WESTLOCK
CONTROLS CORPORATION

7300 SERIES
FOUNDATION FIELDBUS
OPERATING MANUAL

(Non-Incendive and Intrinsically Safe Devices)

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1.1 Scope of Manual

This manual contains installation, configuration and specification data for the FPAC FOUNDATION™ fieldbus valve controller.
This manual assumes a basic level of familiarity and competence with FOUNDATION™ fieldbus terminology and technology. Only qualified personnel should install, operate and maintain this equipment.
This manual uses the term **FPAC** to refer to any FF module of the family Intellis 7300.

1.2 Acronyms, Abbreviations and Symbol Definitions

This section contains a listing of all acronyms, abbreviations and symbol definitions used in this document.

Table 1-Acronyms

NI	Non-incendive
IS	Intrinsically Safe
HW	Hardware
SW	Software
DCS	Distributed Control System
FPAC	Fieldbus Pneumatic Actuator Controller
DD	Device Description
DI	Discrete Input
DO	Discrete Output
FB	Function Block
FF	Foundation™ fieldbus
RB	Resource Block
TB	Transducer Block
ROUT	Remote-Output mode
RCAS	Remote-Cascade mode
CAS	Cascade mode
AUTO	Automatic mode
MAN	Manual mode
LO	Local Override mode
IMAN	Initialization Manual mode
OOS or O/S	Out Of Service mode

Table 2-Abbreviations

fieldbus	FOUNDATION™ fieldbus
xducer	Transducer

1.3 Symbols

This symbol warns the user of possible danger. Failure to heed this warning may lead to personal injury or death and/or severe damage to equipment.

This symbol warns the user of a possible failure. Failure to heed this warning can lead to total failure of the equipment or any other connected equipment.

This symbol gives the user important hints.

1.4 About FOUNDATION™ Fieldbus

Foundation fieldbus is not owned by a company, it is an open, interoperable [fieldbus] that is based on the International Organization for Standardization's Open Systems Interconnection (OSI/ISO) seven-layer communications model. The Foundation specification is compatible with the officially sanctioned SP50 standards project of the Instrumentation, Systems, and Automation Society (ISA) and the International Electrotechnical Commission (IEC).
The FOUNDATION fieldbus system architecture provides a framework for describing these systems as a collection of physical devices interconnected by a fieldbus network.
The FOUNDATION fieldbus architecture specifies two types of network segments, H1 links and High Speed Ethernet (HSE) subnetworks. H1 links use a subset of the IEC 61158 data link layer and HSE subnetworks use standard Ethernet/IP/TCP/UDP protocols.
FOUNDATION fieldbus networks may be composed of one or more of these interconnected segments. HSE subnetworks can use a variety of commercially available interconnection devices such as hubs, switches, bridges, routers, and firewalls. H1 links are interconnected physically only by FOUNDATION fieldbus H1 Data Link bridges. HSE to H1 interconnections are performed by FOUNDATION fieldbus Linking Devices.
Each physical device in a FOUNDATION fieldbus system performs a portion of the total system operation by implementing one or more application processes. Application processes perform one or more time-sensitive functions, such as providing sensor readings or implementing control algorithms. These and other elementary field device functions are modeled as function blocks. Their activities are coordinated through configuration of their operating parameters, execution schedules, and communications. Communication between application processes occurs through application layer protocols.

1.5 Westlock FOUNDATION™ Fieldbus FPAC

The FPAC module is a four input, two output network monitor. Inputs are compatible with dry contact type switches. The outputs are open drain active low (activated by pulling the input of the FET to ground) FET(s) with diode protection to 32Vdc.

Current consumption is a constant 24 mA independent of the piezo operator being energized or not. Operating voltage is 9-32Vdc. The FPAC incorporates a parameter that allows the user to de-activate the I/O LEDs
Use of any standard 4-20 mA instrumentation cable (twisted shielded pair) for trunk and drops is permissible. For maximum drop and trunk distances the use of Type A cable is required. For a more detailed treatment of FOUNDATION™ fieldbus physical media requirements refer to IEC 61158-2 and Fieldbus Foundation documents AG-140, AG-163, AG-181.

1.5.1 LED Status Indicators

The LEDs provide information concerning the status of inputs, outputs, the module and/or the network. The LEDs provide visual indication whether any inputs or outputs are active and whether the module or network are in a fault condition. The I/O Status LEDs are intended to indicate the state of the inputs and outputs of the module, not necessarily the on/off condition of the I/O points themselves.

LED.	State	Indicates
AUX 2	Yellow	Aux. 2 Input active
AUX 1	Yellow	Aux. 1 Input active
DS 1	Green	FPAC communicating on bus
CLSD	Yellow	Valve CLOSED (bottom Limit Sensor)
OPEN	Yellow	Valve OPEN (top Limit Sensor)
OUT 0	Yellow	OUT 0 active
OUT 1	Yellow	OUT 1 active

1.5.2 FPAC Module Layout (no. EL-40133 regular canister or EL-40137 explosion-proof canister).

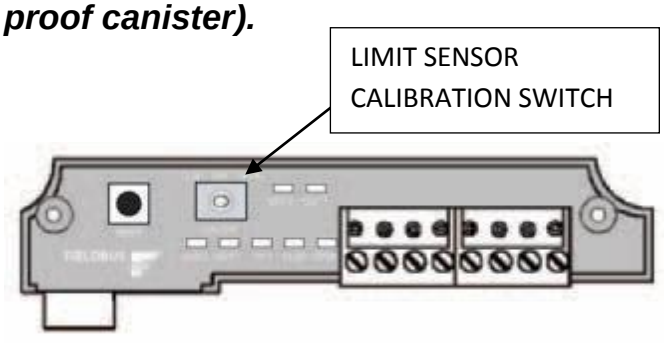


Figure 1 - FPAC Top View

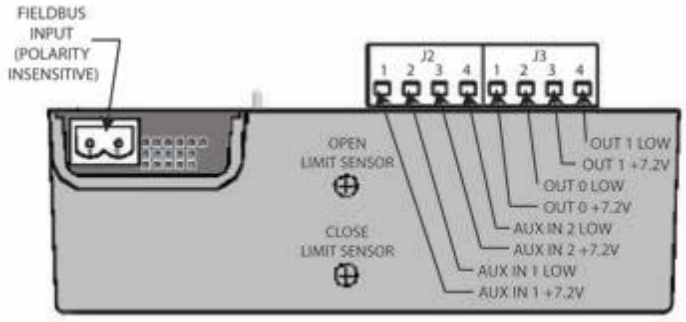


Figure 2 - FPAC Side View

1.6 Device Features

1.6.1 Auxiliary Inputs

There are two auxiliary discrete inputs available on the device. These inputs accept dry-contact type switches and are available as transducer channels for connection to DI function blocks. It is possible to interface the FPAC with active type PNP/NPN sensors, please consult the factory for details (see Appendix A).

1.6.2 Predictive Alarming

There are device specific operational alarms.
The ***Cycle Time Alarm*** is activated when the time between the activation of the valve and the detection of the associated limit switch closure exceeds the time limit set during configuration of the cycle of alarm parameter (located in the TB).
The ***Hi Temperature*** and ***Low Temperature Alarms*** are activated when the ambient temperature of the FPAC module exceeds the limits set during configuration of the Hi_Temperature / Low_Temperature_Alarm(s) (located in the TB). Since the operational temperature range of all piezo operators is (-20°C) - (60°C) it is possible for local environmental conditions to exceed these values.
These conditions can trigger FOUNDATIONTM fieldbus alarms on the bus that can be handled via the standard FOUNDATIONTM fieldbus alarm mechanism. For critical applications the ***Maskable Signal*** described in Section 1.6.4 can be used to link the alarms directly to a DI. This allows the alarm state to be linked directly to another FB for immediate action in the process.

1.6.3 Preventative Maintenance Alarming

Maintenance alarms can be generated when the user configured ***Cycle Count Limit*** is reached. The device will have a continuous cycle count for each piezo operator (dual piezo operator option available for ***Fail Last*** applications). The **cycle_count_limit** parameter (located in the TB) is set during configuration. The maintenance alarm will be generated when **cycle_count** accumulates a number larger than the associated **cycle_countl_limit**. This condition can trigger an FOUNDATIONTM fieldbus alarm on the bus that can be handled via the standard FOUNDATIONTM fieldbus alarm handling. This condition can also immediately transmit to other FB(s) on the bus using the ***Maskable Signal*** described in Section 1.6.4 below.

1.6.4 Maskable Signal

The Maskable signal is a configurable channel (Channel 13) of the TB that can be connected to a DI Block. This channel allows the user to select one or more conditions which can be used to generate a signal in a DI Block that can then be linked via the fieldbus to another function block initiating a process response to the selected condition or conditions.

For example:
The **cycle_count_1** parameter has been enabled in the TB
The accumulated value of the parameter **cycle_count_1** exceeds the configured limit
The Maskable Signal has been associated to the **cycle_count_1** parameter
A DI block has been configured to utilize Channel 13

When the above conditions are TRUE the DI block will indicate when the parameter **cycle_count_1** has exceeded its configured limit and transmit this indication to any FB it is linked to.

The Maskable Signals include:
cycle_count_limit_1 or 2 exceeds the configured limits
cycle_time exceeds the configured limits
Bad Transducer Status
High/Low_Temperature exceeds the configured limits

The alarm signals that are to be transferred through Channel 13 are selected using the **signal_mask** parameter (located in the TB).

1.7 Fieldbus FOUNDATION™ Conformance Documentation, CFF and DD Availability

The Westlock FPAC module is a Fieldbus FOUNDATION™ registered device having successfully completed the required conformance tests. The CFF and DD are downloadable from the Foundation website at www.fieldbus.org (Manufacturer: "Westlock Controls" and Product name "FPAC EL40106") . FPAC EL40106 represents all Westlock FPAC final assemblies (for example:EL-40133 or EL-40137).

Table 4 – Fieldbus Foundation ™ Conformance Documentation

Manufacturer	Westlock Controls
Model	FPAC Valve Controller EL-40133
Type	Discrete Valve Controller
Revision	0X04
Device ID	5743430001Westlock 011001001
VFD Name	FBAP
Tested Function Blocks	6xDI(s), 4xDO(s), 1xRB(s)
Other Blocks	1xTB(c)
UTK	5.2.0
IT Camp. Number	IT079600

1.8 Host System Compatibility Documentation

Allen-Bradley
The FPAC passed all stress and interoperability testing and is certified for installation in Allen-Bradley systems.

Emerson Process Management, Delta-V
The FPAC passed all stress and interoperability testing and is certified for installation in Delta-V systems.

Honeywell
The FPAC passed all stress and interoperability testing and is certified for installation in Honeywell systems.

SMAR
The FPAC passed all stress and interoperability testing and is certified for installation in SMAR systems.

Yokogawa
The FPAC passed all stress and interoperability testing and is certified for installation in Yokogawa systems.

1.9 Non-incendive and Intrinsically Safe Design Criteria and Agency Approvals

The Westlock FPAC module is designed in accordance with the criteria for NI and IS devices.
The FPAC requires the use of an agency approved IS barrier in IS applications. For information on the barrier used by Westlock Controls to obtain the agency approvals listed above, appropriate network architecture and segment device limits refer to Control Drawing WD-11835 located in Appendix F of this document. The FPAC EL-40157 is approved for both Entity and FISCO IS applications. Refer to Section 1.9.1 for parameters.

Table 5 -Hazardous Ratings

Housing	Location Type	Rating
7344 (Resin Enclosure)	**Intrinsically Safe**	IS /I/ 1 ABCD T4 Ta = 80°C IS I / 0 / IIC T4 Ta=80°C
	Non-Incendive	NI / I /2 / ABCD; S / II, III /2 /FG /T4 Ta=60°C TYPE 4X
7379 (Aluminum Explosion-Proof Enclosure)	**Intrinsically Safe**	IS /I/ 1 ABCD T4 Ta = 80°C IS I / 0 / IIC T4 Ta=80°C
	Non-Incendive	N/I / I / 2 / ABCD / T6 Ta = 60◦C; DIP / II, III / 1 / EFG/ T6 Ta = 60°C ; TYPE 4, 4X
	Explosionproof	XP / I /1 CD / T6 Ta= 60°C;

1.9.1 Entity and FISCO Parameters

Table 6 - Entity and FISCO Parameters					
	Vmax	Imax	Pi	Ci	Li
Entity Parameters	30 V	100 mA	N/A	120 pF	0 mH
FISCO Parameters	30 V	380 mA	5.32 W	5 nF	10 µH

1.10 Device Specifications

• FOUNDATIONTM fieldbus Conformant Stack and hardware
• Intrinsically Safe and Non-incendive design and approvals
• Solid State position Limit Sensors
• Limit Sensor calibration switch
• Internal temperature sensor
• User configurable High and Low temperature alarm thresholds
• User configurable custom alarms
• Transducer with diagnostic features
• Polarity insensitive Fieldbus input
• Auxiliary Inputs

• 1x Resource Block
• 1x Transducer Block
• 6x Discrete Input
• 4x Discrete Output

• Function Block execution time: 60 mS
• UDC- User Defined Channel with Boolean output
• 20 configurable VCR(s)
• Valve driver: 2-piezo operators
• Operating voltage: 9-32VDC
• Maximum voltage: 35VDC
• Current consumption: 24 mA

1.11 Bibliography

Fieldbus FOUNDATIONTM - FOUNDATION Specification Function Block Application Process, Part 1 (FF-890)
Fieldbus FOUNDATIONTM - FOUNDATION Specification Function Block Application Process, Part 2 (FF-891)
Fieldbus FOUNDATIONTM - FOUNDATION Specification Transducer Block Application Process, Part 1 (FF-902)
Fieldbus FOUNDATIONTM - FOUNDATION Specification Transducer Block Application Process, Part 2 (FF-903)
Fieldbus FOUNDATIONTM - FOUNDATION Specification Common File Format (FF-103)
Fieldbus FOUNDATIONTM - FOUNDATION Specification Device Description Language (FF-900)
IEC 61158: Digital data comm. for measurement and control – Fieldbus for use in industrial control systems

2.1 Mounting

For steps 1-3 refer to Figure 3 below.
Attach the proper mounting bracket and adapter (if required) to the valve monitor housing with the hardware provided.
Operate the actuator to full closed position.
Attach the valve monitor and mounting bracket to the actuator.
Note the position of the actuator/valve and confirm the Beacon position is properly aligned, as shown in Figure 4 below while replacing the cover.

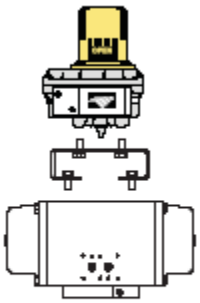


Figure 3

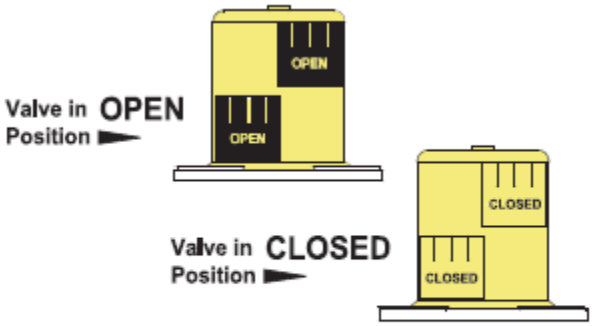


Figure 4

2.2 Pneumatic Connections

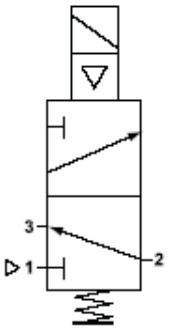
Personal injury and/or property damage may occur from loss of process control if the supply medium is not clean, dry oil-free air or non-corrosive gas. Instrument quality air that meets the requirements of ISA Standard S7.3-1975 is recommended for use with pneumatic equipment in process control environments. Westlock Controls recommends the use of a 20 micron filter with all Falcon solenoids.

2.2.1 Tubing and Fittings

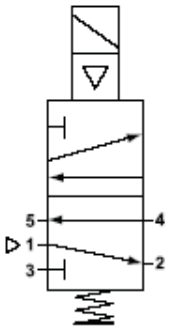
The use of copper, stainless steel, nylon or polyethylene tube is recommended for piping up air circuits and equipment. As a general rule, pipe threaded fittings should not be assembled to a specific torque because the torque required for a reliable joint varies with thread quality, port and fitting materials, sealant used, and other factors. The suggested method of assembling pipe threaded connections is to assemble them finger tight and then wrench tighten further to a specified number of turns from finger tight. The assembly procedure given below is for reference only; the fitting should not be over tightened for this will lead to distortion and most likely, complete valve failure.

1. Inspect port and connectors to ensure that the threads on both are free of dirt, burrs and excessive nicks.
2. Apply sealant/lubricant or Teflon tape to the male pipe threads. With any sealant tape, the first one or two threads should be left uncovered to avoid system contamination.
3. Screw the connector into the port to the finger tight position.
4. Wrench tighten the connector approximately 1 - 2 turns (to seal) from finger tight. Again this is only reference - the fitting should NOT be over tightened.3

2.2.2 Porting



3 Way Spring Return Valve
Solenoid De-energized - air flows from Outlet Port 2 to Exhaust Port 3.
Solenoid Energized - air flows from Inlet Port 1 to Outlet Port 2.



4 Way Spring Return Valve
Solenoid De-energized - air flows from Inlet Port 1 to Outlet Port 2 and exhausts from Port 4 to Port 5.
Solenoid Energized - air flows from Inlet Port 1 to Outlet Port 4 and exhausts from Port 2 to Port 3.

2.2.3 Maintenance

Routine maintenance is usually confined to the periodic replenishment of ***Dow Corning III*** lubricant or equivalent to spool and spring.

2.2.4 Pneumatic Specifications

Table 7 -Pneumatic Specifications	
Operating Pressure	45-120 PSIG
Operating Temperature	-10°C to +60°C (14°F to +140°F)
Operating Media	Non Lubricated Filtered Air to 20 Microns
Porting	1/4” NPT air ports for inlet, outlet and exhaust (3.5 Cv valve has 1/2” NPT air ports)

2.3 Switch Adjustment

Switches are factory set. If you need to adjust switches for any reason follow instructions below.

2.3.1 Position Limit Sensor Calibration Switch

For convenience in setting the position Limit Sensors the FPAC allows the user to stroke the actuator via the ***Limit Sensors Calibration Switch*** (***LSCS***) (for location of switch on FPAC module see Section 1.5.2).
The ***LSCS*** enables the user to set the Limit Sensors without an Open or Close command being sent to the FPAC from the host system.
Three conditions must be TRUE for the switch to operate:
The RB must be OOS
The TB must be OOS
The **”CALIBRATION ENABLE”** parameter in the TB must be enabled.

2.3.2 Position Limit Sensor Calibration

For steps 1-8 refer to Figures 5 and 6.
Refer to Figure 6 and note the approximate locations of the Open and Close targets on the FPAC module.
With the valve in the closed position, lift bottom cam of the Close sensor trigger.
Turn cam until face of trigger is perpendicular to the target and sensor is activated as evidenced by the lighting of the corresponding module LED.
Release the cam and the spring will push cam back onto the splined shaft.
Operate the actuator to the opened position.
Push down the top cam of the Open sensor trigger.
Turn cam until face of trigger is perpendicular to the target and sensor is activated as evidenced by the lighting of the corresponding module LED.
Operate actuator from one extreme to the other several times to check Limit Sensor operation.

