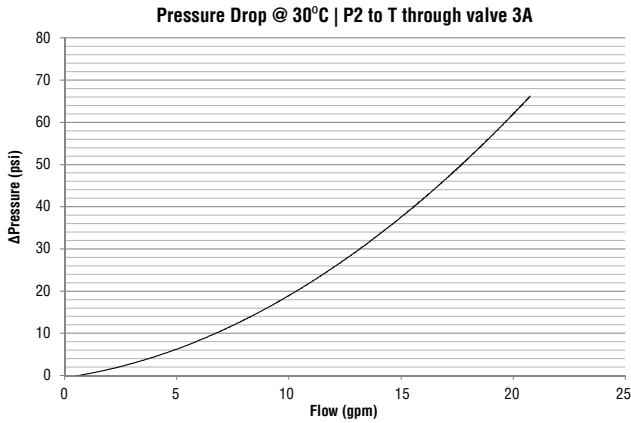


Faulted

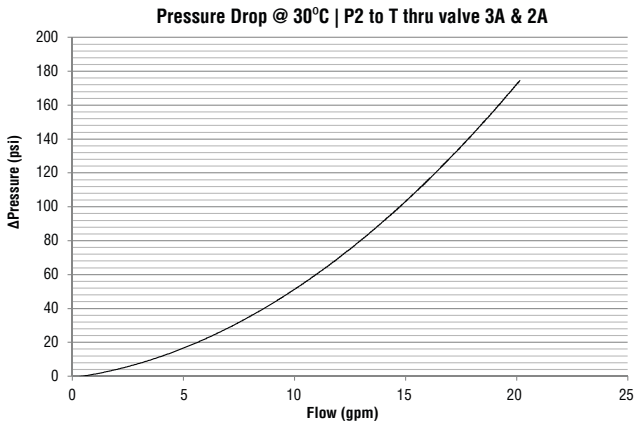


Size D05

Normal

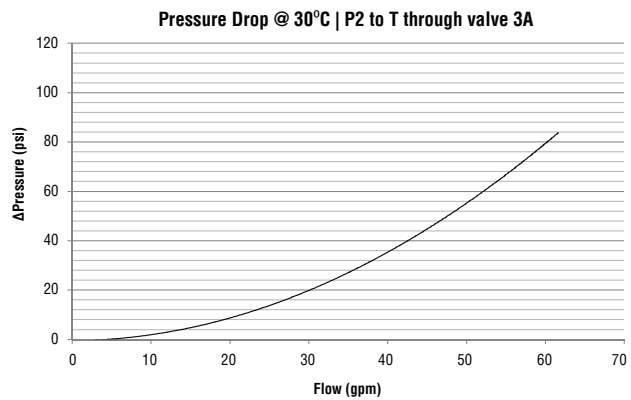


Faulted

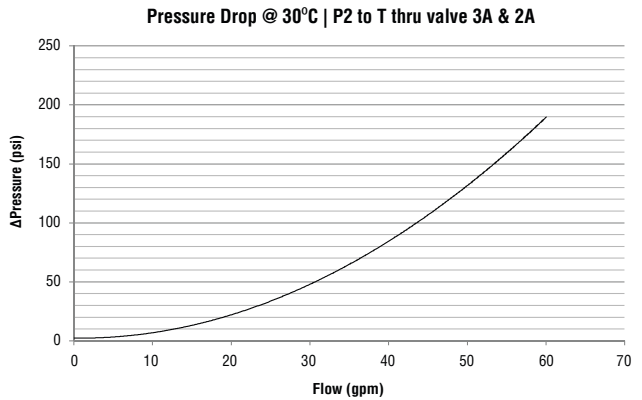


Size D07

Normal



Faulted

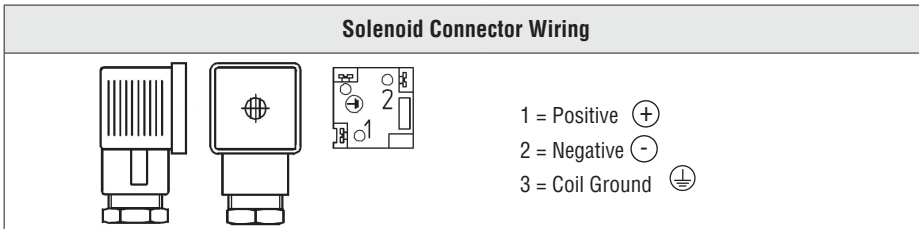
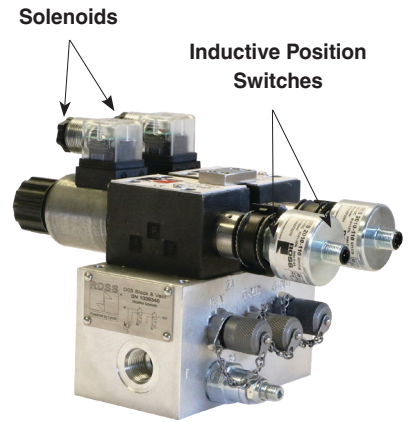


