Automax BUSwitch™ – Profibus-DP

Flowserve Corporation
Flow Control Division

765 South 100 East
Provo, Utah 84606
www.flowserve.com

Phone: 801 373 3028
Facsimile: 801 489 2228
Email: actuators@flowserve.com

Installation, Operating & Maintenance Instructions

Electronic Printed Circuit Board Specifications

Power requirements†	
XA0231 Profibus-DP Interface Card	24 VDC - 675 mA max with solenoid activated.
Temperature	
Operational	-40 °F to +185 °F (-40 °C to +85 °C)
Storage	-40 °F to +250 °F (-40 °C to +120 °C)

† To operate, an external 24 VDC source must be locally supplied to the interface card.

Profibus Information

Manufacturer	
ID	0867 (Hex)
Device	
GSD File	AMAX0867.GSD
Firmware Revision	1.13
Transmission Speed	12 MBaud maximum
GSD file supplied on diskette included with every device.	

Principles of Operation

Flowserve's BUSwitch™ is a valve automation and control product that uses the Profibus-DP communication protocol to operate and monitor position as well as provide predictive and preventative maintenance functions. In response to a command from the operator, the BUSwitch energizes the appropriate solenoid valve, which shifts a spool valve, directing the pneumatic force to the appropriate actuator port, thereby operating the valve actuator. For single coil operation, the solenoid coil is mounted internal to the BUSwitch housing to protect it from the environment. A 4-way spool valve is bolted externally to the housing. The fail direction of the actuator can be established based on which set of terminals (open or closed) the solenoid coil is connected to. For dual coil operation, externally mounted solenoid valves must be used as the housing will not accommodate two internal coils. Upon reception of an open or close command, a timer is started whose value is compared to a user-defined setpoint for that particular operation. If this timer value exceeds the setpoint, an alarm is sent back to the control operator to indicate a possible problem exists at the valve. In addition, an odometer counter totals the number of transitions the valve has made, which is then compared to a user-defined limit. If this limit is exceeded an indication is sent back to the control operator. The odometer limit can be reset by the control operator after maintenance has been performed. During operation the valve status (open, closed or in-transit) is continuously available to the control operator. The Profibus-DP Interface Board (XA0231) requires 24 VDC at 175 mA maximum. Current consumption with a solenoid activated will be the sum of the solenoid current plus 175 mA.

Mechanical Installation

Installation is best performed with Flowserve NAMUR mounting kits. These kits allow direct mounting of the BUSwitch shaft to the actuator pinion without a coupler. The NAMUR mounting kits will work with any actuator conforming to the NAMUR standard for accessory mounting hole locations and pinion dimensions. Simply attach the bracket to actuator and BUSwitch to the bracket with the included fasteners. The BUSwitch shaft features an integral alignment pin that engages the tapped pinion hole. Flowserve also offers a full line of non-NAMUR kits.

Spool and Tubing Configuration

1. For spring return actuators, a 4-way spool valve is provided with port #2 plugged. For double acting actuators, the same valve is provided with no plugs. Make sure the correct spool is selected before installing tubing. (Note: the Flowserve APS2 purge module can be supplied on spring return actuators to purge the spring chamber with supply air.)
2. Make sure all air pressure is removed before installing tubing.
3. Attach tubing according to Figures 1 or 2 below, depending upon application. Attach supply tubing to Port 1 and use 3 and 5 for exhaust.
4. To prolong actuator life use only clean, dry plant air. Lubricated air is not required, although it is recommended, particularly for high cycle applications.

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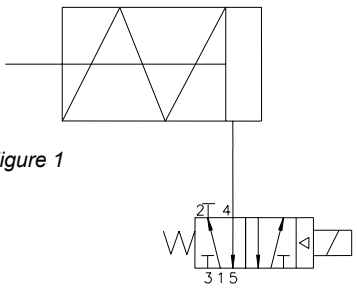


Figure 1

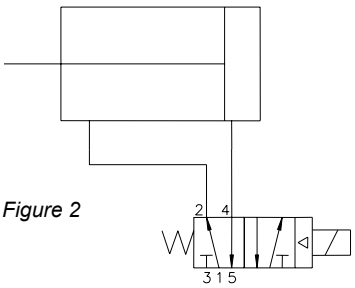


Figure 2

Lubrication

All **BUSwitch™** spool valves are pre-lubricated and will operate dry (with no additional lubrication). The use of lubricated air will not interfere with the BUSwitch's functioning. If air lubrication is used, the oils listed below are popular, easily obtainable, fluids that are recommended for use with the **BUSwitch™** spool valve: Gulf Harmony 47, Mobil DTE Medium, Shell Tellus 29, Texaco Rondo B, Sohivis 47 and Sunnis 921. Many other lubricants are acceptable providing they do not contain detergents that will attack Buna-N or Viton Seals.