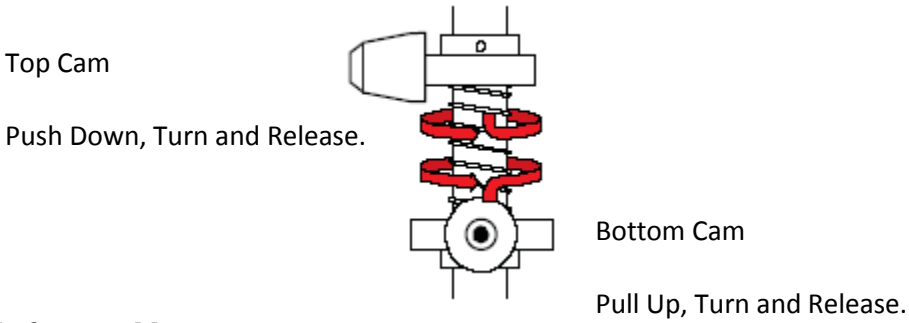


Figure 5- Trigger/Shaft Assembly

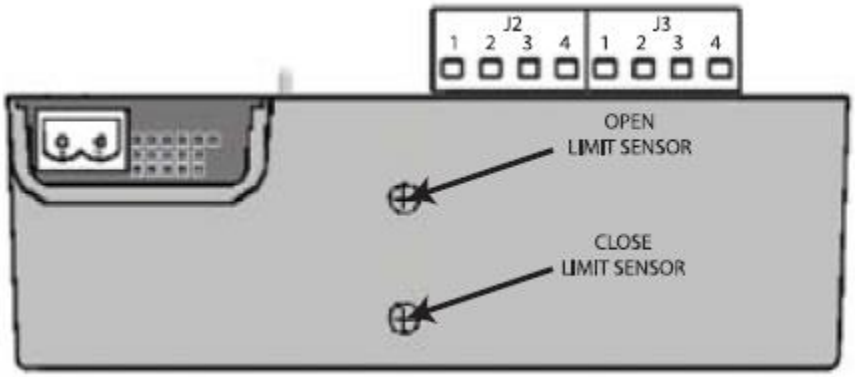


Figure 6- FPAC Hall Sensor Location

2.4 Wiring Instructions

STOP
WARNING

All wiring must be in accordance with National Electrical Code (ANSI-NFPA-70) for the appropriate area classifications.

Attention

Models 7344 and 7379 are approved as Intrinsically Safe for Class I, Division 1, Groups A,B,C and D, Class I, Zone 0, Group IIC; with ***Entity*** and ***FISCO*** parameters.
Model 7344 is also approved as Nonincendive for Class I, Division 2, Groups A,B,C and D; Suitable for Class II, III, Division 2, Groups F and G; Type 4X applications.
Model 7379 is also approved as Explosionproof for Class I, Division 1, Groups C and D; Dust Ignition Proof for Class II, III, Division 2, Groups E, F and G; Type 4, 4X applications.

STOP
WARNING

Always check the nameplate to make sure the agency approval ratings coincide with the application.

Note

The proper wiring diagram for your unit is shown on the inside of the enclosure cover.

1. Diagrams of the FPAC are shown in Figures 7 and 8.
2. Make the necessary wiring connections to the FPAC module as shown in Figure 9. Refer to Section 2.4.1 for connector pin outs.
3. Replace the electronics housing cover or junction housing cover.
4. Unit is now ready for automatic operation. For further assistance please contact Westlock Controls.

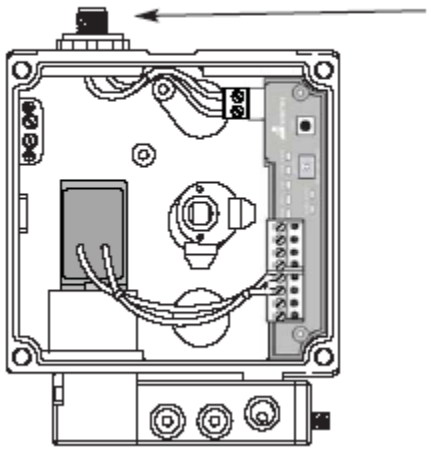


Figure 7 – Resin Enclosure

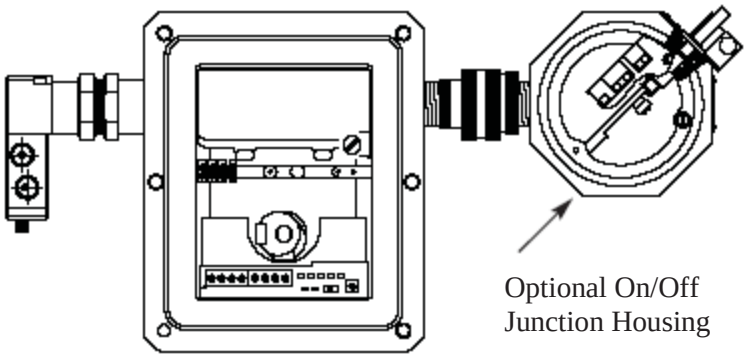


Figure 8 – Explosion-Proof Enclosure

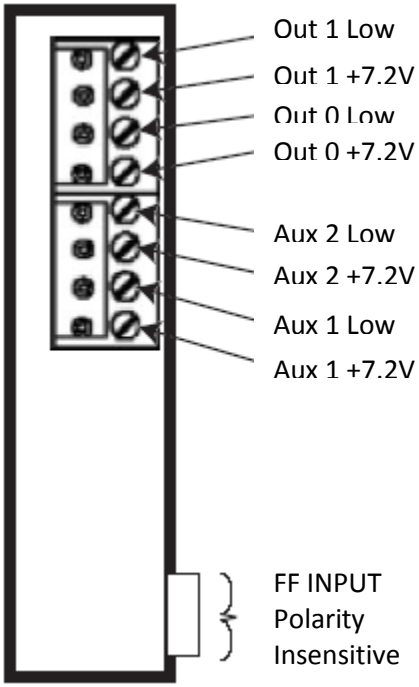


Figure 9 - FPAC Wiring Diagram

2.4.1 FPAC Connector Pin Out

Note

FF input is ***polarity insensitive***.

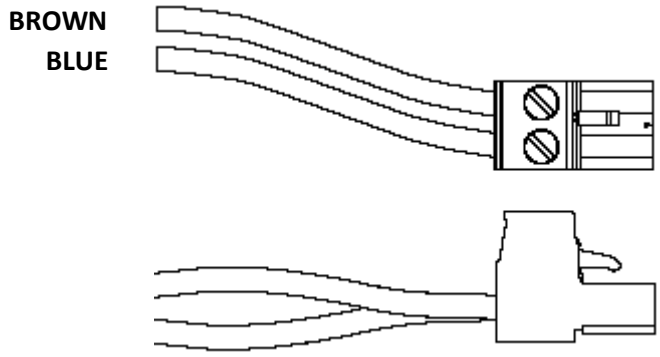


Figure 10 - FPAC 2 pin Phoenix Style Connector

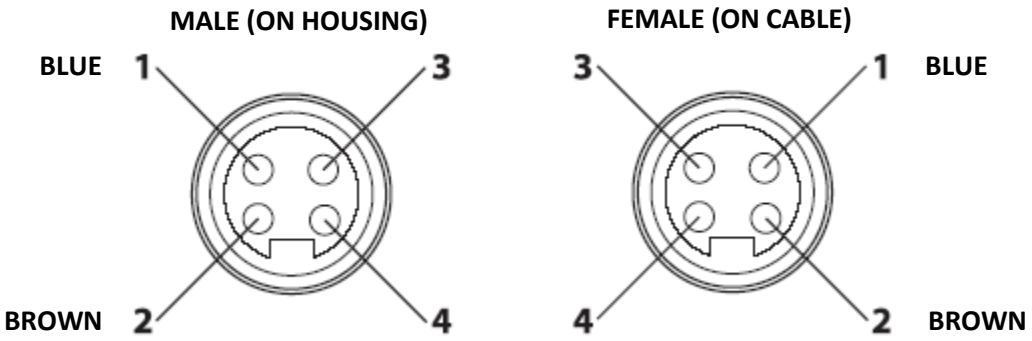


Figure 11- Fieldbus 4 pin Mini Connector

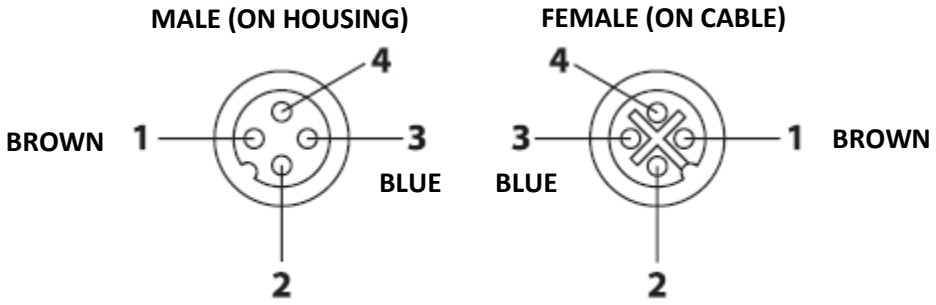


Figure 12- Fieldbus 4 pin Micro Connector

2.4.2 FPAC Module Terminations and LED Locations

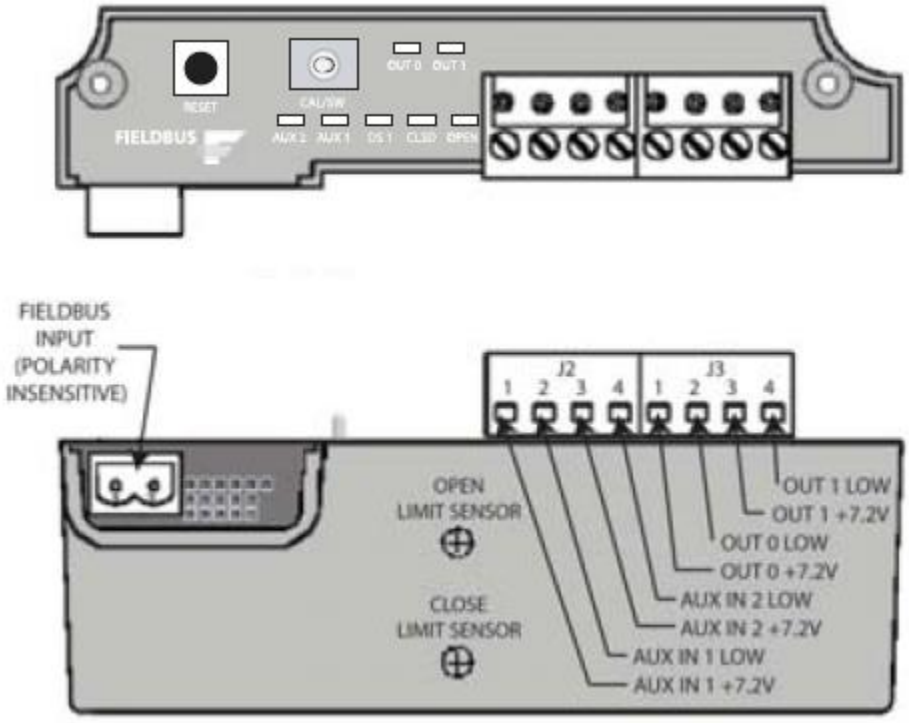


Figure 13 - FPAC Module

3.1 Quick Configuration

Note

For QuickConfig Sheet see Appendix B.

Note

For detailed instructions, with graphics, on configuring the FPAC for the most common modes of operation refer to Appendix C.

3.2 Hardware Write Protection

Note

After the FPAC is configured the HW Write Protect jumper may be inserted into the Program Port to prevent configuration of device from being changed.

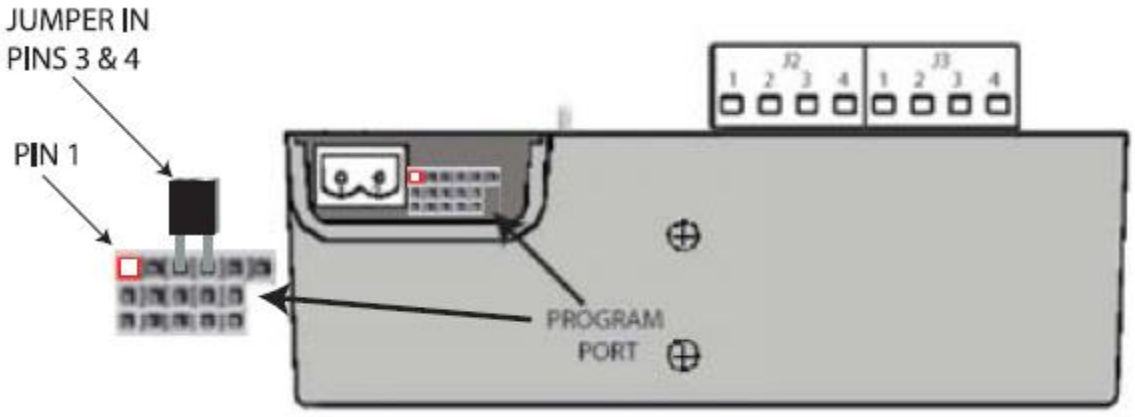


Figure 14 - Write Protect Jumper

Inserting the programmable jumper in Pins 3 & 4 of the Program Port will enable the Hardware Write Protection feature preventing any changes to the configuration of the device until the jumper is removed. Inserting the jumper in Pins 1 & 2 or removing the jumper completely allows normal operation of the device.

3.3 Channels

Channels are used to connect a standard Function Block to hardware functionality in the Transducer Block. There can be only one physical output or input per Channel. Multiple Channels may reference the same physical output or input, though not at the same time.
The specific channels in this device are listed in Sections 3.8 and 3.9.

3.3.1 Discrete Input Channels

Discrete Input Channels link the discrete input data from the FPAC Input HW (Limit Sensors, dry contact Aux. Inputs) selected by channel number, through the TB to the Discrete Input function blocks on fieldbus for use in control.
Discrete Input blocks convert data from the input hardware in the device to a value it makes available to other function blocks.
FPAC discrete inputs are developed from internal events such as an alarm or limit sensor state change and/or from external events via Auxiliary input state changes such as a High Level or pressure switch contacts being made.

3.3.2 Discrete Output Channels

Discrete Output Channels link the discrete output data from the Discrete Output function blocks on fieldbus, through the TB to the FPAC Output HW (piezo, Aux. Output) selected by channel number. Discrete Output function blocks on fieldbus always include a parameter **readback_d**.
A Discrete Output block converts the value received across the fieldbus to something useful for the output hardware in the device. The hardware may open or close a valve, turn a motor on or off, sound a buzzer, etc. **readback_d** is the actual discrete state value provided by the Limit Sensors (if appropriately configured in **io_opts** located in the DO FB). The actual discrete state is passed back through the Discrete Output function block via the **readback_d** parameter. Control schemes may use the **readback_d** value to reflect the actual position of the affected control element.

3.3.3 Channel Errors

Write checks limit the writing to only valid channels based upon the configuration already present. If no channels are currently configured, the first channel written determines the limits on subsequent channels. Attempts to run devices with invalid channel selections will result in the blocks not running and the generation of active block alarms from one of the following ***channel errors***:
No Output Channels
Close without Open
Open without Close
Conflicting Channels Assigned

3.3.4 Multi-State Channels

The device includes several multi-state discrete channels. A single discrete output channel includes three states: Open, Close, and Stop. Three discrete input channels are multi-state: **maskable_signal**, Open/Close, and Open/Close/Stop. The ***Maskable Signal*** discrete input channel can have any of 9 discrete states.
If a channel is not multi-state it is bi-state.

3.4 Using Two Valves

When the device is configured to operate two valves, the device must be wired a certain way for correct operation (refer to Appendix D) and the **action_element** parameter must be configured correctly (refer to Section 3.3.6, TB Configuration).
The open limit switch of the secondary valve should be wired to the Auxiliary Input 1, and the close limit switch should be wired to the Auxiliary Input 2. If the device is not wired this way, the values for the secondary valve channels will not be correct.
The Outputs must be wired so that Output_0 is wired to the primary valve_1 and Output_1 is wired to the secondary valve.

3.5 Global Block Parameters

3.5.1 Mode Parameter

Mode is a parameter of four parts:
1. Actual mode
2. Target mode
3. Permitted mode(s)
4. Normal mode.

Target mode may be set and monitored by the user. Target mode determines which mode the user wants the block to transfer.
Actual mode is set by the block during its execution and reflects the mode used during execution.
Allowed target modes are defined by ***permitted mode(s)***. This is configured in each block.
Normal mode is the desired operating mode of the block in normal operation.

When a block is in ***Out of Service*** mode (***O/S*** or ***OOS***) it will not evaluate and the associated data will have Bad Status. If the mode is OOS the output of the function block is usually maintained at the last value but can be configured to go to a predefined ***Fail State***.

Parameter configurations are usually performed in OOS mode so there is no bump in a running process. Before a particular block will be usable in a configuration, the mode must not be OOS and block specific parameters may need modification (appropriate Channel or **action_element** selected, etc.).

Table 8 -Mode Enumerations	
Numerical Value	**Enumerations**
0x01	Remote-Output (Rout)
0x02	Remote-Cascade (RCas)
0x04	Cascade (Cas)
0x08	Automatic (Auto)
0x10	Manual (Man)
0x20	Local Override (LO)
0x40	Initialization Manual (IMan)
0x80	Out of Service OOS or

3.5.2 Status

Input and Output parameters have a value, and status. The ***status*** tells the condition of the value, whether the data is Bad, Uncertain, Good (cascade), or Good (non-cascade). A sub-status tells more about the value, such as possible reasons for the status. The Quality narrows the conditions even more.
Status can assist in diagnosing issues in the system and is used for validating communicated data.

Note

Use the **block_err** (Block Error) parameter as an aid in troubleshooting.

The **block_err** parameter, common to all blocks, will remain active until the condition causing the error is no longer active. The values for block_err are defined by the Fieldbus Foundation.

Table 9 -block_err Enumerations		
Bit Value	**Hex Value**	**Enumeration**
0	0x0001	Other -a non zero error condition in the transducer error parameter.
1	0x0002	Block Configuration
2	0x0004	Link Configuration
3	0x0008	Simulation
4	0x0010	Override
5	0x0020	Fault State
6	0x0040	Maintenance Needed Soon
7	0x0080	Input Failure
8	0x0100	Output Failure
9	0x0200	Memory Failure
10	0x0400	Lost Static Memory
11	0x0800	Lost NV Memory

12	0x1000	ReadBack Failure
13	0x2000	Maintenance Needed Now
14	0x4000	Power Up
15	0x8000	Out of Service

3.6 Resource Block Configuration

3.6.1 Resource Block Supported Modes

Some host systems handle ***enumerations*** correctly while others do not. Please note that these tables may be very useful for those using host systems that do not process enumerations correctly and are unable to display the appropriate text strings.

Table 10-RB -Supported Modes

Numerical Value	Enumerations
0x08	Automatic (Auto)
0x40	Initialization Manual (IMan)
0x80	Out of Service (O/S)

Resource block supported modes are defined by the FOUNDATION™ fieldbus Specifications.

3.6.2 Discrete Readback Parameter

FOUNDATION fieldbus output blocks have a **readback_d** parameter. For different Channels it may show different values. Control schemes may use the **readback_d** value to reflect the actual state of the affected controlled element.

To enable **readback_d** in any standard FOUNDATION™ fieldbus output block two options must be verified:
1. In the RB, **feature_sel** must include bit 5- ***Out ReadBack*** (**feature_sel** enumeration 0x20).
   To change **feature_sel**, the RB must be in OOS.
2. In the Discrete Output block, the **io_opts** Bit 9- ***Use PV for bkcall_out*** must be selected to enable **readback_d**. The DO block must be in OOS before modifying IO_OPTS.

3.6.3 Fault State Parameter

The **fault_state** parameter, located in the RB, defines the action taken by a block when stale data or communication failure is detected. **fault_state** is also used when bad or uncertain quality is specified for each block. Function blocks that utilize process input (DO, PID, etc.) will have parameters to allow a special ***Fault State*** action to be specified on detection of an input with bad or uncertain quality (stay put, fail open, etc.).

The actual fault state parameter is included in the RB since it is common to all function and transducer blocks. The fault state parameter determines the response of an output block if one or more fault state conditions are present in the device longer than the value specified in the parameter **fstate_time**.
fault state conditions include:
loss of communications to **cas_in**
Initiate **fault_state** status at **cas_in** when the target mode is CAS
Initiate **fault_state** status at **rcas_in** when the target mode is RCAS

If a fault state condition does not clear within the user specified value for **fstate_time**, then the block output will be automatically driven to the predefined fault state and, optionally, the target mode will be set to MAN.
The **fstate_type** parameter determines the action to be taken - hold last value or go to the state defined by the user via the **fstate_val_d** parameter.

Writing the **set_fstate** parameter of the RB may also put this block into the predefined fault state. To clear the fault state, either the condition clears, or the user may write the **clr_fstate** parameter in the RB.

If the external condition which caused the fault state condition has not cleared writing the **clr_fstate** will have no effect as the device will immediately reenter fault state

The **io_option** parameter located in the DO(s) must be appropriately configured.

An FOUNDATION™ fieldbus alarm will be generated upon transition to an active fault state. The alarm will be handled using the standard alarm handling mechanism.