HBB Wiring (Pinouts)

Connection Type:

- Solenoids: DIN 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).



Position Switch Connector Pinout			
	Size D03 & D05	Size D07	<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>
	1 = Supply +24 volts DC 2 = Output Signal NC 3 = Ground 4 = Output Signal NO	1 = Supply +24 volts DC 2 = Output Signal NO 3 = Ground 4 = Output Signal NC	

Please note that the function of the switch varies depending on valve size. As a result, in the normal valve off condition, the D03 & D05 valves utilize pin 2 of the switches as NC outputs and pin 4 as NO outputs. On the D07 size valves pin 4 is used as the NC output and pin 2 is used as the NO output. This is due to the fact that in the valve off condition on the size D07, the switches are in the actuated condition when the valve is off.

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	
	Size D03 & D05	Size D07
	1 = Supply +24 V DC 4 = Output Signal NO 2 = Output Signal NC 3 = Ground	1 = Supply +24 V DC 4 = Output Signal NC 2 = Output Signal NO 3 = Ground
<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>		

Output Signal Status for Each Valve in the HBB System	
Size D03 & D05	
Hydraulic configuration	
Spool position	
Pin 2	ON: OFF:
Pin 4	ON: OFF:
Size D07	
Hydraulic configuration	
Spool position	
Pin 2	ON: OFF:
Pin 4	ON: OFF:

Pilot Supply Conversion (only applies to D07 size)

The HBB Series valve systems are available in three sizes, D03, D05, & D07. The valves used in the D03 and D05 systems are direct solenoid-operated. However, the D07 system is solenoid pilot-operated and requires pilot pressure to actuate. This pilot pressure can be sourced internally (internal pilot supply) or separately (external pilot supply).

The D07 size HBB Series valve system is shipped from the factory configured for internal pilot supply, which sources pilot supply pressure internally from port P1 in the valve sub-base. The valve can be converted to operate with external pilot supply through the X port in the manifold.

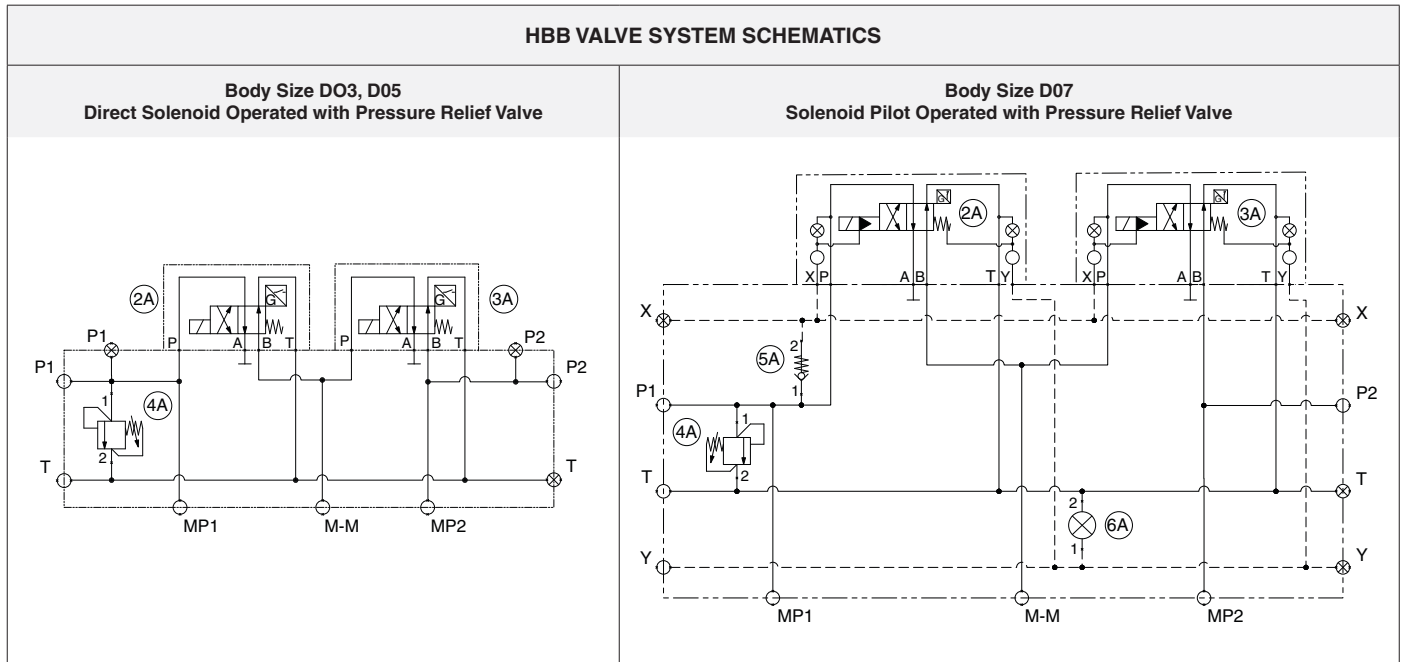
In order to convert the D07 size HBB valve to external pilot supply:

- A. Shut off and relieve all pressure from the system and disconnect all electrical power from the system.
- B. Remove the plug from Port X.
- C. Connect a separate supply line to port X (SAE #6).

Due to the internal porting arrangement in the manifold, the solenoid pilot valves in the HBB D07 system will be supplied with operating pressure from the source that has the highest available pressure - either internally from port P1 or externally from port X.

Operation & Monitoring Requirements for HBB Series Valve System

The intent of this document is to provide guidance on how to operate and monitor the HBB 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! HBB spool valves must only be replaced with the appropriate type and model number and installed only in the proper manifold position. The individual spool valves designated as 2A and 3A on sizes D03 and D05 and the main spool valves on size D07 (not including the pilot valves) have different spool configurations. After any disassembly, care should be taken to ensure the correct valves are re-installed or replaced at the correct position on the manifold. Refer to the engravings on the top of the manifold.

Valve Operation

NOTE: Block and Bleed functions are intended to permit flow when switched on and to block supply and to bleed off downstream energy when switched off or in a faulted state. It is important to note that the ability to bleed may be affected by other components downstream of the HBB valve. PO checks, counterbalance, and closed-center valves are designed to block flow under certain conditions. Depending on the application, these devices may be detrimental or they may be beneficial to complete the needed safety function. Careful consideration of the required safety function and how to achieve that goal is absolutely necessary.

NOTE: HBB 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 HBB Series valve system is a redundant safety block and bleed (dump) valve system. Its function is that of a 3/2, normally closed, single-solenoid valve. However, because the system is redundant it has two solenoids that must be operated simultaneously in order to operate. In addition, each valve element within the HBB 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.

Switching the valve ON will allow flow from port P1 (supply) to port P2 (outlet) and close port T (tank). Switching the valve ON is accomplished by energizing both solenoids simultaneously.

De-actuating the valve will close port P1 (supply) and open port P2 (outlet) to port T (tank). De-actuation of the valve is accomplished by turning off both solenoids simultaneously.

Normal operation occurs when both sets of valve internals shift within 200 msec of the change of the solenoid signals. For example, when both solenoids are signaled to energize, we would expect both position switches to change state within 200 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 shut off supply (block) and dump (bleed) downstream pressure to tank.

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 HBB 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 HBB 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 HBB valve system. The switches are supplied with both NC and NO outputs. Please note that the function of the switch varies depending on valve size. As a result, in the normal valve off condition, the D03 & D05 valves utilize pin 2 of the switches as NC outputs and pin 4 as NO outputs. On the D07 size valves pin 4 is used as the NC output and pin 2 is used as the NO output. This is due to the fact that in the valve off condition on the size D07, the switches are in the actuated condition when the valve is off. The statements below only refer to the condition of pin 2 of the D03 & D05, and only pin 4 of the D07.