Electrical Connections

CAUTION

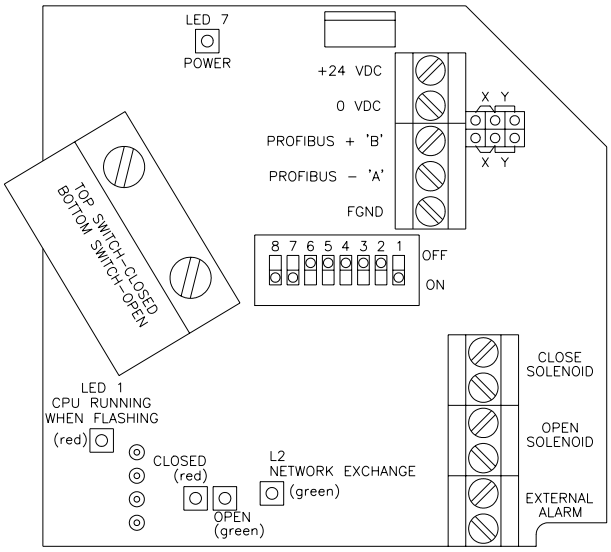
To prevent ignition of hazardous atmospheres, keep cover bolts tight while circuits are live. Disconnect supply circuit before opening.

Entry into the BUSwitch housing is made through three ½" NPT conduit entries. All electrical connections (power, data, external alarm, open and close solenoids) are made to captive screw cage terminal strips located on the Profibus-DP Interface board (XA0231). BUSwitch models with an internal pilot valve will have the valve connected to the appropriate circuit board terminals by the factory. For dual solenoid applications, connect the respective solenoids to the terminal strip locations marked 'OPEN' and 'CLOSE'. External power (24 VDC) is connected to the indicated location.

CAUTION

BE SURE TO OBSERVE CORRECT POLARITY OF THE EXTERNAL POWER CONNECTIONS OR DAMAGE TO THE PRINTED CIRCUIT BOARD WILL OCCUR!

A 'dry-contact' device can be connected to the terminals marked 'EXTERNAL ALARM', the meaning of which is determined by the customer. Refer to figure three. The data cable connection is made to the locations marked PROFIBUS + B and PROFIBUS – A, observing polarity. If this is the last device on the segment, move the shorting jumpers to the Y position to enable the termination resistor. Refer to figure three for data cable connection locations.



Profibus-DP Interface Card (XA0231)
Figure 3

For hazardous locations, Underwriters Laboratories (UL) and the National Electric Code (NEC) require an approved sealing fitting within eighteen inches of the switch enclosure. Sealing fittings are not required for Division 2 non-incendive applications. Open conduit entries must be closed after installation using a close-up plug approved for hazardous locations. Conduit and plugs must engage a full five threads. Flowserve can provide the sealing fitting with a union and junction box for 'daisy chain' wiring applications.

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Special notes on the fieldbus cabling.
Due to the high-speed communication capability of Profibus-DP networks, it is important to follow established specifications closely to ensure full communication capability. Governance of the physical level requirements is specified in the European Norm ***EN50170: "General Purpose Field Communication System."*** To obtain the maximum communication capability it is highly recommended to only use type 'A' cable as defined in table one below. As a rule, data speed and maximum segment length are inversely related. At 9.6 kBaud, segment lengths up to 1200 meters are allowed. At 12 MBaud the segment length falls to 100 meters. The following tables were obtained from ***The Rapid Way to Profibus-DP*** by Manfred Popp; available from the PROFIBUS Nutzerorganisation (PNO) as order number 4.072. To order, contact the Profibus Trade Organization (PTO) in your area.

Line Parameters

	Line Type A	Line Type B
Impedance (Ω)	135 to 165	100 to 130
Capacitance per unit length (pF/m)	<30	<60
Loop resistance (Ω/km)	110	---
Core diameter (mm)	0.64	>0.53
Core cross section (mm^2)	>0.34	>0.22

Table 1

Recommended Line Lengths

Transmission rate (kBaud)	9.6	19.2	93.75
Line Type A	1200	1200	1200
Line Type B	1200	1200	1200

Transmission rate (kBaud)	187.5	500	1500
Line Type A	1000	400	200
Line Type B	600	200	-

Transmission rate (kBaud)	1200
Line Type A	100
Line Type B	-

Table 2

Adjustment of Switch Cams

1. Loosen five captive cover screws and remove lid, turning slightly while lifting.
2. Place the actuator in the clock-wise (CW) position and apply 24 VDC to the Profibus-DP Interface Card.
3. Push down on the top cam (figure 4) until it clears the splined coupler and rotate clockwise until the CW LED (red) is illuminated.
4. Release the cam and insure that it fully engages the spline.
5. Place the actuator in the counter-clockwise (CCW) position.
6. Pull up on the lower cam (figure 4) until it clears its splined coupler and rotate counter-clockwise until the CCW LED (green) is illuminated.
7. Release the cam and insure that it fully engages the spline.
8. Cycle the actuator to insure that each LED is illuminated at the appropriate time. Some minor readjustment might be necessary.
9. Clean base, lid flanges, and replace lid on base. Make sure wires are NOT caught between flanges, and tighten captive screws.