3.6.4 Resource State Parameter

Note

The **rs_state** (***Resource State***) parameter, located in the RB, reflects the overall status of the function block application. There are 6 resource state enumerations. The **rs_state** parameter can be used to determine hardware and resource failures that effect operation of the device.

Table 11-RB State Enumerations

Numerical Value	Enumeration	Description
0x01	Restart	The resources are restarting and are unavailable at this time
0x02	Init	Block resources are initializing. All Alarms are acknowledged and cleared automatically
0x03	Linking	Links are being established, blocks are not yet ready for control
0x04	Online	Operational, all systems functional. Links established, parameters evaluated
0x05	Standby	Block mode is Out Of Service
0x06	Failure	Memory or other hardware failure that prevents reliable operation

Note

3.7 Transducer Block Configuration

3.7.1 Transducer Block Supported Modes

Some host systems handle enumerations correctly while others do not. Please note that these tables may be very useful for those using host systems that do not process enumerations correctly and are unable to display the appropriate text strings.

Table 12-TB -Supported Modes

Numerical Value	Enumerations
0x08	Automatic (Auto)
0x10	Manual (Man)
0x80	Out of Service (O/S)

The modes supported by the TB are defined by the device manufacturer. In Man mode the DO channel values are not acted upon, but instead the output can be set using the **sp_d** and **sp_d2** parameters.

3.7.2 Block Alarms Active Parameter

Note

Use the **block_err** (Block Error) parameter as an aid in troubleshooting (refer to Table 9 in Section 3.5.3).
The **block_alms_active** parameter, located in the TB, gives the user further insight into configuration errors that prevent expected operation of the device. After the error is identified, the user must take the appropriate steps to eliminate the error before the device will function as intended.

Table 13-block_alms_active Enumerations

Numerical Value	Enumeration	Description
0x00000000	None Active	No active block alarms
0x08000000	Fault State Active	Fault State is active in the transducer block due to an invalid input or mis-configuration
0x04000000	Invalid Mode	The computed actual mode for the block is not supported, the block s actual mode will go to out of service
0x02000000	Bad Output Configuration	Conflicting output channels have been assigned. Please review channels assignments and make appropriate corrections
0x01000000	Invalid Input	The target position is not valid for the current device configuration
0x00800000	Out Of Service	Transducer block is out of service
0x00400000	No Output Channels	No output channels have been assigned, i.e. there can be no action

0x00200000	Open without Close	An Open output channel has been assigned without Close a channel
0x00100000	Conflicting Channels	Conflicting output channels have been assigned, please review and correct
0x00080000	Both Contacts Closed	Both contacts are closed
0x40000000	Mode Error	the mode calculator detected an error

3.7.3 Start Up State Parameter

The **start_up_state** parameter, located in the TB, specifies the initial position of the valve upon startup of the device.

Table 14-start_up_state Enumerations

Numerical Value	Enumeration
0	Close
1	Open
2	Stop
3	No-

3.7.4 Fault State and Fault State 2 Parameters

If the status from the associated function block is bad or if the RB has determined a problem, the valve will default to this position.

The primary valve is the target of **fault_state** and the secondary valve is the target of **fault_state_2** Both parameters are located in the TB.

Table 15-fault_state Enumerations

Numerical Value	Enumeration
0	Close
1	Open
2	Stop
3	No-

3.7.5 Discrete State Parameter

The **discrete_state** parameter, located in the TB, provides indication of the state of the following variables; ***Auxiliary1 active***, ***Auxiliary2 active***, ***Write Protect Jumper Enabled***, ***Simulate Jumper Enabled***, ***Valve 1 Active***, or ***Valve 2 Active***.

Table 16-discrete_state Enumerations

Numerical Value	Enumeration
0x01	Write Protect Jumper
0x02	Simulate Jumper
0x04	Valve1 Active
0x08	Valve2 Active
0x10	Auxiliary 1
0x20	2

3.7.6 Action Element Parameter

The **action_element** parameter is located in the TB and is user configurable. This parameter determines the type of valve operation required by the process application.

The selection of the **action_element** parameter will affect the meaning of the outputs of the device. It **MUST** be configured and configured correctly or the device may either operate in an unexpected manner or will not operate at all.

Table 17-action_element Enumerations

Numerical Value	Enumeration
0	No Selection
1	Single Action
3	Double Action
4	Single Action, Reverse Acting
6	Double Action, Reverse Acting
8	Independent, both Normal Acting
9	Independent, 1Reverse Acting 2Normal Acting
10	Independent, 1Normal Acting 2Reverse Acting
11	both Reverse

3.7.7 Maskable Signal Parameter

The **maskable_signal** parameter, located in the TB, can be used to allow certain alarms to be linked via a DI Function Block directly to the control process. The alarms are based upon certain conditions in the device as listed in Table 18 below. This is accomplished by configuring the signal mask in the TB and configuring a DI to use Channel 13 (see Section 3.8.1 below for a complete listing of DI Channels).

Note

This feature allows the user to configure the process in such a way that critical responses to the selected alarms can be acted upon immediately by another function block on the bus (to close a valve, stop a pump, etc). Alarm signals are typically handled by the standard FOUNDATION™ fieldbus alarm handling mechanisms which can impart latency to the alarm signal as it must be processed by the host system.

Table 18-maskable_signal Enumerations and Descriptions

Numerical Value	Enumerations	Description
0	No Selection	No signal is selected to generate discrete
1	Cycle Count 1 exceeds limits	Number of valve cycles exceeds the Cycle Count1 limit
2	Cycle Time exceeds limits	Cycle time exceeds limit set in **`cycle_time_lim`**
4	Bad Xducer Status	Status of the transducer is not Good
5	Hi Temp. Alarm exceeds limits	Threshold configured for this parameter has been exceeded
6	Hi Temp. Alarm exceeds limits	Threshold configured for this parameter has been exceeded

3.7.8 Cycle Time History Parameter

The **cycle_time_history** parameter is configurable and located in the TB. A set of up to 400 cycle times can be stored in the device and later retrieved using the standard fieldbus trend system.
To store the cycle times the **cycle_time_collect_type** parameter must be enabled. Either ***continuous collection*** or ***one-time collection*** may be chosen.
To initiate the collection of timing data the **collect_cycle_time** parameter must be set to Active . If you select continuous collection , select ***Inactive*** to stop the collection of data.
To report the collected data, configure the **cycle_time_history** parameter as a standard fieldbus trend.
Once configured, set the **collect_cycle_time** parameter to ***Report***. The collected data will be sent via the standard trend mechanism. Once all the collected data has been reported, the report will stop. To have the report sent again, set **collect_cycle_time** parameter to Report again.

3.8 Discrete Input Block Configuration

Note

The Auxiliary Inputs have special meanings when the device is configured for a second valve. Please refer to the information in Section 3.4 for further details.

3.8.1 Available Discrete Input Channels

Table 19-Discrete Input Channels	
0	No Transducer Connection
9	Open/Close
10	Open
11	Close
12	Open/Close/Stop
13	Maskable Signal
14	Auxiliary Input
15	Auxiliary Input 2
16	Open/Close for second valve (when available)
17	Open for second valve (when available)
18	Close for second valve av

3.8.2 Multi-State Channels

There are three ***multi-state*** discrete input channels:
1. maskable_signal - The Maskable Signal discrete input channel can have any of 9 discrete states.
2. Open/Close
3. Open/Close/Stop.
All other DI channels are ***bi-state***.

3.8.3 Discrete Input Conditional Enumerations

Conditionals are expressions in the device description that allow the enumerations of one parameter to be based on the value of another parameter. In other words, conditionals can be used to present the user a certain list of **out_d** enumerated values based on the Channel that was selected for the block.

Some host systems handle conditionals correctly while others do not. Please note that these tables may be very useful for those using host systems that do not process conditionals correctly and are unable to display the appropriate text strings.

The device contains several conditionally evaluated parameters. The DI conditionals are listed in Table 20.

Table 20-Discrete Input Conditional Enumerations		
Channel Value	**Channel Meaning**	**Enumerations for Simulate** Value, OUT_D, PV_D
0	No Transducer Connection	No Transducer Connection
9	Open/Close	0, Closed 1, Opened 2, Stopped 3, Is Closing 4, Is Opening
10	Open	0, Not Open 1, Opened
11	Close	0, Not Closed 1, Closed
12	Open/Close/Stop	0, Closed 1, Opened 2, Stopped 3, Is Closing 4, Is Opening
13	Maskable Signal	0, Maskable Signal Items OK 1, One or more Maskable Signal Items has Exceeded Limit
14	Auxiliary Input 1	0, Auxiliary 1 Dry Contact Closed 1, Auxiliary 1 Dry Contact Open
15	Auxiliary Input 2	0, Auxiliary 2 Dry Contact Closed 1, Auxiliary 2 Dry Contact Open
16	Open/Close for second valve	0, Closed 2 1, Opened 2 2, Stopped 2 3, Is Closing 2 4, Is Opening 2
17	Open for second valve	0, Not Open 2 1, Open 2
18	Close for second valve	0, Not Closed 2 1, Close 2

3.8.4 Discrete Input Block Supported Modes

Note

Some host systems handle enumerations correctly while others do not. Please note that these tables may be very useful for those using host systems that do not process enumerations correctly and are unable to display the appropriate text strings.

Table 21-DI Block-Supported Modes	
Numerical Value	Enumerations
0x08	Automatic (Auto)
0x10	Manual (Man)
0x80	Out of Service

DI block supported modes are defined by the FOUNDATION™ fieldbus Specifications.

3.9 Discrete Output Block Configuration

3.9.1 Available Discrete Output Channels

Table 22-Discrete Output Channels	
0	No Transducer Connection
1	Open/Close
2	Open
3	Close
4	Stop
5	Open/Close/Stop
6	Open/Close for second valve (when available)
7	Open for second valve (when available)
8	Close for second valve av

3.9.2 Multi-State Channels

There is a single ***multi-state*** discrete output channel which includes three states: Open, Close, and Stop.
All other DO channels are ***bi-state***.

3.9.3 Discrete Output Channel Interlocks

Note

The Discrete Output Channels have ***interlocks*** that only allow certain configurations. These are validated based upon the first channel selected. The first column lists the current channel selected in a Discrete Output Block. When the channel in the first column is selected, the row corresponds to the required, disallowed or optional selections for the other Discrete Output blocks.

The device contains several conditionally evaluated parameters. The DO **readback_d** conditionals are listed in Sect.3.3.2 while the **out_d** and other conditionals are listed in Table 24.

Table 23-DO Block Interlocks						
Selected Channel	0	1	2	3	4	5
0 -No Xducer Connection	O	O	O	O	O	O
1 -Open/Close-out	O	X	X	X	O	X
2 -Open-out	O	X	X	!	O	X
3 -Close-out	O	X	!	X	O	X
4 -Stop-out	O	O	O	O	X	X
5 -Open/Close/Stop-out	O	X	X	X	X	X

! - Required, X - Disallowed, O - Optional

3.9.4 Discrete Output Conditional Enumerations

Conditionals are expressions in the device description that allow the enumerations of one parameter to be based on the value of another parameter. In other words, conditionals can be used to present the user a certain list of **out_d**, **readback_d** and other enumerated values based on the Channel that was selected for the block.

Some host systems handle conditionals correctly while others do not. Please note that these tables may be very useful for those using host systems that do not process conditionals correctly and are unable to display the appropriate text strings.

Table 24 (a)-Discrete Output -Readback Enumerations		
Channel Value	**Channel Meaning**	**Enumerations for `readback_d`**
0	No Transducer Connection	No Transducer Connection
1	Open/Close	0, is closed 1, is opened 4, is closing 3, is opening
2	Open	0, not open 1, is opened
3	Close	0, not closed 1, is closed
4	Stop	0, not stopped 1, is stopped
5	Open/Close/Stop	0, is closed 1, is opened 2, is stopped 3, is opening 4, is closing

Table 24 (b) -Discrete Output -Readback Enumerations		
Channel Value	**Channel Meaning**	**Enumerations for `readback_d`**
6	Open/Close for second valve	0, is closed 2 1, is opened 2 4, is closing 2 3, is opening 2
7	Open for second valve	0, not closed 2 1, is closed 2
8	Close for second valve	0, not open 2 1, is opened 2

Table 25-Discrete Output -Enumerations, Other		
Channel Value	**Channel Meaning**	**Enumerations for Simulate Value, out_d, pv_d, cas_in_d, rcas_in_d**
0	No Transducer Connection	No Transducer Connection
1	Open/Close	0, Close 1, Open
2	Open	0, Not Closed 1, Close
3	Close	0, Not Open 1, Open
4	Stop	0, No Operation 1, Stop
5	Open/Close/Stop	0, Close 1, Open 2, Stop

3.9.5 Discrete Output Block Supported Modes

Some host systems handle enumerations correctly while others do not. Please note that these tables may be very useful for those using host systems that do not process enumerations correctly and are unable to display the appropriate text strings.

Table 26-DO Block-Supported Modes	
Numerical Value	**Enumerations**
0x02	Remote-Cascade (RCas)
0x04	Cascade (Cas)
0x08	Automatic (Auto)
0x10	Manual (Man)
0x20	Local Override (LO)
0x40	Initialization Manual

Note

DO block supported modes are defined by the FOUNDATION™ fieldbus Specifications. Therefore while the DO block supports ***Local Override*** and ***Initialization Manual***, these modes are not user selectable.

3.9.6 Discrete Readback Parameter

Note

Foundation fieldbus output blocks have a **readback_d** parameter. For different Channels it may show different values. Control schemes may use the **readback_d** value to reflect the actual state of the affected controlled element.

To enable ***Discrete Readback*** in any standard FOUNDATION fieldbus output block two options must be verified:
In the RB, the **feature_sel** parameter must include bit 5- Out ReadBack (**feature_sel** enumeration 0x20). To configure **feature_sel**, the RB must be in OOS.
In the Discrete Output block, the **io_opts** parameter Bit 9- Use PV for BKCAL_OUT must be selected to enable **readback_d**. The DO block must be in OOS before modifying **io_opts**.

3.9.7 Fault State

Note

The **fault_state** parameter, located in the RB, defines the action taken by a block when stale data or communication failure is detected. ***Fault State*** is also used when bad or uncertain quality is specified for each block. Function blocks that utilize process input (DO, PID, etc.) will have parameters to allow a special ***Fault State*** action to be specified on detection of an input with bad or uncertain quality (stay put, fail open, etc.).

Note

The **fault_state** and **fstate_time** parameters located in the RB must be appropriately configured, refer to Section 3.6.3 for details.

The ***Fault State to value*** option in **io_opts** in the DO determines whether the action is simply to hold the current state, or move to **fstate_val_d**. If the **io_opts** is 0, the value will hold the current value (freeze) if a fault is detected. If the **io_opts** is 1, the output will go to the preset **fstate_val_d** value, if a fault is detected.

The ***Target to Manual if IFS*** option in **io_opts** may be used to latch the **fault_state** parameter. Setting the **io_opts** to this option will cause the target mode to automatically change to Man when a fault is detected. The block will then have to be manually set to its normal target mode.

Note

The target mode needs to be manually changed from Man mode when conditions are corrected. If the external condition which caused the fault state condition has not cleared the device will immediately reenter fault state.

A FOUNDATION™ fieldbus alarm will be generated upon transition to an active fault state. The alarm will be handled using the standard alarm handling mechanism.
The choices for **fstate_val_d** are listed in Table 27.

Table 27-fstate_val_d Enumerations

Numerical Value	Enumeration
0	Close
1	Open
2	Stop
3	No-

3.10 Required Parameter Configuration

This section lists the parameters that are required to be configured for the device to operate. It is suggested that other parameters be configured by the end user to optimize the functionality of the FPAC for your specific application. For a complete listing of all parameters in the device refer to Section 5.

Note

To view the ***Quick Configuration Sheet***, see Appendix B.

Note

For detailed instructions, with graphics, on configuring the FPAC for the most common modes of operation refer to Appendix C.

Note

All required parameters of the FPAC have been configured for normal operation out of the box as a single acting spring return valve.

Note

The **restart** parameter in the RB allows the user to return the FPAC to the factory default settings by selecting the ***Restart with factory defaults*** option.

Restarting the device may cause loss of process control. Confirm that you fully understand what the effect on the process will be if the device is being restarted. A device undergoing ***restart*** will be offline during the restart process and may force the valve to a preconfigured fault state.

3.10.1 Resource Block

Required Configuration
mode_blk.target

3.10.2 Transducer Block

Required Configuration

action_element
mode_blk.target

3.10.3 DI Block(s)

Required Configuration

mode_blk.target
channel (if block is to be used)

3.10.4 DO Block(s)

Required Configuration

mode_blk.target
channel (if block is to be used)

4.1 The FOUNDATION™ Fieldbus Protocol

FOUNDATION™ fieldbus communications protocol is an industry proven international standard (IEC 61158) designed for use in the process industry. Features include multi-drop capabilities (as many as 32 devices per segment), extended trunk length, single loop integrity, control in the field , power and communication on a shielded twisted pair network, and compatibility with intrinsically safe networks. A key feature of the fieldbus protocol is the ability to select where control of the process is situated - in the host, in the field, or in various combinations of both locations.

The Fieldbus FOUNDATION defined application layer is based on Function Blocks. Function Blocks are structures with defined behavior used to represent different types of functions that the device performs. Figure 1 below illustrates a simple control loop with an AI FB in a level transmitter linked to a PID FB whose signal is controlling the position of the control valve via the DO FB. Both the PID and DO reside within the control valve.

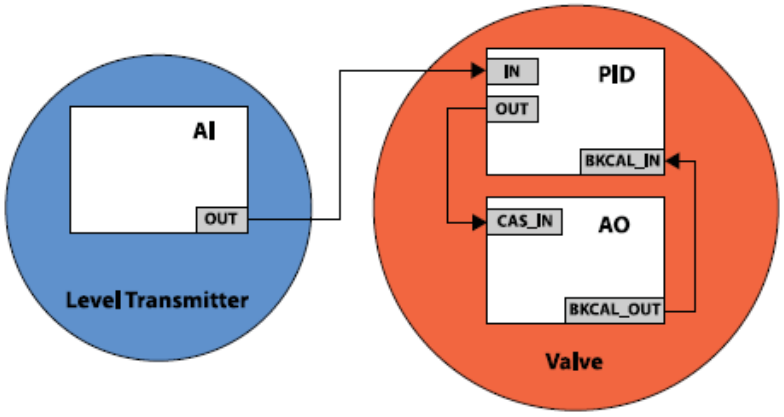


Figure 15 Linked Function Blocks

The parameters of these blocks follow a standard framework, but manufacturers are free to enhance standard features and add additional functions as necessary. Every Fieldbus FOUNDATION device has a Resource Block, Function Blocks, and possibly a Transducer Block.

Once the hardware of a fieldbus device is configured, fieldbus communication is used to configure the transducer block parameters. The desired transducer functionality is associated with a specific function block via a Channel. A Channel links real world HW with the functionality of associated FB(s) as shown in Figure16.

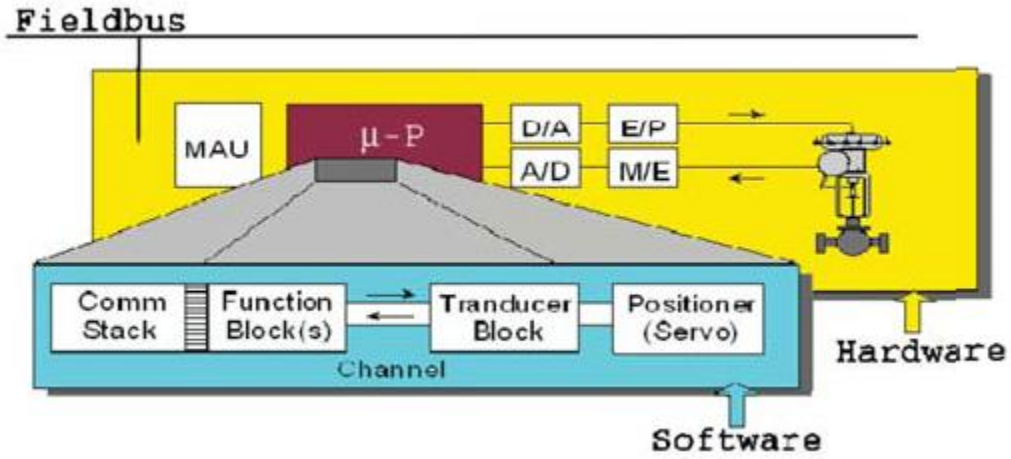


Figure 16 Channel Linking HW via TB Configuration with FB(s)

The host system s Engineering Station is used to link the function blocks together to create a control application that can be downloaded to the devices on the H1 segment as illustrated in Figure 17.