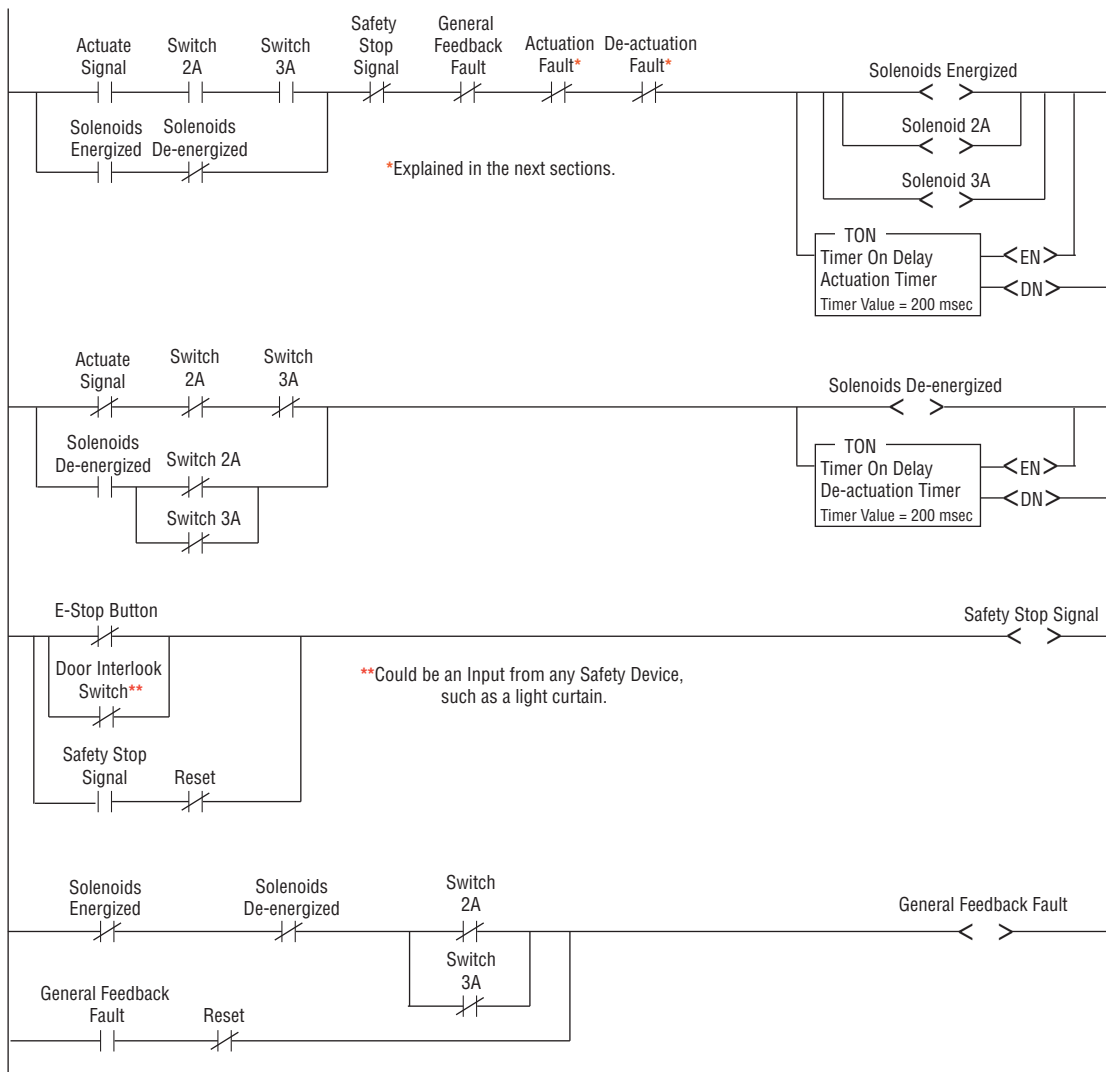
WARNING: It is possible to operate at a cycle rate that could result in non-monitored operation. To prevent exceeding this rate, ensure that the valve is de-actuated (both switch outputs should be on) before attempting to energize the solenoids. Likewise, ensure that the valve is actuated (both switch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

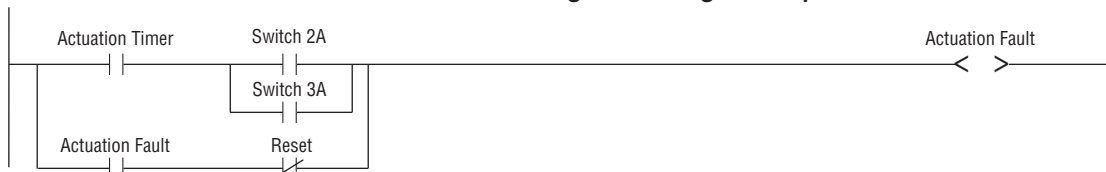
HBB Valve System Operation and General Feedback Monitoring Ladder Logic Example