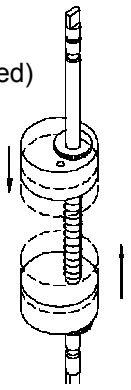

Figure 4

BUSwitch Configuration

Configuration of the BUSwitch is accomplished through three main steps; physically connecting to the network, setting the device address / operating mode and sending operating parameters over the Profibus segment. The physical connection to the segment was covered previously in this document. Setting of the device address and operating mode is accomplished by a printed circuit board (PCB) mounted switch assembly (refer to figure three). The switch assembly has eight numbered positions, each of which can be set to either ON or OFF. Switch #1 sets dual coil operation when in the ON position, or single coil operation when placed in the OFF position. Switches 2 through 8 are used to set the address of the BUSwitch on the Profibus segment. The switches are a binary representation of the address with switch number 2 being the most significant digit and switch number 8 being the least significant digit. The decimal value of each switch when set to the ON position is as follows.

Switch #	2	3	4	5	6	7	8
Decimal Value	64	32	16	8	4	2	1

Table 3

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A simple algorithm that can be used to set the board to a specific address is.

1. Put switches 2 through 8 into the OFF position.
2. Determine the address where the BUSwitch will reside. This value will be known as the 'target' value.
3. Referring to Table 3, locate the switch with the highest decimal value that is less than or equal to the target value. Move that switch to the ON position. For example if the target value is 33, switch #3, with a decimal value of 32, would be moved to the ON position.
4. Subtract the decimal value of the switch that was just turned on from the target value. The difference, if it is not equal to zero, will become the new 'target' value. From the example above, 1 will be the new target value (33-32=1).
5. Repeat steps 3 and 4 until the difference between the switch value and the target value is zero. Upon application of power to the board, the address will be read from the switches.

Communication of the operating parameters to the BUSwitch is accomplished by reading and writing of six, 16-bit words. To ensure that the BUSwitch sends and receives the correct data, all six words should be read or written anytime one of the parameters is changed.

Board Indicators

The Profibus-DP Interface Board (XA0231) contains several indicators that are helpful when initially configuring the device or when troubleshooting. Refer to figure three for the locations of the indicators.

LED 7 – Power Illuminated when 24 VDC is present.

LED 1 – CPU Running When Flashing This indicator will flash red approximately every 2 seconds to indicate that the microprocessor is operating normally. If the indicator glows steadily or does not come on, remove device power for 10 seconds and then reapply to reset.

L2 – Network Exchange This indicator will be green when communication with the device is taking place over the network.

Terminations

For proper communication to take place, each end of the network segment must have terminators. Terminators are resistive devices used to insure the proper network impedance is maintained. In most systems, one of the terminators will be located at the PLC. The other terminator is located at the last device on the segment. If the BUSwitch is the last device on the segment, move the two jumpers on the 'X" locations over to the 'Y' locations to enable the on board terminator. If the BUSwitch is located within the center of the segment, the jumpers should be set on the 'X' locations. Refer to figure five.

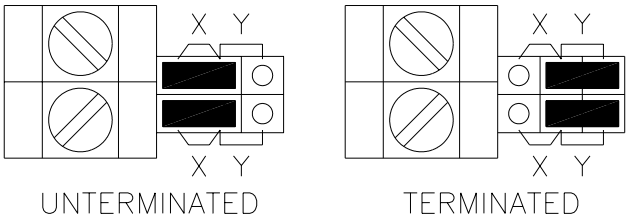

Figure 5

BUSwitch Input Data Packet

Word ↓	Bit→ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	OP	CL	RS	AL	FA	FO	Reserved									
2	Odometer Limit (Most significant word)															
3	Odometer Limit (Least significant word)															
4	Oneshot Duration (50 millisecond 'ticks')															
5	Valve Opening Response Timeout (50 millisecond 'ticks')															
6	Valve Closing Response Timeout (50 millisecond 'ticks')															

Table 4 – Input Data Packet

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OP (OPen) Changing this bit from a zero to a one will result in the valve actuating to the open position - only if the valve is in the closed position. If the valve is currently in the 'OPEN' state, this bit will be ignored. This bit is dependent on the value written to the closed bit (CL). If CL contains a one when OP is set to one, actuation will not occur until CL is reset.

CL (**CL**osed) Changing this bit from a zero to a one will result in the valve actuating to the closed position - only if the valve is in the open position. If the valve is currently in the 'CLOSED' state, this bit will be ignored. This bit is dependent on the value written to the open bit (OP). If OP contains a one when CL is set to one, actuation will not occur until OP is reset.