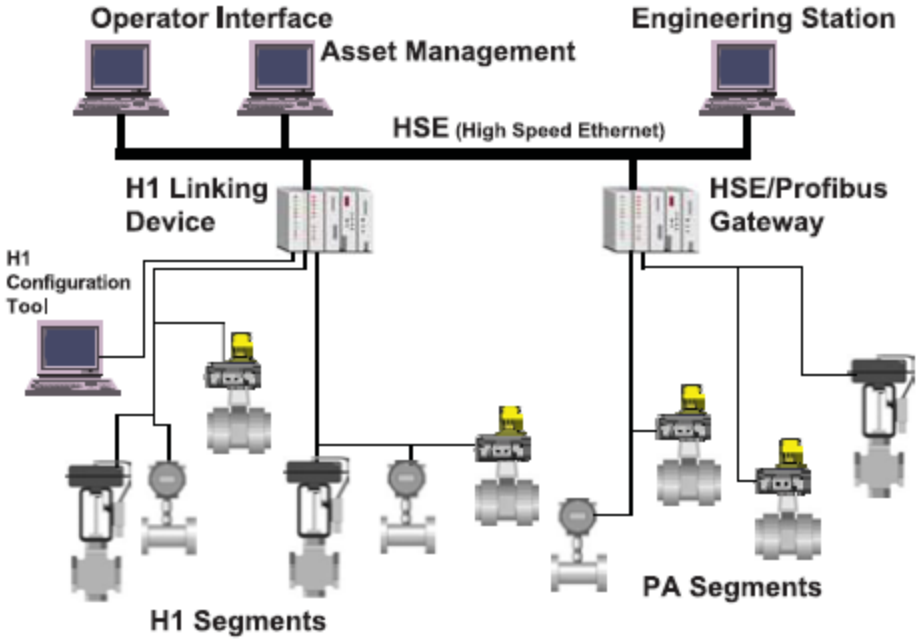


Figure 17 Download of Control Application to Field Device

FOUNDATION Fieldbus provides the user with standardized calibration, diagnostic, and status data that enables users of Fieldbus FOUNDATION registered products to benefit from the advantages of smart instruments.

4.2 Fieldbus Supported Topologies

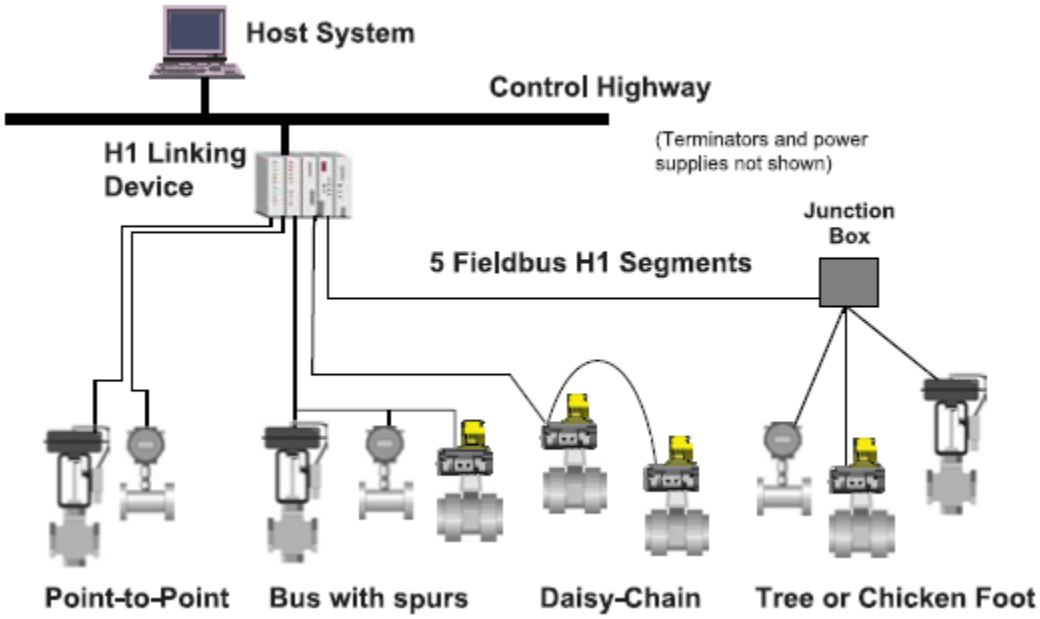


Figure 18 FF Supported Topologie**s**

Tables 28 31 list and define all parameters for each block contained in this device. The parameters are listed by name as they appear in the DD (***Device Description file***).

Some parameters are Read/Write and others are read-only. Some Write parameters are only configurable when the appropriate interlocks are configured and/or the required block is OOS.

Note

Table 28(a) Resource Block Parameters	
Parameter	**Description**
st_rev	The revision level of the static data associated with the function block. To support tracking changes in static parameter attributes, the associated block s static revision parameter will be incremented each time a static parameter attribute value is changed. Also, the associated block s static revision parameter may be incremented if a static parameter attribute is written but the value is not changed.
tag_desc	The user description of the intended application of the block.
strategy	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
alert_key	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
mode_blk	The actual, target, permitted, and normal modes of the block.
block_err	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
rs_state	State of the function block application state machine.
test_rw	Read/write test parameter used only for conformance testing.
dd_resource	String identifying the tag of the resource which contains the Device Description for this resource.
manufac_id	Manufacturer identification number used by an interface device to locate the DD file for the resource
dev_type	Manufacturer s model number associated with the resource used by interface devices to locate the DD file for the resource.
dev_rev	Manufacturer revision number associated with the resource used by an interface device to locate the DD file for the resource.
dd_rev	Manufacturer revision number associated with the resource used by an interface device to locate the DD file for the resource.
grant_deny	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
hard_types	The types of hardware available as channel numbers.
restart	Allows a manual restart to be initiated. Several degrees of restart are possible. They are 1: Run, 2: Restart resource, 3: Restart with defaults, and 4: Restart processor.
features	Used to show supported resource block options.
features_sel	Used to select resource block options.
cycle_type	Identifies the block execution methods available for this resource.

Table 28(b) Resource Block Parameters	
cycle_sel	Used to select the block execution method for this resource.
min_cycle_t	Time duration of the shortest cycle interval of which the resource is capable.

memory_size	Available configuration memory in the empty resource. To be checked before attempting a download.
nv_cycle_t	Minimum time interval specified by the manufacturer for writing copies of NV (non- volatile) parameters to NV memory. Zero means it will never be automatically copied. At the end of **nv_cycle_t** only those parameters which have changed (as defined by the manufacturer) need to be updated in NVRAM
free_space	Percent of memory available for further configuration. Zero in a preconfigured resource.
free_time	Percent of the block processing time that is free to process additional blocks.
shed_rcas	Time duration at which to give up on computer writes to function block RCas locations. Shed from RCas shall never happen when **shed_rcas**=0.
shed_rout	Time duration at which to give up on computer writes to function block ROut locations. Shed from Rout shall never happen when **shed_rout**=0.
fault_state	Condition set by loss of communication to an output block, fault promoted to an output block or a physical contact. When Fault State condition is set, Then output function blocks will perform their **fstate** actions.
set_fstate	Allows the Fault State condition to be manually initiated by selecting Set.
clr_fstate	Writing a Clear to this parameter will clear the device fault state if the field condition, if any, has cleared.
max_notify	Maximum number of unconfirmed notify messages possible.
lim_notify	Maximum number of unconfirmed alert notify messages allowed.
confirm_time	The time the resource will wait for confirmation of receipt of a report before trying again. Retry shall not happen when **confirm_time**=0.
write_lock	If set, no writes from anywhere are allowed, except to clear write_lock. Block inputs will continue to be updated.
update_evt	This alert is generated by any change to the static data.
block_alm	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
alarm_sum	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ack_option	Selection of whether alarms associated with the block will be automatically acknowledged.
ls_cal_switch	Parameter must be enabled for the Limit Sensor Calibration Switch to be operative.
set_currentsink	Allows user to select Ultra-low Current mode (FPAC-IS consumes 18 mA) by disabling I/O LED(s).
write_pri	Priority of the alarm generated by clearing the write lock.
write_alm	This alert is generated if the write lock parameter is cleared.

itk_ver	Major revision number of the interoperability test case used in certifying this device as interoperable. The format and range of the version number is defined and controlled by the Fieldbus Foundation. Note: The value of this parameter will be zero (o) if the device has not been registered as interoperable by the Fieldbus Foundation.

Table 28(c) Resource Block Parameters

Parameter	Description
block_alms_act	Enumerations of the active blocks alarms for improved debugging.
supported_modes	The modes supported by the block.
ikey	License key.
revision_id	The revision identifier of the device.
revision_date	The revision date of the device.

5.2 Transducer Block Parameter Descriptions

Table 29(a) Transducer Block Parameter Descriptions

Parameter	Description
act_fail_action	Specifies the final failure position of the actuator as defined in section 4.6 of FF-903 rev PS3.0
act_man_id	The actuator manufacturer identification number.
act_model_num	The actuator model number.
act_sn	The actuator serial number.
action_element	User configurable parameter to determine the type of valve operation needed. It MUST be set before operation.
alert_key	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
auxinput1	State of first auxiliary discrete state.
auxinput2	State of second auxiliary discrete state.
block_alm	Used for all configuration, hardware, connection failure, or system problems in the block. The cause of the alert is entered in the subcode field. Queued and reported as generated.
block_alms_active	Detailed listing of active block alarms to assist troubleshooting.
block_err	The error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
breakaway_time	Westlock reported time taken for valve to begin moving.
clear_cycle_count	User writable to clear the cycle count of the first valve and begin counting from 0 again.

clear_clcle_count2	User writable to clear the cycle count of the second valve and begin counting from 0 again.
close_lim_switch	Discrete showing state of the close limit switch as seen in Shared Data.
collect_cycle_time	Enables the collection of cycle_time in cycle_time_history
cycle_count	Westlock reported number of cycles on the first valve.
cycle_count_alm	Alarm generated when the number of cycles on the first valve exceeds the limit.
cycle_count_lim	User configurable limit of number of cycles on first valve before alarm is generated.
cycle_count2	Westlock reported number of cycles on the second valve.
cycle_time	Westlock reported time taken to cycle the valve.
cycle_time_alm	Alarm generated when valve does not cycle in the desired time.

Table 29(b) Transducer Block Parameter Descriptions

Parameter	Description
cycle_time_collect_type	Selects Continuous or stop when full collection of cycle time.
cyclce_time_history	Last **cycle_time**, used for trending **cycle_time.**
cycle_time_lim	User configurable Floating Point value used as limit to determine cycle time alarm.
cycle_time_pri	User configurable priority of cycle time alarm
device_err	Errors preventing proper operation of device.
discrete_state	FPAC generated value indicating whether Auxiliary1 active, Auxiliary2 active, Write Protect Jumper Enabled, Simulate Jumper Enabled, Valve 1 Active, or Valve 2 Active.
fault_state	If the status from the associated function block is bad or if the transducer block has determined a problem, the first valve will default to this position.
fault_state2	If the status from the associated function block is bad or if the transducer block has determined a problem, the second valve will default to this position.
final_position_value_d	Actual position of the first valve.
final_position_value_d2	Actual position of the second valve.
final_value_d	The requested position and status written by a discrete function block for the first valve.
final_value_d2	The requested position and status written by a discrete function block for the first valve.
hi_temp_limit	Sets the threshold for the **hi_temp** alarm
lo_temp_limit	Sets the threshold for the **lo_temp** alarm
maskable_signal	User configurable mask that allows alarms to be linked as discrete parameter.
mode_blk	The actual, target, permitted, and normal modes of the block.
module_temp	Displays the ambient temperature of the FPAC module.
open_lim_switch	Discrete showing state of the open limit switch as seen in Shared Data.

shared_data	The shared data structure used for communication between FOUNDATION Fieldbus Function Blocks and hardware. This is available for debugging and troubleshooting.
sp_d	The discrete setpoint of the first valve.
sp_d2	The discrete setpoint of the second valve.
start_up_state	The initial position of the valve upon startup.
st_rev	The revision level of the static data associated with the function block. To support tracking changes in static parameter attributes, the associated block s static revision parameter will be incremented each time a static parameter attribute value is changed. Also, the associated block s static revision parameter may be incremented if a static parameter attribute is written but the value is not changed.
strategy	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.
supported_modes	Read only parameter that indicates the modes supported by the block.
tag_desc	The user description of the intended application of the block.

Table 29(c) Transducer Block Parameter Descriptions

Parameter	Description
travel_time	Westlock reported time needed for the valve to move between limit switches.
updage_evt	This alert is generated by any change to the static data.
valve_man_id	The valve manufacturer identification number.
valve_model_num	The valve model number.
valve_sn	The valve serial number.
xd_cal_date	The date of the last positioner calibration.
xd_cal_loc	The location of last positioner calibration. This describes the physical location at which the calibration was performed.
xd_cal_who	The name of the person responsible for the last positioner calibration.
xd_error	One of the error codes defined in section 4.8 **xd_error** and Block Alarm Subcodes (FF-903 revPS3.0 section 4.8)
valve_type	The type of the valve as defined in section 4.7 Valve Type (FF-903 revPS3.0 section 4.7)

Table 30(a) Discrete Input Parameters	
Parameter	**Description**
st_rev	The revision level of the static data associated with the function block. To support tracking changes in static parameter attributes, the associated block s static revision parameter will be incremented each time a static parameter attribute value is changed. Also, the associated block s static revision parameter may be incremented if a static parameter attribute is written but the value is not changed.
tag_desc	The user description of the intended application of the block.
strategy	The strategy field can be used to identify grouping of blocks.. This data is not checked or processed by the block.
alert_key	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
mode_blk	The actual, target, permitted, and normal modes of the block.
block_err	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
pv_d	Either the primary discrete value for use in executing the function, or a process value associated with it. May also be calculated from the **readback_d** value of a DO block.
out_d	The primary discrete value calculated as a result of executing the function.
simulate_d	Allows the transducer discrete input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.
xd_state	Index to the text describing the states of a discrete for the value obtained from the transducer.
out_state	Index to the text the states of a discrete

Table 30(b) Discrete Input Parameters	
Parameter	**Description**
grant_deny	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
io_opts	Options which the user may select to alter input and output block processing.
status_opts	Options which the user may select in the block processing of status.
channel	The number of the logical hardware channel that is connected to this I/O block. This information defines the transducer to be used going to or from the physical world.
pv_time	Time constant of a single exponential filter for the PV, in seconds.
field_val_d	Raw value of the field device discrete input, with a status reflecting the Transducer condition.
update_evt	This alert is generated by any change to the static data.

block_alm	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
alarm_sum	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ack_option	Selection of whether alarms associated with the block will be automatically acknowledged.
disc_pri	Priority of the discrete alarm.
disc_lim	State of discrete input which will generate an alarm.
disc_alm	The status and time stamp associated with the discrete alarm.
xducer_val_d	The value and status received from the transducer block on the selected channel.
block_alms_act	Enumerations of the active blocks alarms for improved debugging.
supported_modes	The modes supported by the block.

5.4 Discrete Output Parameters

Table 31(a) Discrete Output Parameters

Parameter	Description
st_rev	The revision level of the static data associated with the function block. To support tracking changes in static parameter attributes, the associated block s static revision parameter will be incremented each time a static parameter attribute value is changed. Also, the associated blocks static revision parameter may be incremented if a static parameter attribute is written but the value is not changed.
tag_desc	The user description of the intended application of the block.
strategy	The strategy field can be used to identify grouping of blocks. This data is not checked or processed by the block.

Table 31(b) Discrete Output Parameters	
Parameter	**Description**
alert_key	The identification number of the plant unit. This information may be used in the host for sorting alarms, etc.
mode_blk	The actual, target, permitted, and normal modes of the block.
block_err	This parameter reflects the error status associated with the hardware or software components associated with a block. It is a bit string, so that multiple errors may be shown.
pv_d	Either the primary discrete value for use in executing the function, or a process value associated with it. May also be calculated from the READBACK_D value of a DO block.
sp_d	The discrete setpoint. The desired value of the output.
out_d	The primary discrete value calculated as a result of executing the function.
simulate_d	Allows the transducer discrete input or output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.
pv_state	Index to the text describing the states of a discrete for the value obtained from the transducer.
xd_state	Index to the text describing the states of a discrete output.
grant_deny	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
io_opts	Options which the user may select to alter input and output block processing.
status_opts	Options which the user may select in the block processing of status.
readback_d	This indicates the readback of the actual discrete valve or other actuator position, in the transducer state. This must be configured through IO_OPTS.
CAS_IN_D	This parameter is the remote setpoint value of a discrete block, which must come from another Fieldbus block, or a DCS block through a defined link.
CHANNEL	The number of the logical hardware channel that is connected to this I/O block. This information defines the transducer to be used going to or from the physical world.
FSTATE_TIME	The time in seconds from detection of fault of the output block remote setpoint to the output action of the block output if the condition still exists.
FSTATE_VAL_D	The preset discrete SP_D value to use when fault occurs. This value will be used if the I/O option Fault State to value is selected.
BKCAL_OUT_D	The output value and status provided to an upstream discrete block. This information is used to provide bumpless transfer to closed loop control.
RCAS_IN_D	Target setpoint and status provided by a supervisory Host to a discrete control or output block.
SHED_OPT	Defines action to be taken on remote control device timeout.
RCAS_OUT_D	Block setpoint and status provided to a supervisory Host for back calculation and to allow action to be taken under limiting conditions or mode change.
UPDATE_EVT	This alert is generated by any change to the static data.

Table 31(c) Discrete Output Parameters	
Parameter	**Description**
BLOCK_ALM	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
XDUCER_VAL_D	The value and status received from the transducer block on the selected channel.
BLOCK_ALMS_ACT	Enumerations of the active blocks alarms for improved debugging.
SUPPORTED_MODES	The modes supported by the block.

Appendix A

FPAC QuickCal Instructions

The following instructions provide for the minimum required configuration of parameters for the FPAC module to operate in the most frequently used applications as listed below.
For a more detailed treatment of configuration options see Section 3 of this document. It is suggested that other parameters listed in Section 5 be configured by the end user to optimize the functionality of the FPAC module for your specific application.

All required parameters of the FPAC module have been configured for “out of the box“ factory default operation as a single acting fail close valve unless specific request has been made to the factory for an alternate configuration.

The **restart** parameter in the Resource Block allows the user to return the FPAC module to the factory default settings by selecting the “Restart with factory defaults“ option.

Restarting the device may cause loss of process control. Confirm that you fully understand what the effect on the process will be if the device is being restarted. A device undergoing restart will be offline during the restart process and may force the valve to a preconfigured fault state.

If connecting the FPAC module to a Delta-V DCS for the first time it may be necessary to use the “Restart with factory defaults“ option to transition the mode of the Transducer Block (TB) from Manual to OOS as the Delta-V only supports OOS and Auto modes for the TB. Once the TB is in OOS mode you will be able to then transition the TB mode to Auto (see Appendix C for more information).

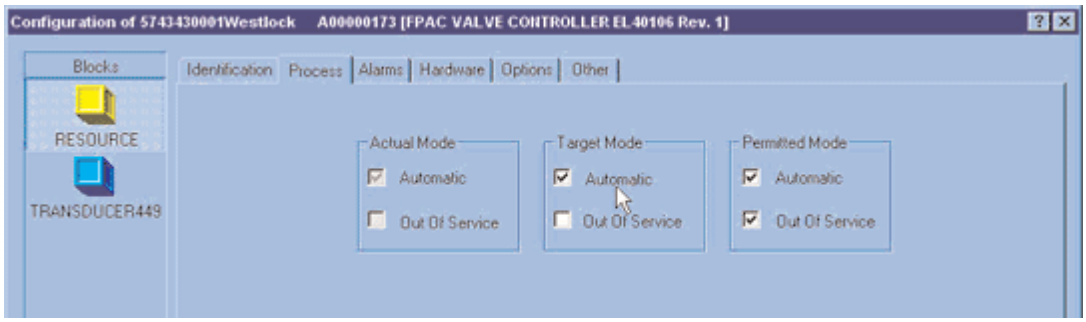
The graphics and instructions which follow, while specific to the Delta-V DCS, are for the most part ransferable to all FF user interfaces. If you have questions concerning the configuration of the FPAC with your system please contact the factory (see Appendix A).