Actuation Fault Monitoring

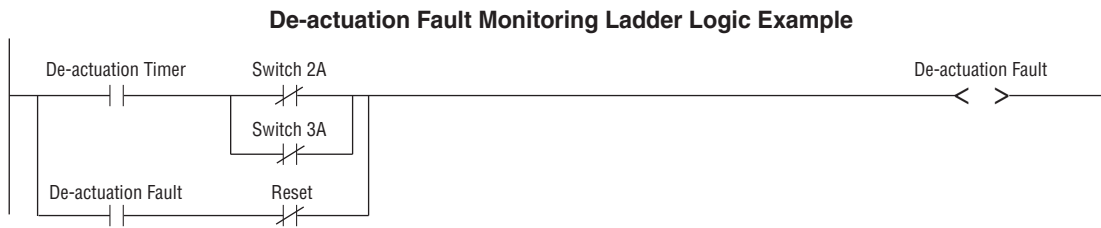
Actuation fault monitoring should check for actuation of both valves within 200 msec of the actuation signal. After the safety control system outputs provide simultaneous actuation signals to both solenoids, both NC switch outputs should switch off within 200 msec. If both switches have not changed state within the 200 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 200 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 200 msec. If both switches have not changed state within the 200 msec time frame, this should be registered as a valve fault.



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.

NOTE: This is only possible when using INTERNAL pilot supply on size D07 HBB 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 close 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 open (sensing the actuated position) to closed (not sensing the actuated position).

NOTE: HBB valve systems that are size D03 and D05 are direct solenoid-operated and will not de-actuate due to loss of supply pressure. This is also true of D07 size valves operated with EXTERNAL pilot supply. An additional upstream pressure switch or transducer is needed in these systems in order to detect the loss of supply pressure while the solenoids are energized.

NOTE: No ladder logic example provided for additional equipment.

NOTE: No additional ladder logic is required for Loss of Supply While Actuated if using size D07 with INTERNAL pilot supply because this fault is detected by the Actuation Fault Monitoring logic.

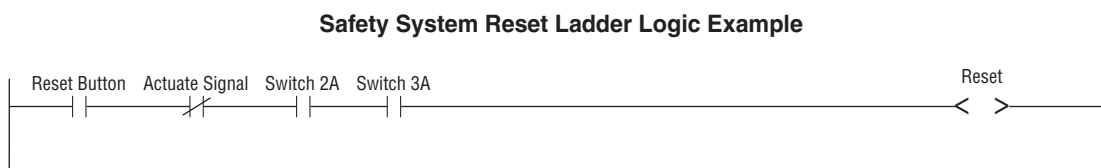
No Supply Applied Before Actuation

Monitoring of supply before actuation 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 is insufficient.

NOTE: No ladder logic example 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 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.



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

NOTE 1:	This validation test procedure should only be performed with an HBB 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 connected to inlet port P1 and a separate hydraulic supply to port X if using external pilot supply.
NOTE 4:	Steps 47 – 51 only pertain to D07 with internal pilot configuration.
NOTE 5:	“-“ indicates no change from previous step.
NOTE 6:	Actuate Signal is the signal to switch on the solenoids either from a physical input switch or a software signal.
NOTE 7:	The switches are supplied with both NC and NO outputs. The statements below only refer to the condition of pin 2 of the D03 & D05, and only pin 4 of the D07. Please note that the D07 size HBB normal valve off switch conditions are opposite of those for the D03 & D05 valves.

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

* Fault should be detected within 200 msec.