RS (Odometer **R**e**S**et) Setting this bit to a value of one will result in the odometer counter being set to zero subject to the following conditions:

1. RS is set to one
2. OP is set to zero
3. CL is set to zero
4. The odometer limit has all bits set to 1
5. No valve actuation is currently in process

AL (ALarm) The value written to this bit will affect the meaning of the external alarm input of the BUSwitch. When a zero is placed in this position, the external alarm bit (EX) of the BUSwitch output data packet will be set to a one when the connection to the external alarm input terminals is broken. Placing a one in this position will result in the EX bit being set when a closed connection is made to the external alarm input terminals.

FA (**F**ailsafe **A**rm) If communication over the network is lost, the default action of the valve is to fail in place. By setting this bit to one, either fail open or fail close can be enabled. The fail direction is determined by the state of the FO bit described below.

FO (**F**ail **O**pen) This bit determines the direction of the fail action when the FA bit has been enabled. When this bit is set to zero and the FA bit is set to one, the valve will fail close upon loss of communication with the master. If it is desired for the valve to fail open, set this bit to one.

The following truth table illustrates the interactions between the FA and FO bits.

FA	FO	Failsafe Action
0	0	Fail in place
0	1	Fail in place
1	0	Fail closed
1	1	Fail Open

Table 5

Odometer Limit: The odometer limit is a 32-bit value that is comprised of words 3 and 4 of the input data packet. When the odometer counter exceeds this value, the Odometer Limit (LI) bit of the output data packet is set to one, indicating an alarm condition. When set to zero the BUSwitch will default to 2,000,000. Valid range is from 0 to 4,294,967,295 (2^{32}-1).

One-shot Duration: Integer value that when multiplied by 0.05, represents the number of seconds to energize the solenoids in dual coil mode. Any integer value between 0 and 65535 can be input, however, values below 10 (0.5 seconds) will result in a value of 10 being used. Integer values above 6000 (300 seconds) will result in 6000 being used. To calculate the value to enter from a desired time value, divide the time value by 0.05 and round to the nearest integer.

Valve Opening Timeout / Valve Closing Timeout: When a either the OPEN or CLOSE solenoid is activated, the response time for the valve to complete the transition is monitored and compared to the limit specified by the user for that respective operation. If the transition time exceeds the value specified for that operation, the time-out (TO) bit will be set to one in the BUSwitch output data packet. As with the one-shot duration value above, the value entered into these words represent 50 millisecond intervals. Values entered that are below 10 (0.5 seconds) will default to 10 (0.5 second). Values above 6000 (300 seconds) will default to 6000. Allowable input range is from 0 to 65535.

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BUSwitch Output Data Packet

Word ↓	Bit→ 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	VO	VC	EX	LI	TO											
2	Odometer Counter (Most significant word)															
3	Odometer Counter (Least significant word)															
4	Reserved															
5	Transition Timer (50 millisecond 'ticks')															
6	Firmware Version															

Table 6 – Output Data Packet

VO (**V**alve is **O**pen) This reflects the actual state of the valve position by monitoring the state of the OPEN proximity switch. A one in this bit position indicates the OPEN proximity switch is closed.

VC (**V**alve is **C**losed) Reflects the actual state of the valve by monitoring the CLOSED proximity switch. A one in this position indicates the CLOSED proximity switch is closed.

EX (**EX**ternal Limit) This bit is set to one to indicate an alarm condition depending on the state of the external alarm input AND the value of the AL bit in the input data packet. When AL is set to 0, if the circuit connected to the external alarm input is broken, the EX bit will be set to one. When AL is set to 1, the circuit connected to the external alarm input must be made for EX to be set.

LI (Odometer **LI**mit) When the number of valve transitions exceeds the odometer limit value, this bit will be set to one.

TO (Valve **T**ime**O**ut) This bit is set when the valve has not reached its end of travel within the time specified by either Valve Opening Response Timeout or Valve Closing Response Timeout. This bit is cleared upon reversal of motion. For example, if the TO bit was set during a close operation, it will only clear when the valve has been commanded to open and the valve subsequently leaves the closed position.

Transition Timer: This integer value indicates the number of 50 millisecond periods that have elapsed since the last request of valve motion and completion of the valve movement. This value is reset to zero upon change of direction.

Odometer Counter: This value is the cumulative number of valve transitions since the counter was reset. The value is incremented when the valve completes a transition.

Firmware Version: Expresses the firmware version of the BUSwitch in decimal form. The value should be divided by 100 to obtain the correct form. For example, a value of 113 in this word corresponds to firmware version 1.13.

Reserved bits are reported back to the controller as zero.

CE 0518 **Ex II 2 G EEx d II T5**