Single Action Fail Close Valve

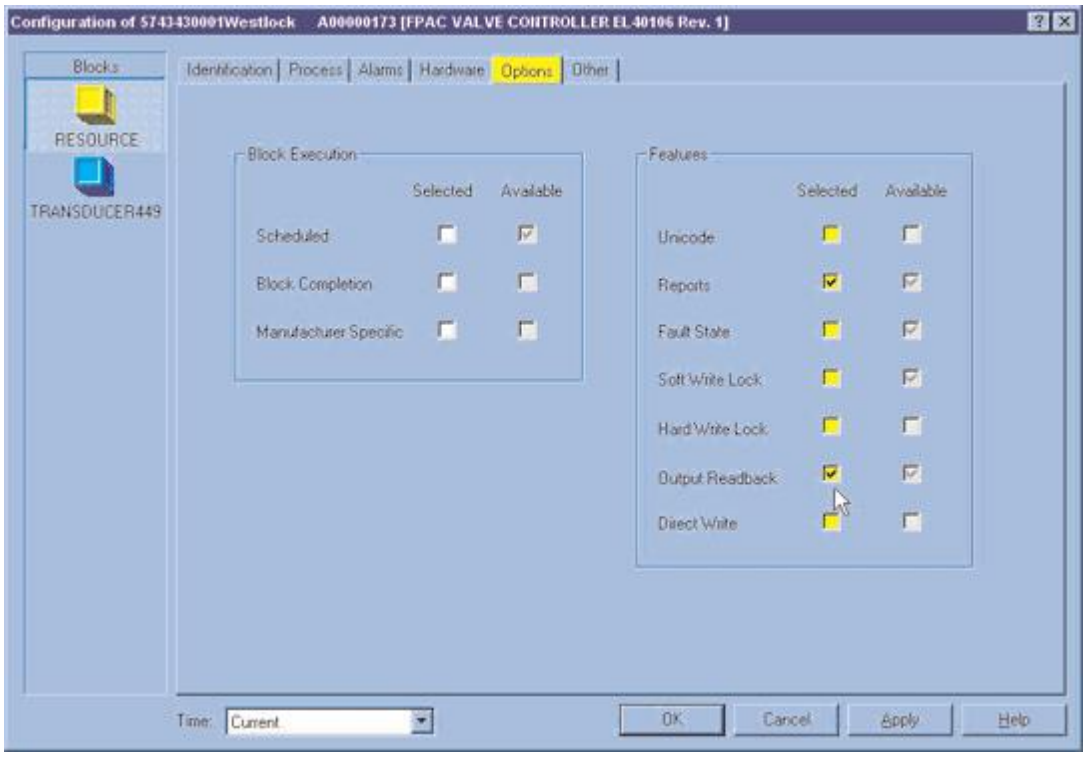
Configuring the parameters as follows allows the valve to be Opened or Closed by sending a 1 or 0, respectively, to the DO Block.
Valve position is indicated via the **readback_d** parameter where the status of the Limit Sensors, 1 for Open and 0 for Close, is available. Control schemes may use the readBack value to reflect the actual state of the affected control element. This eliminates the need to use a DI Block for position feedback. See Section 3.3.2 for more information.

Resource Block

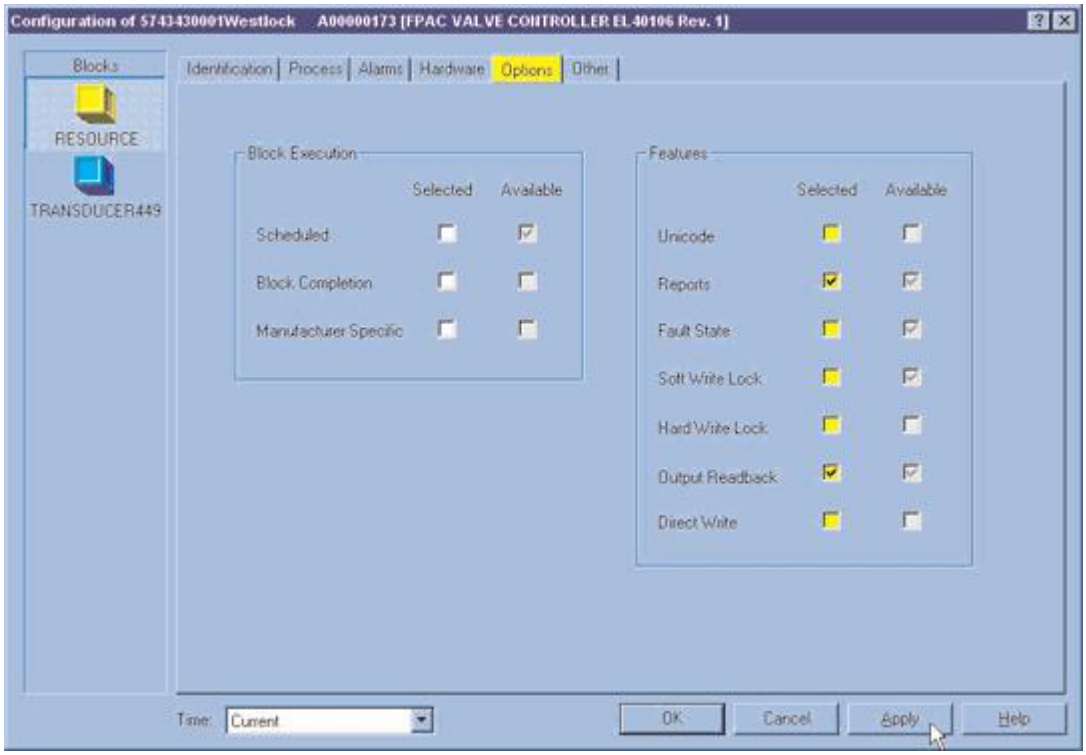
• • Under the “Process“ tab, confirm **mode_block** is “Auto“



• • Under the “Options“ tab, configure the **feature_sel** parameter to enable “Output Readback“ (enumeration 0x20)

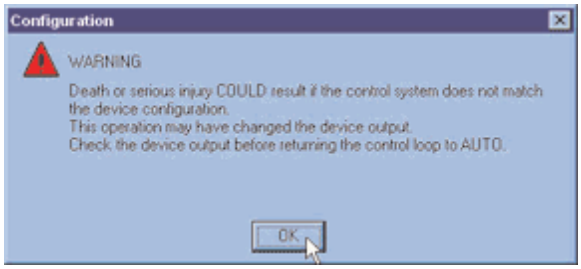


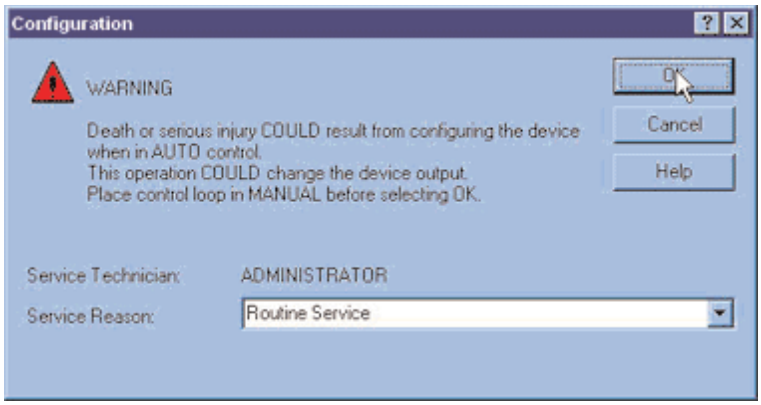
• • Click “Apply“.



Note the Warnings Screens and click “OK“ if you have determined it is safe to do so.

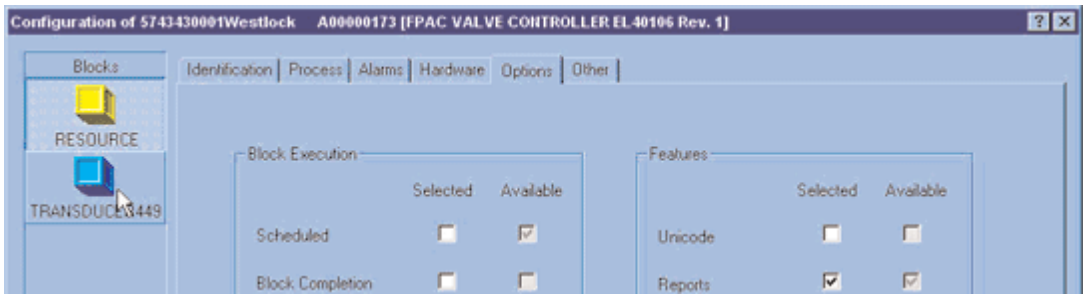
Note



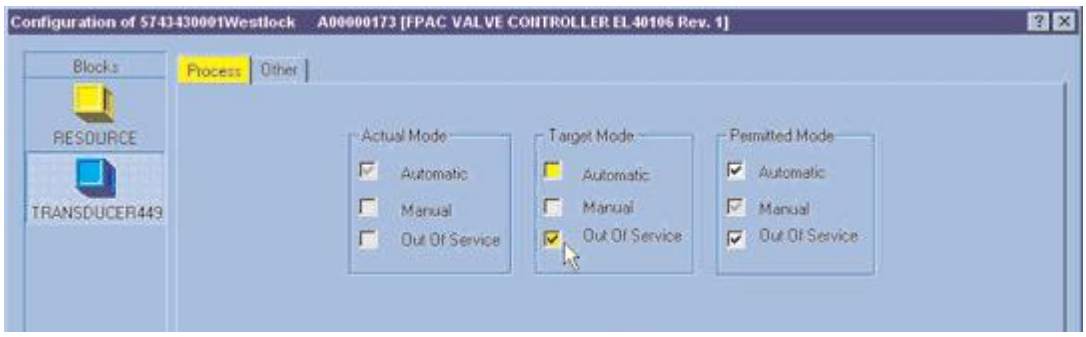


Transducer Block

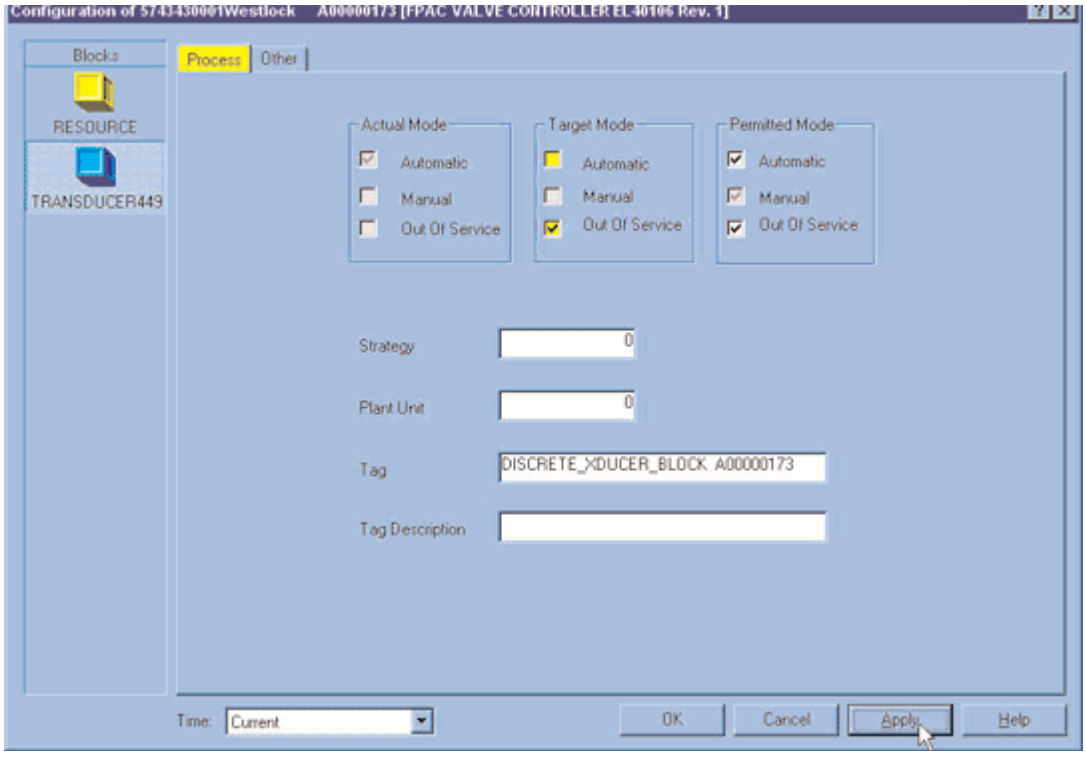
• • Select the Transducer Block (TB).



• • Under the “Process“ tab, set **mode_block** to “OOS“

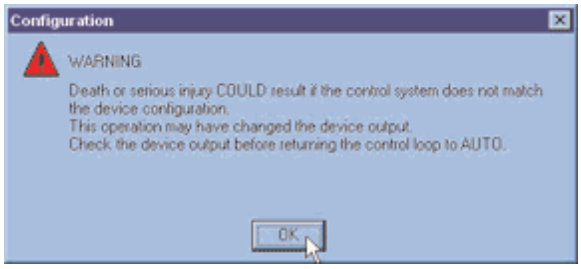


• • Click “Apply“.



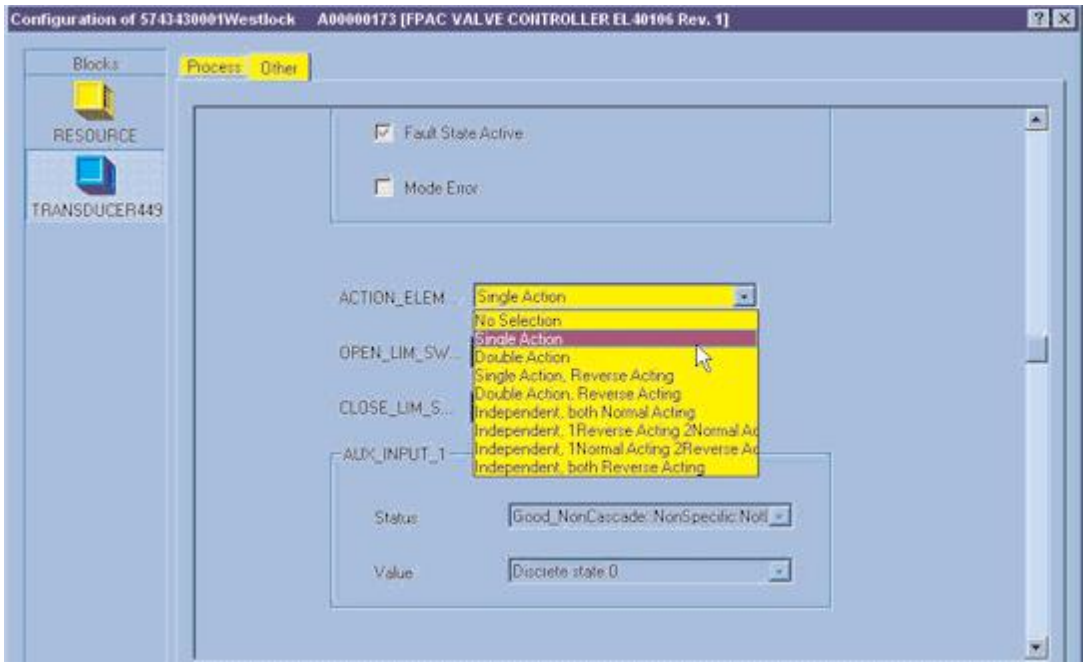
Note

Note the Warnings Screens and click “OK“ if you have determined it is safe to do so.

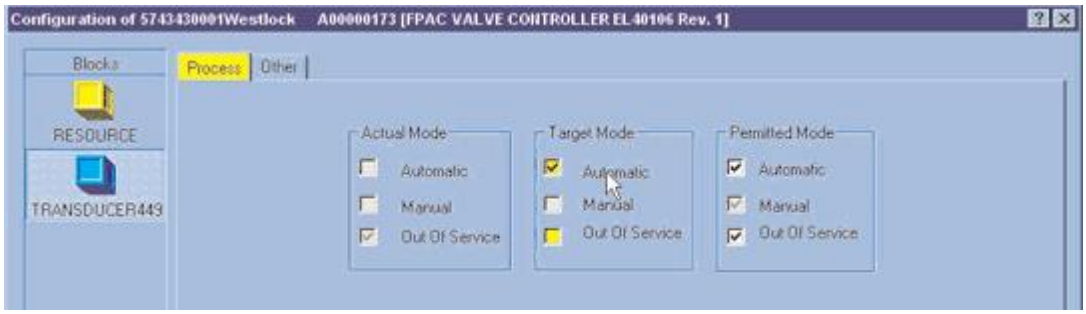


Configure parameter action_element

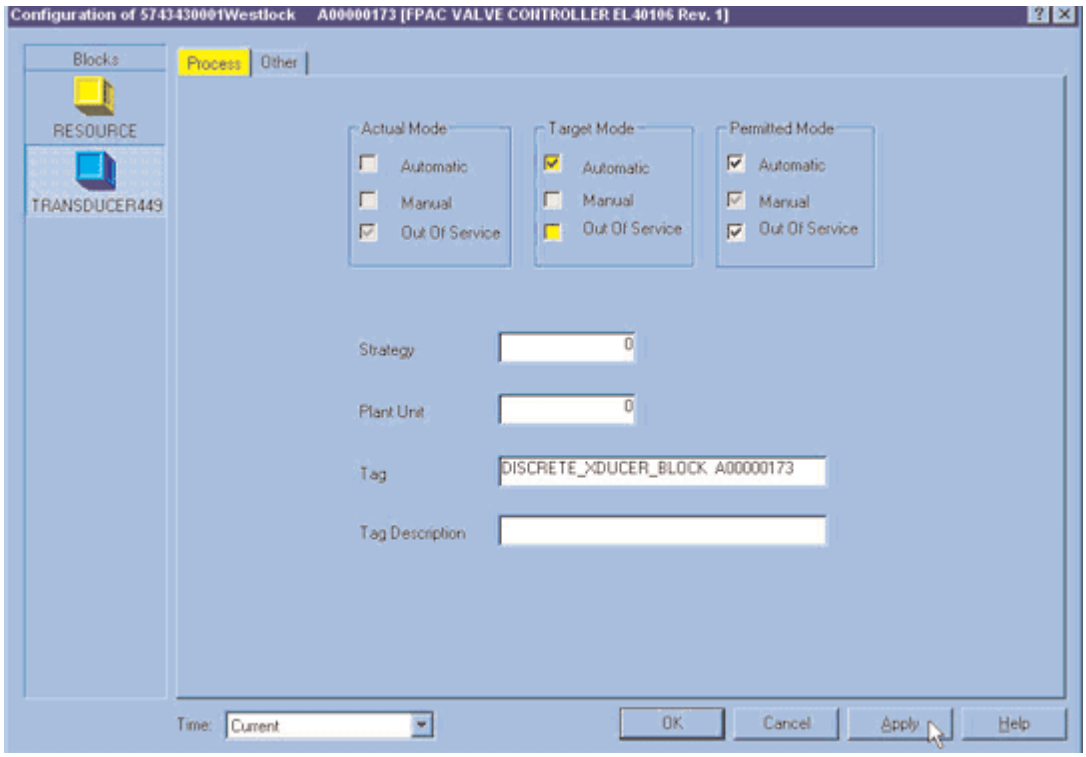
- • Under the “Others“ tab, locate the **action_element** parameter, approximately half way down through the list.
- • From the drop down list select “Single Action“ (enumeration = 1) for single acting, spring return valves.