** Fault should occur immediately.

Step	Action	Actuate Signal	Sol 2A	Sol 3A	Flow Conditions	Switch Conditions		Fault ?	Pass/Fail (P/F)
		Sol 2A & Sol 3A				Switch 2A	Switch 3A		
18	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	No	
19	Disconnect solenoid cable from solenoid 3A	-	OFF	OFF	P1 P2 to T	CLOSED	CLOSED	Yes**	
20	Reconnect solenoid cable to solenoid 3A	-	-	-	-	-	-	-	
21	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-	
22	Reset the safety control system	-	-	-	-	-	-	No	
23	Disconnect switch cable from switch 2A	OFF	OFF	OFF	P1 P2 to T	OPEN	CLOSED	Yes**	
24	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-	
25	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-	
26	Reconnect switch cable to switch 2A	-	-	-	-	CLOSED	-	-	
27	Reset the safety control system	-	-	-	-	-	-	No	
28	Disconnect switch cable from switch 3A	OFF	OFF	OFF	P1 P2 to T	CLOSED	OPEN	Yes**	
29	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-	
30	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-	
31	Reconnect switch cable to switch 3A	-	-	-	-	-	CLOSED	-	
32	Reset the safety control system	-	-	-	-	-	-	No	
33	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	No	
34	Disconnect switch cable from switch 2A	-	-	-	-	-	-	-	
35	De-energize solenoids 2A & 3A	OFF	OFF	OFF	P1 P2 to T	-	CLOSED	Yes*	
36	Reconnect switch cable to switch 2A	-	-	-	-	CLOSED	-	-	
37	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-	
38	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-	
39	Reset the safety control system	-	-	-	-	-	-	No	
40	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	No	
41	Disconnect switch cable from switch 3A	-	-	-	-	-	-	-	
42	De-energize solenoids 2A & 3A	OFF	OFF	OFF	P1 P2 to T	CLOSED	-	Yes*	
43	Reconnect switch cable to switch 3A	-	-	-	-	-	CLOSED	-	
44	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-	
45	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-	
46	Reset the safety control system	-	-	-	-	-	-	No	
47	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	No	

* Fault should be detected within 200 msec.

** Fault should occur immediately.

Step	Action	Actuate Signal		Sol 2A	Sol 3A	Flow Conditions	Switch Conditions		Fault ?	Pass/Fail (P/F)
		Sol 2A & Sol 3A					Switch 2A	Switch 3A		
48	Turn off and bleed supply to port P1	-	OFF	OFF	P1 P2 to T	CLOSED	CLOSED	Yes**		
49	Turn supply back on to port P1	-	-	-	-	-	-	-		
50	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-		
51	Reset the safety control system	-	-	-	-	-	-	No		
52	Disconnect switch cable from switch 2A	OFF	OFF	OFF	P1 P2 to T	OPEN	CLOSED	Yes**		
53	Attempt to reset the safety control system	-	-	-	-	-	-	-		
54	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-		
55	Reconnect the switch cable to switch 2A	-	-	-	-	CLOSED	-	-		
56	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-		
57	Reset the safety control system	-	-	-	-	-	-	No		
58	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	-		
59	De-energize solenoids 2A & 3A	OFF	OFF	OFF	P1 P2 to T	CLOSED	CLOSED	-		
60	Disconnect switch cable from switch 3A	OFF	OFF	OFF	P1 P2 to T	CLOSED	OPEN	Yes**		
61	Attempt to reset the safety control system	-	-	-	-	-	-	-		
62	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-		
63	Reconnect the switch cable to switch 3A	-	-	-	-	-	CLOSED	-		
64	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-		
65	Reset the safety control system	-	-	-	-	-	-	No		
66	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	-		
67	De-energize solenoids 2A & 3A	OFF	OFF	OFF	P1 P2 to T	CLOSED	CLOSED	-		
Items 68 through 75 could also be done with Switch 3A instead of Switch 2A.										
68	Disconnect switch cable from switch 2A	OFF	OFF	OFF	P1 P2 to T	OPEN	CLOSED	Yes**		
69	Reconnect the switch cable to switch 2A	-	-	-	-	CLOSED	-	-		
70	Attempt to energize solenoids 2A & 3A	ON	-	-	-	-	-	-		
71	Attempt to reset the safety control system	-	-	-	-	-	-	-		
72	De-energize solenoids 2A & 3A	OFF	-	-	-	-	-	-		
73	Reset the safety control system	-	-	-	-	-	-	No		
74	Energize solenoids 2A & 3A	ON	ON	ON	P1 to P2 T	OPEN	OPEN	-		
75	De-energize solenoids 2A & 3A	OFF	OFF	OFF	P1 P2 to T	CLOSED	CLOSED	-		

** Fault should occur immediately.

Notes

Notes



AMERICAS	USA	ROSS CONTROLS	Tel: +1-248-764-1800	www.rosscontrols.com
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