• • Under the “Process“ tab, set **mode_block** to “Auto“

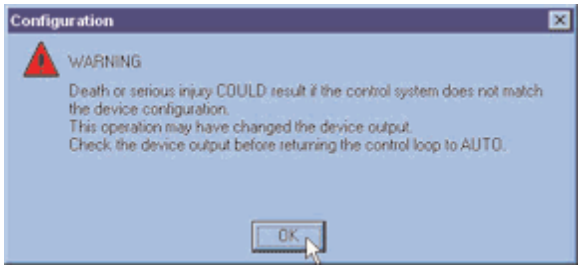


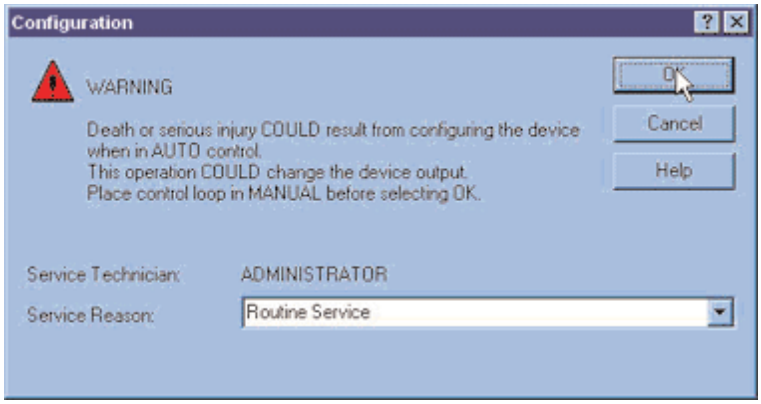
• • Click “Apply“.



Note

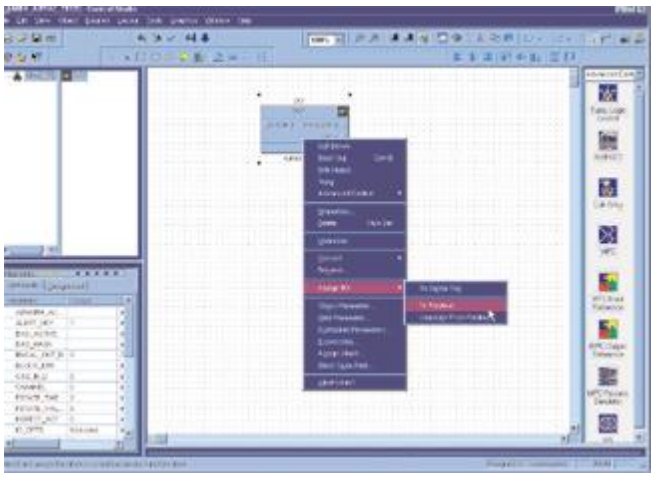
Note the Warnings Screens and click “OK“ if you have determined it is safe to do so.



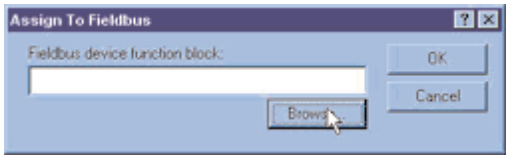


Discrete Output Block

• • Right click on the DO and assign device tag to block.



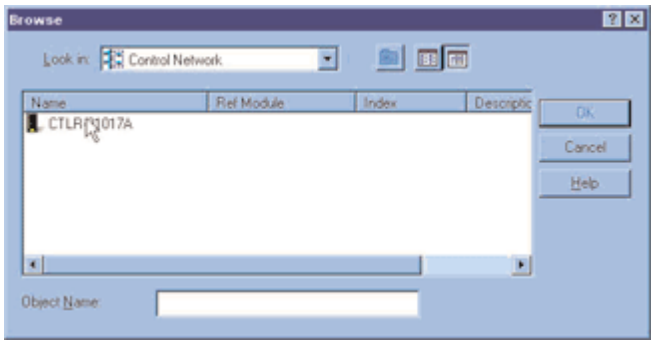
• • Browse to define the path to the desired device tag reference.



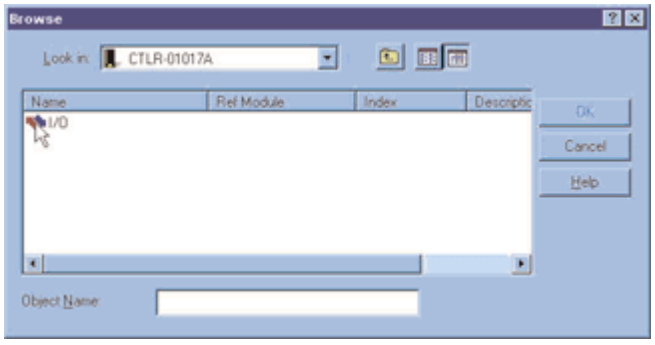
Note

NOTE: Double click an item to select it.

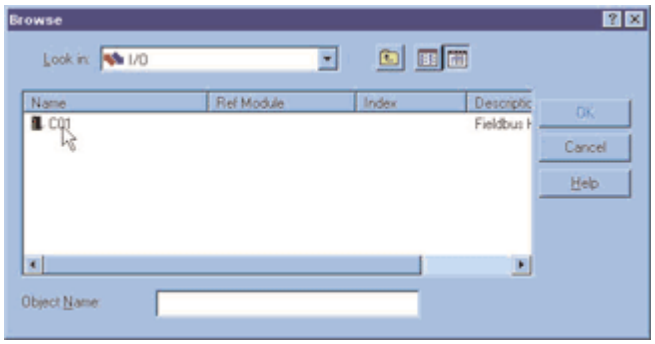
• • Select the desired controller.



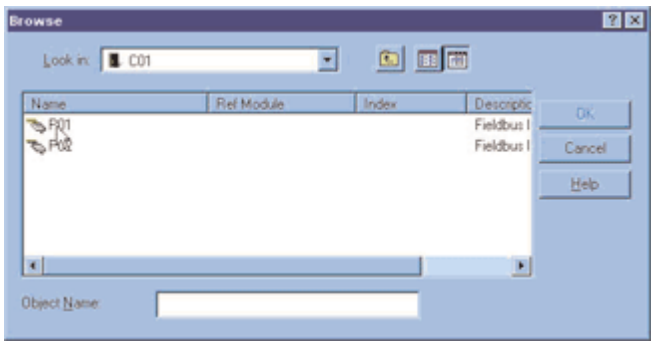
• • Select the desired I/O.



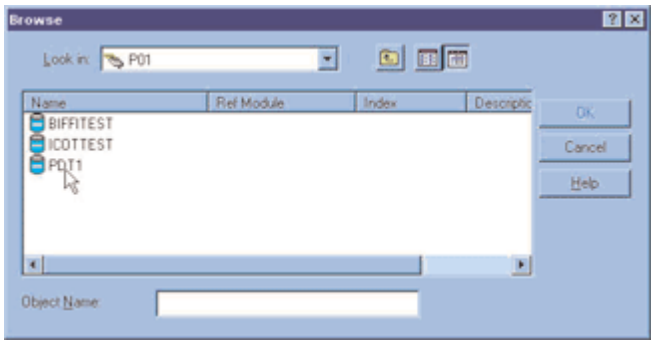
• • Select the desired I/O card.



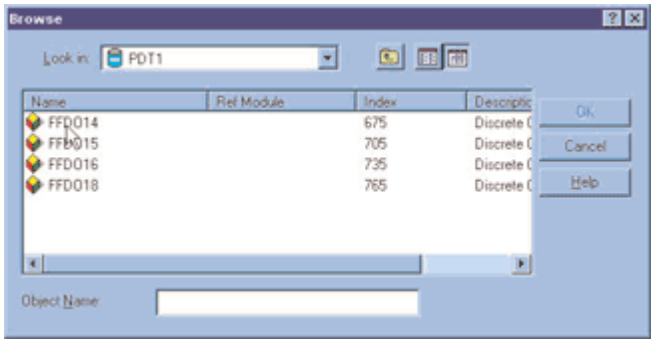
• • Select the desired port.



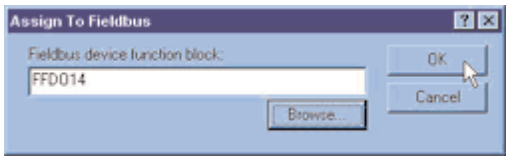
• • Select the desired device.



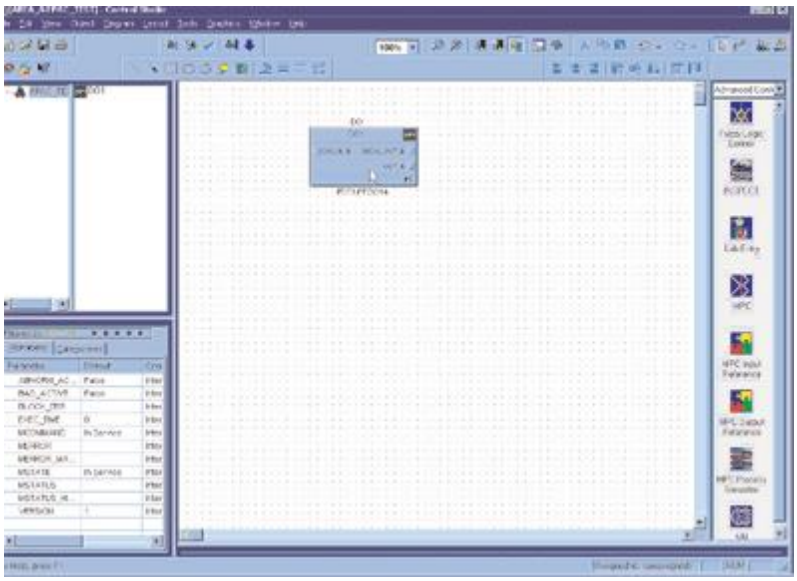
• • Select the desired function block.



• • Click “OK“ to accept device tag reference.

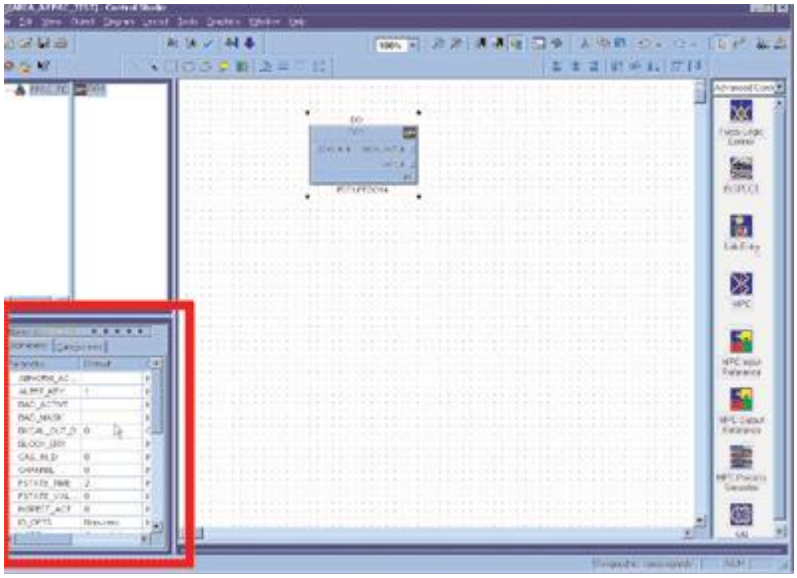


• • Left click DO to view its parameters



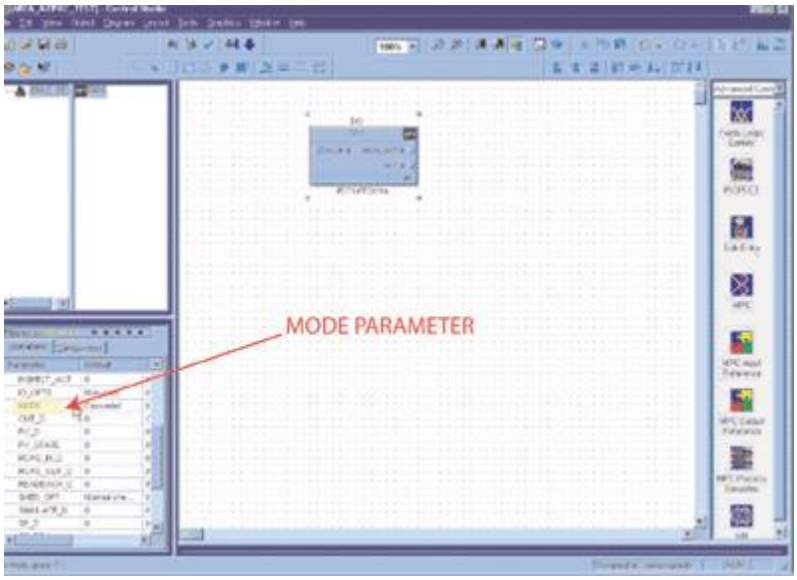
NOTE that the DO parameters are no visible in this section of the Control Studio window.

Note

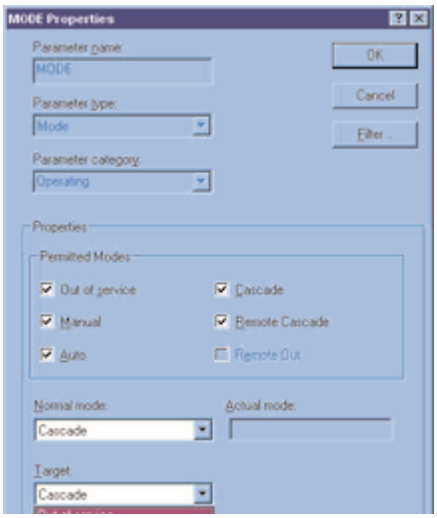


Set mode_block of DO1 to “OOS“

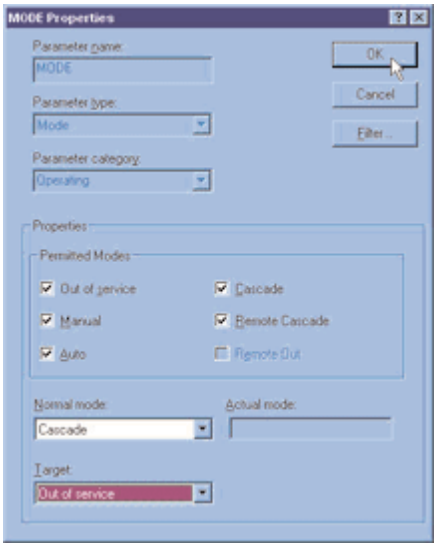
• • Double click on MODE parameter.



• • Select “Out of Service“ from drop down list.

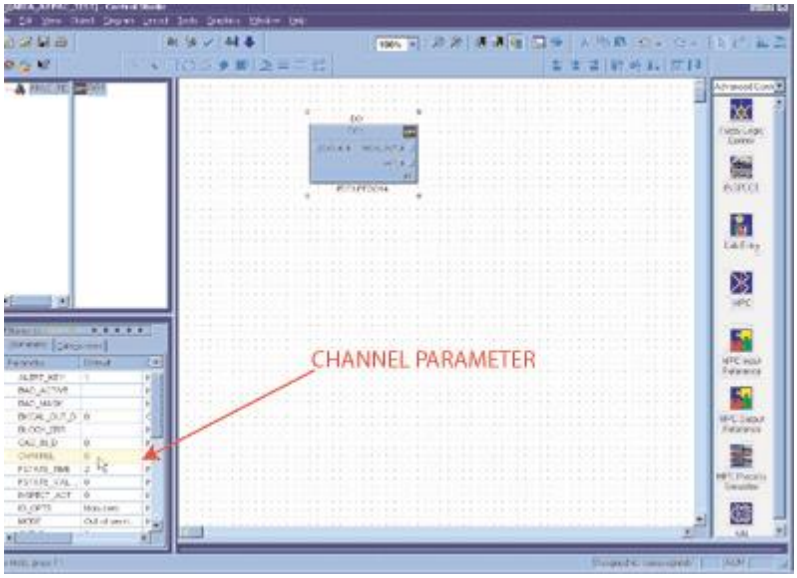


• • Click “OK“.

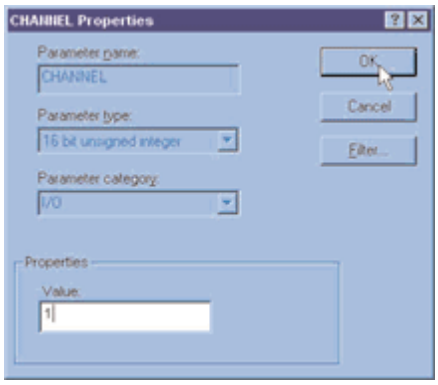


Configure Channel for “Open/Close“ (enumeration 1)

• • Double click the **channel** parameter.

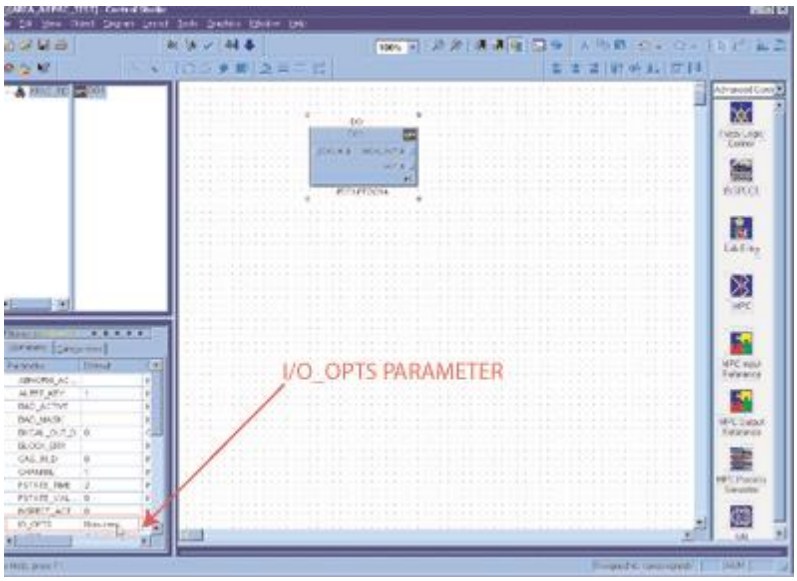


• • Enter 1 as the desired Channel number and click “OK“.

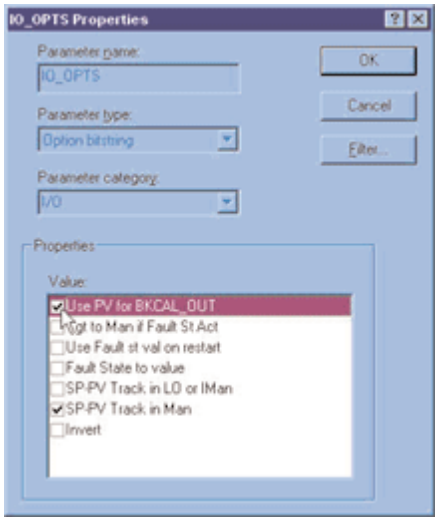


Configure DO Block to Utilize ReadBack

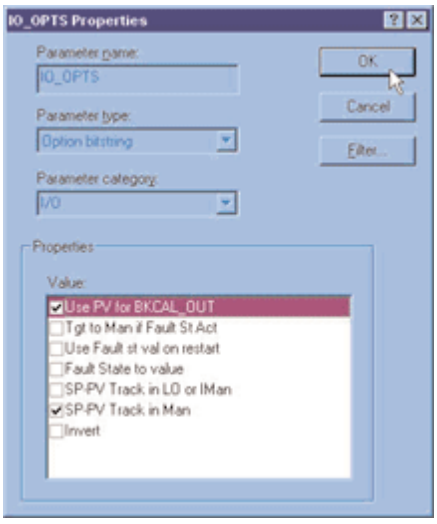
• • Double click the **i/o_opts** parameter.



• • Select “Use PV for BKCAL_OUT“.

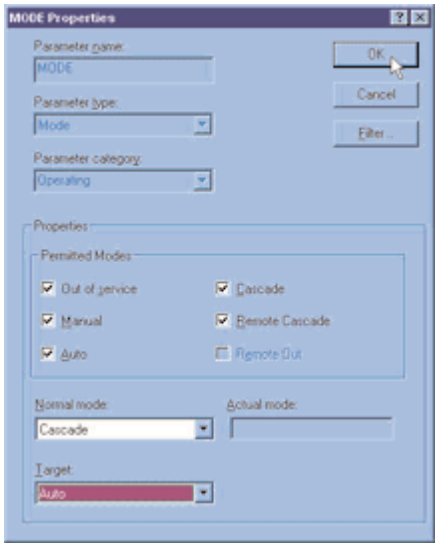


• • Click “OK“.



Set Block Mode of DO1 to “Auto“ or “CAS“

• • Select “Auto“ or “CAS“ from the drop down list and click “OK“.



Single Action Fail Open Valve

Configuring the parameters as shown below allows the valve to be Opened or Closed by sending a 0 or 1, respectively, to the DO Block.
The parameter **readback_d** may be used for position feedback as discussed in Section 3.6.2 above.

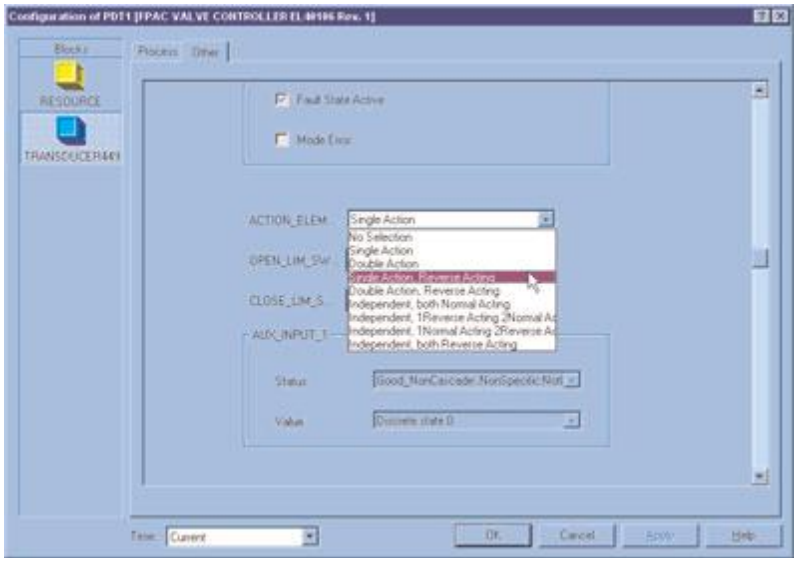
Note

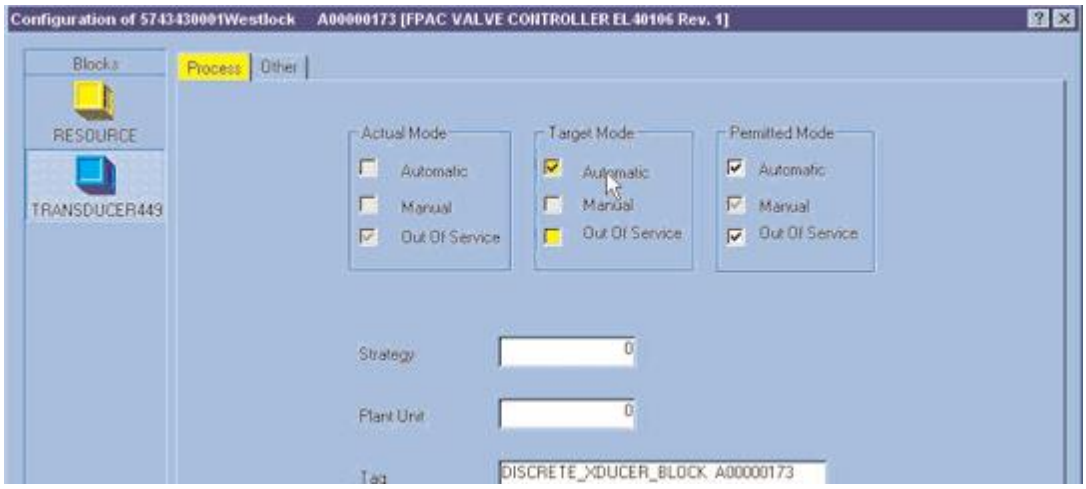
Configure all parameters as in Section 1 above except the following:

Transducer Block

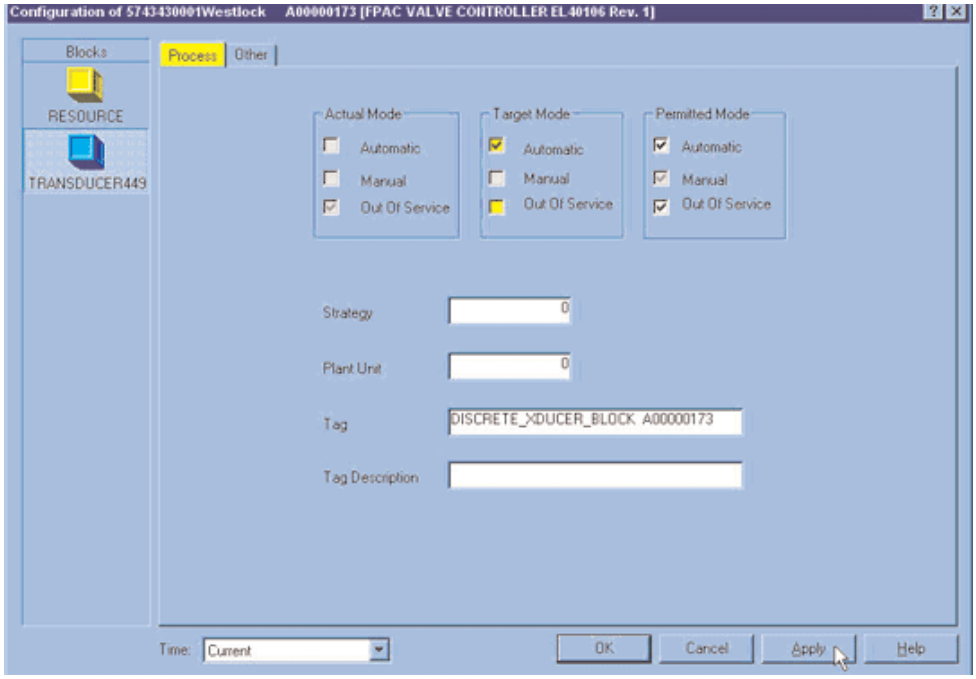
Configure parameter action_element

• • Under the “Others“ tab, locate the **action_element** parameter, approximately half way down through the list.
• • Select “Single Action, Reverse Acting“ (enumeration = 4) for single action, fail open valves





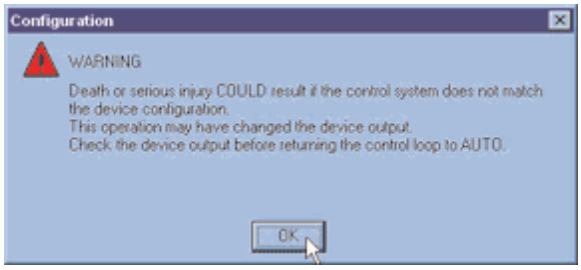
• • Under the “Process“ tab, set **mode_block** to “Auto“



• • Click “OK“.

Note

Note the Warnings Screens and click “OK“ if you have determined it is safe to do so.



Double Action

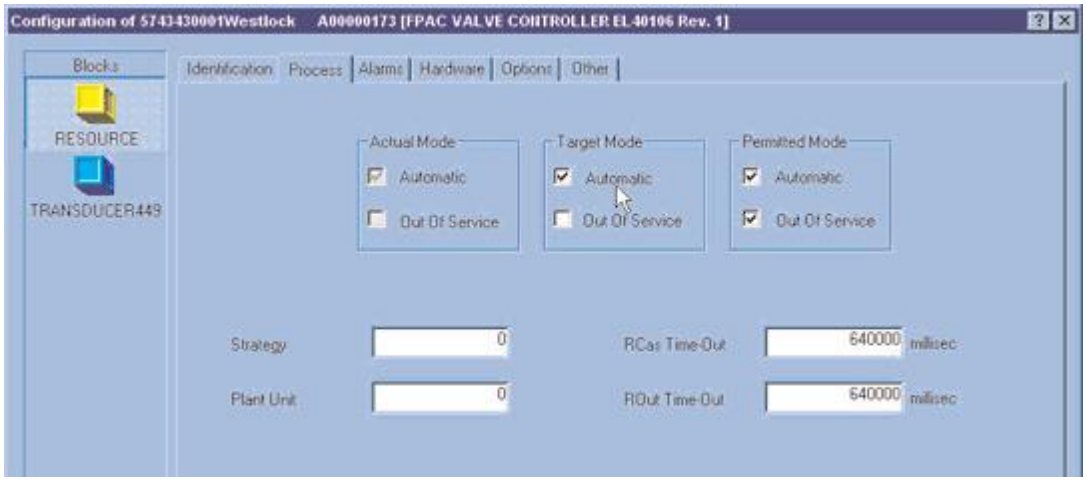
Configuring the parameters as follows allows the valve to be Opened or Closed by sending a 1 to the Open DO Block or 0 to the Close DO Block.
Valve position is indicated via the readback_d parameter where the status of the Limit Sensors is as indicated in the following table:

Table 32 – Discrete Output -ReadBack

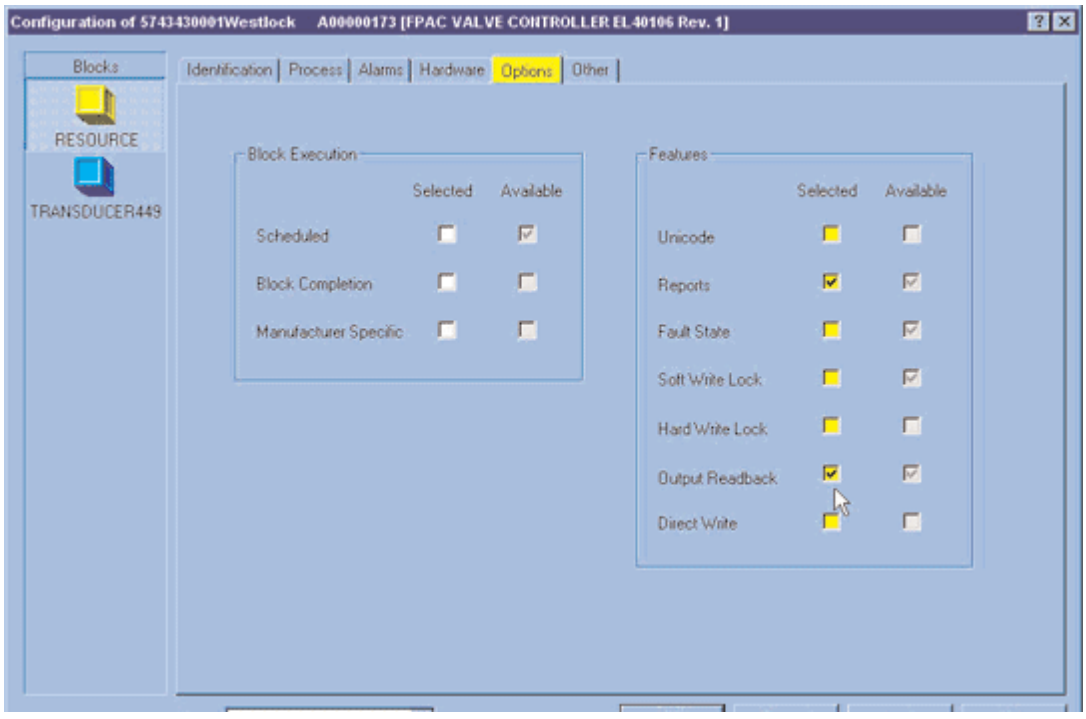
Channel Value	Channel Meaning	Enumerations for READBACK_D
2	Close	0, Not Closed
		1, Close
3	Open	0, Not Open
		1, Open

1 for Open and 0 for Close, is available. Control schemes may use the ReadBack value to reflect the actual state of the affected controlled element. This eliminates the need to use a DI Block for position feedback.

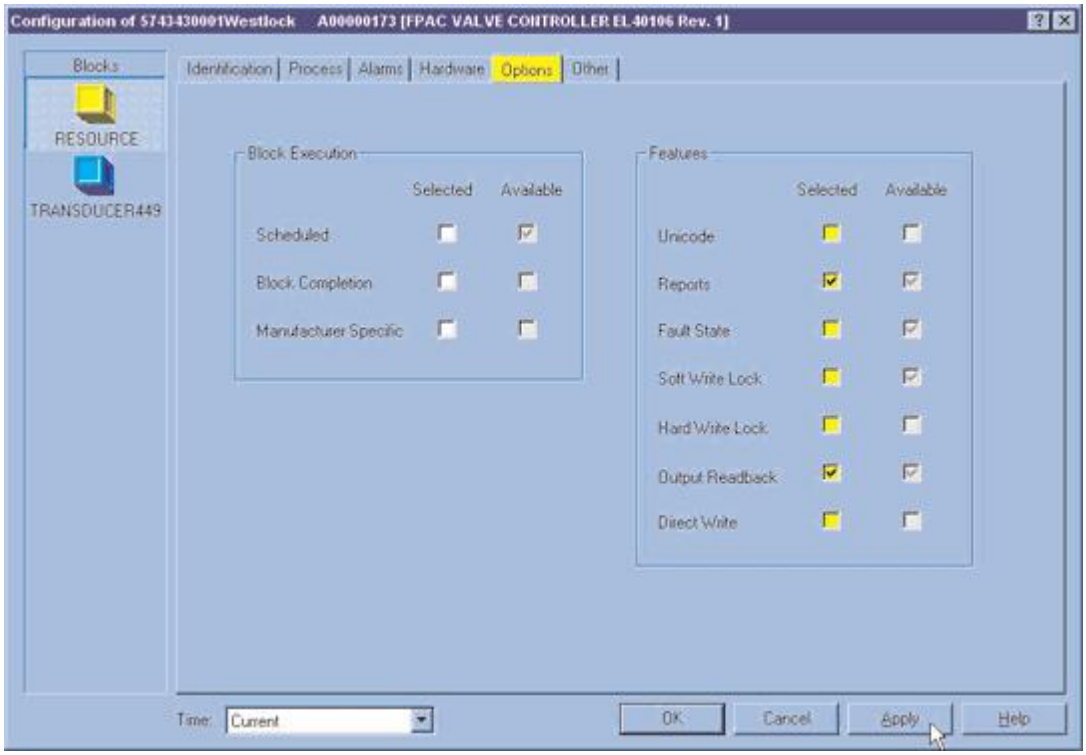
• • Under the “Process“ tab, confirm **mode_block** is “Auto“



• • Under the “Options“ tab, configure the **feature_sel** parameter to enable “Out ReadBack“ numeration 0x20)

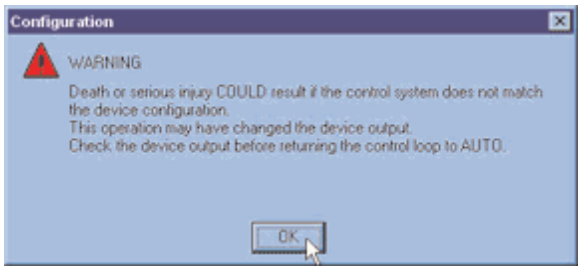


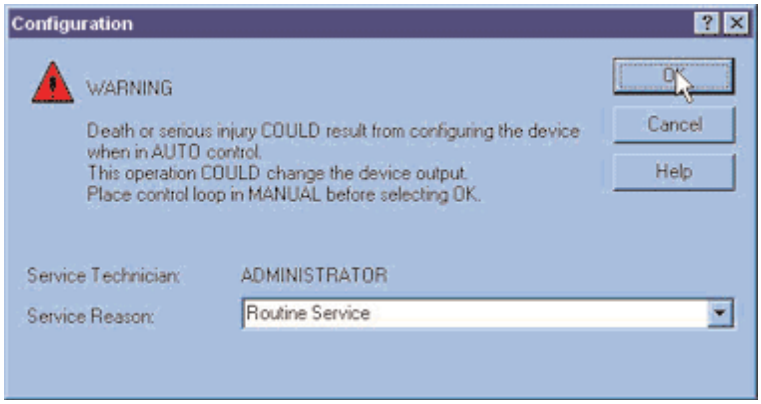
• • Click “Apply“.



Note the Warnings Screens and click “OK“ if you have determined it is safe to do so.

Note

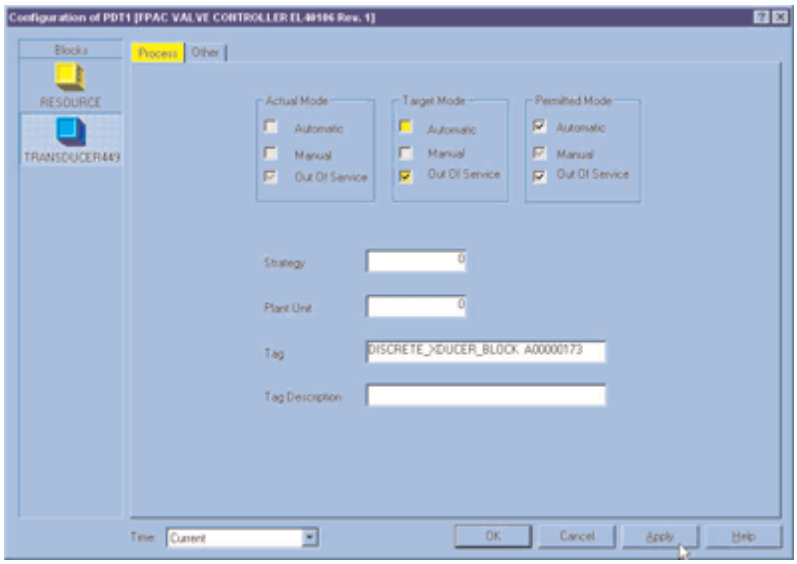




Transducer Block

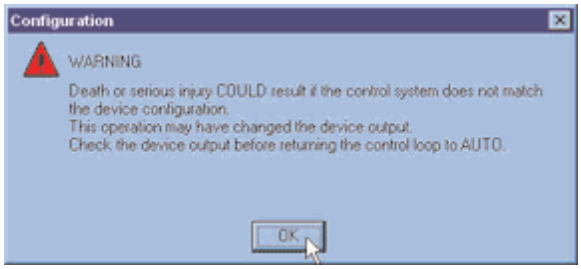
• • Under the “Process“ tab, set **mode_block** to “OOS“

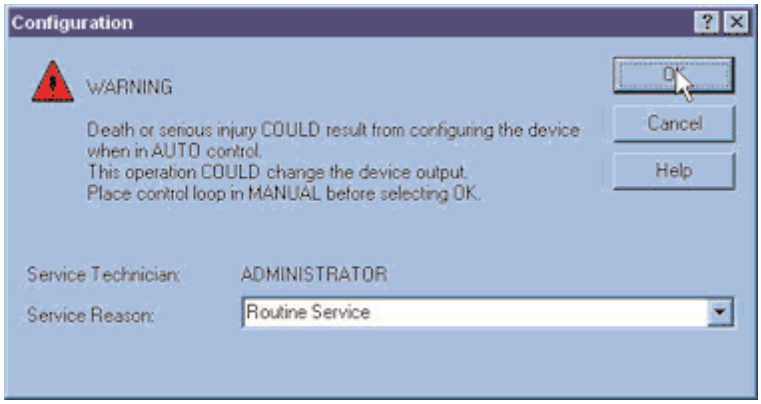
• • Click “Apply“.



Note

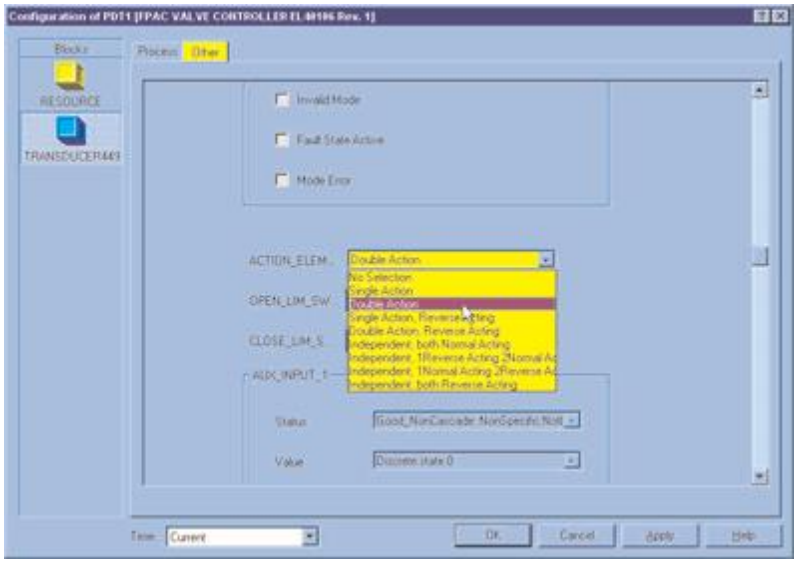
Note the Warnings Screens and click “OK“ if you have determined it is safe to do so.





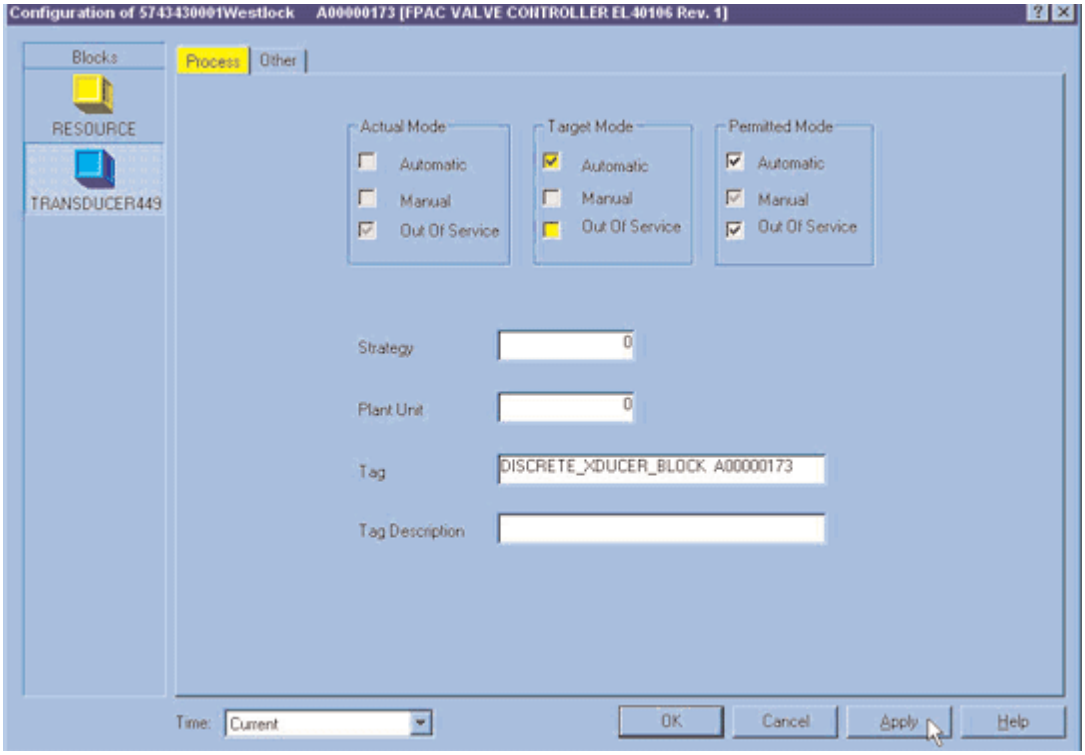
Configure parameter action_element

- • Under the “Others“ tab, locate the **action_element** parameter, approximately half way down through the list.
- • Select “Double Action“ (enumeration = 3) from the drop down list for double acting valves



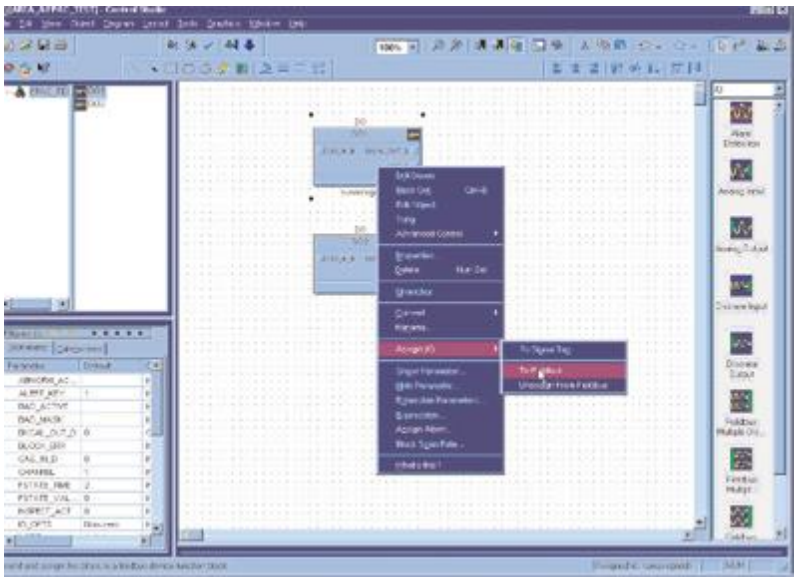
- • Under the “Process“ tab, set **mode_block** to “Auto“

• • Click “Apply“.

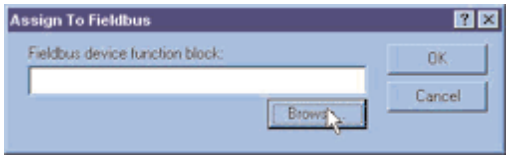


Discrete Output Block

• • Right click on DO1 and assign device tag to block.



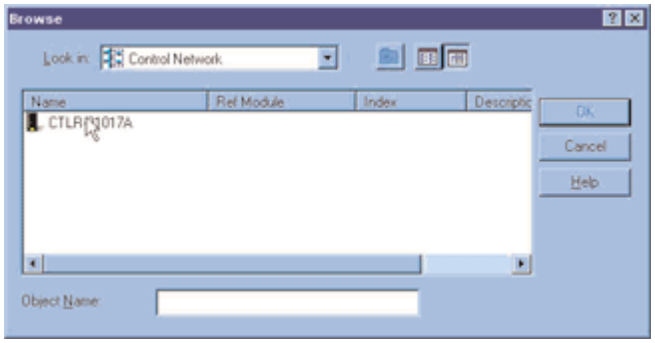
• • Browse to define the path to the desired device tag reference.



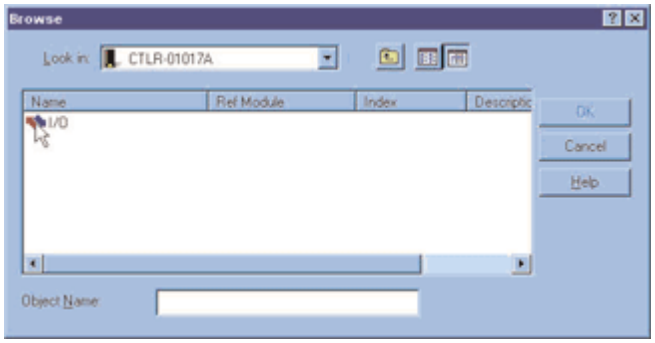
Note

NOTE: Double click an item to select it.

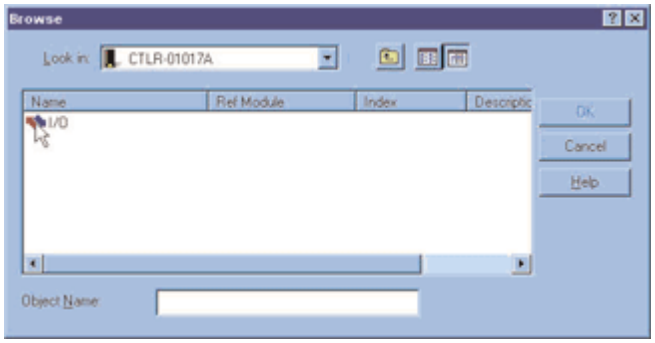
• • Select the desired controller.



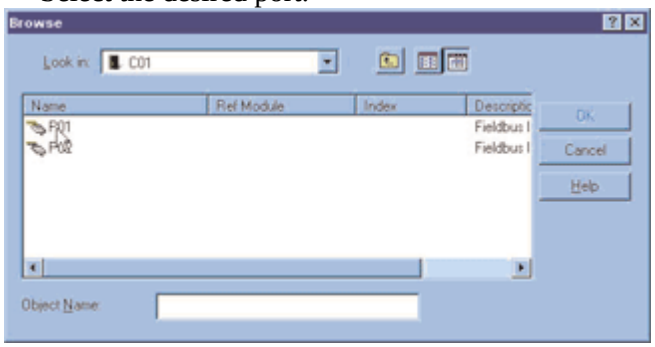
• • Select the desired I/O.



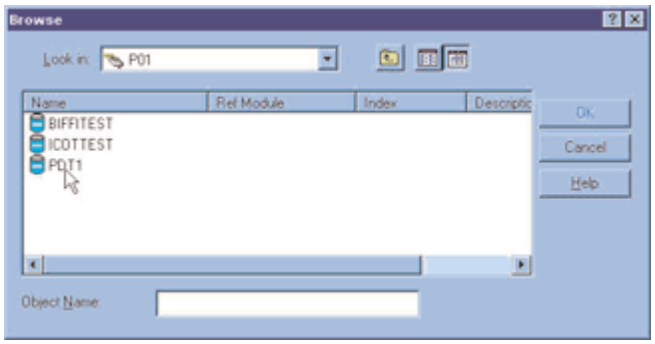
• • Select the desired I/O card.



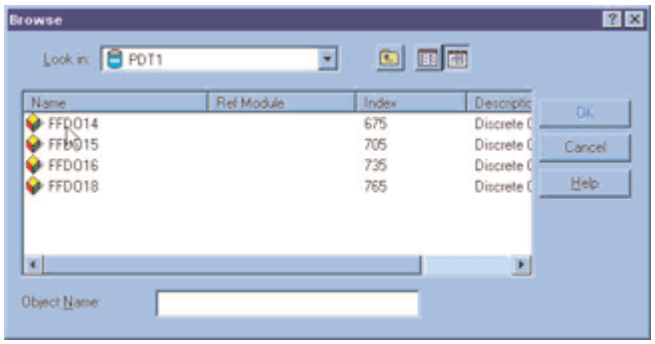
• • Select the desired port.



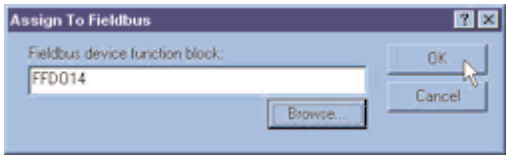
• • Select the desired device.



• • Select the desired function block.

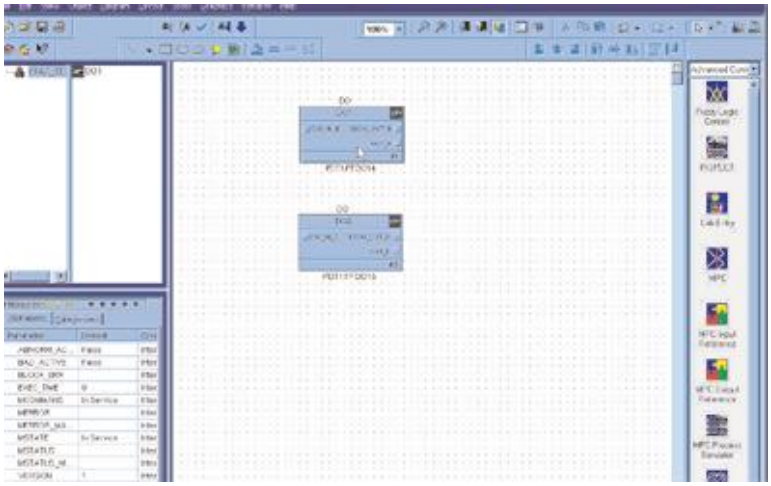


• • Click “OK“ to accept device tag reference.



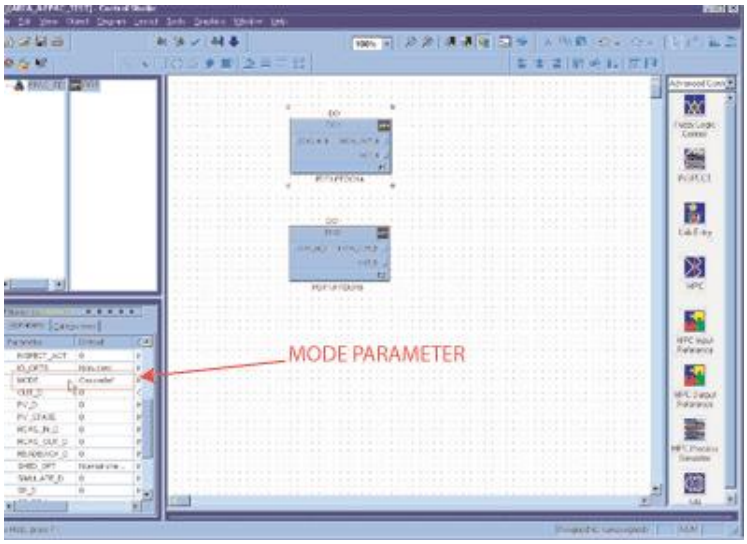
• • Follow the same procedure to assign device tag to DO2.

• • Left click DO1 to view it’s parameters

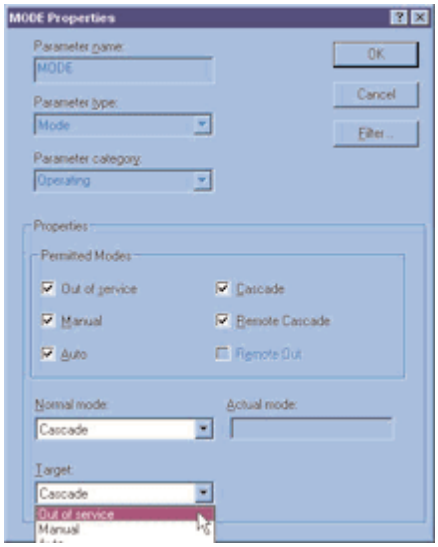


Set mode_block of DO1 to “OOS“

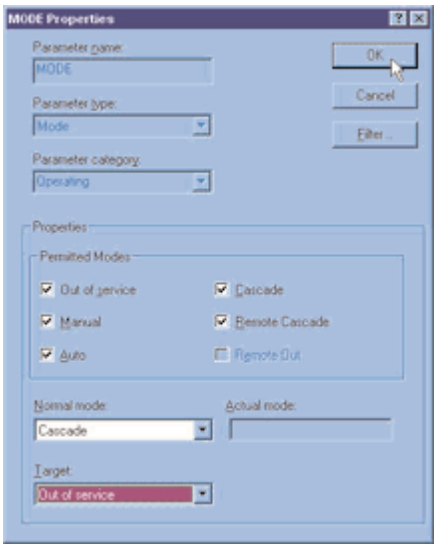
• • Double click on MODE parameter.



• • Select “Out of Service“ from drop down list.



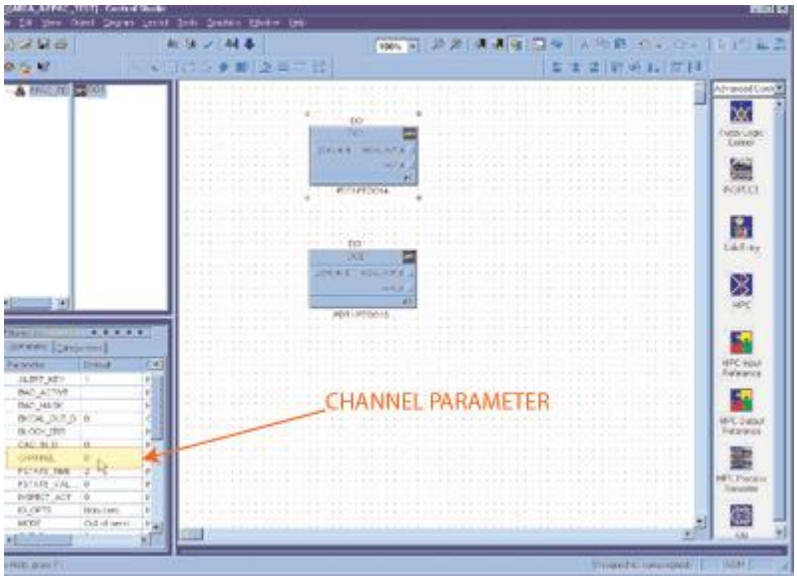
• • Click “OK“.



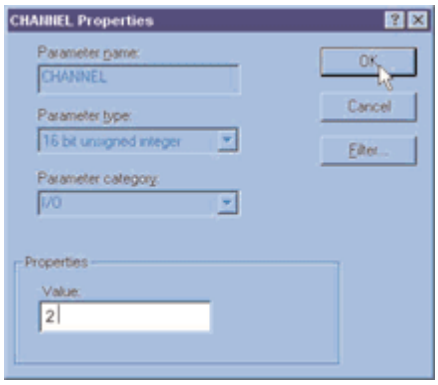
• • Follow the same procedure to set **mode_block** of DO2 to “OOS“

Configure DO1 Channel for “Open“ (enumeration 2)

• • Double click the **channel** parameter.



• • Enter 2 as the desired Channel number and click “OK“.

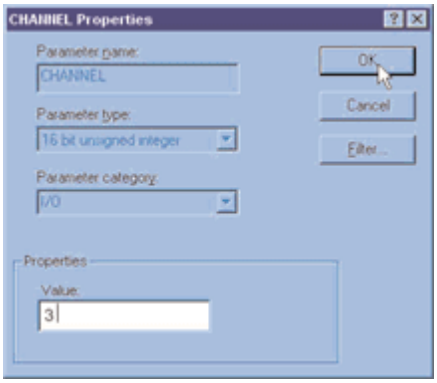


Configure DO2 Channel for “Close“ (enumeration 3)

• • Left click DO2.

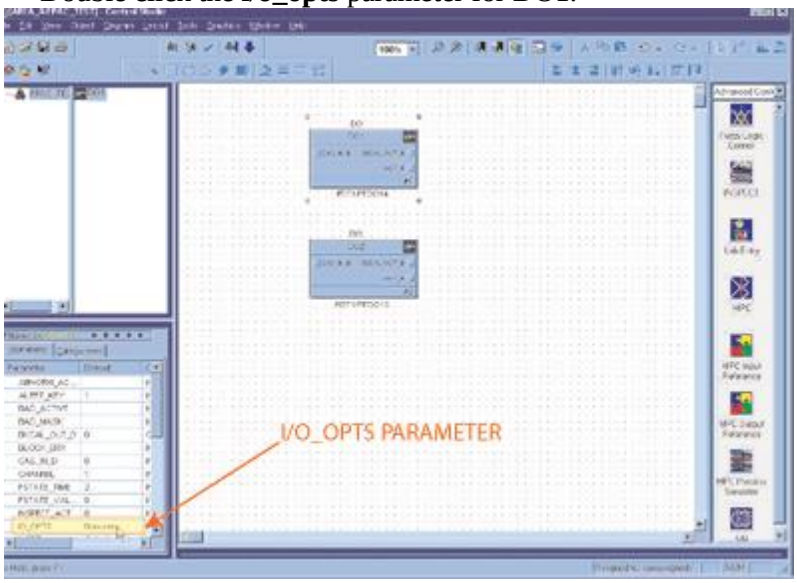
• • Double click the **channel** parameter as for DO1 above.

• • Enter 3 as the desired Channel number and click “OK“.

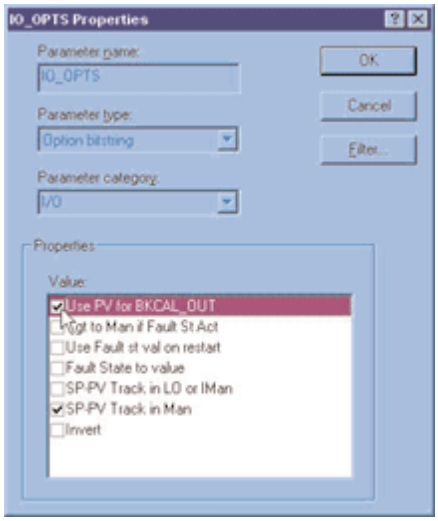


To utilize ReadBack, configure i/o_opts for “Use PV for BKCAL_OUT“ for both DO1 and DO2

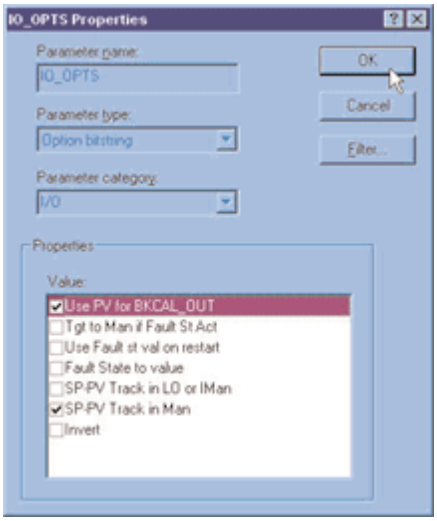
• • Double click the **i/o_opts** parameter for DO1.



• • Select “Use PV for BKCAL_OUT“.



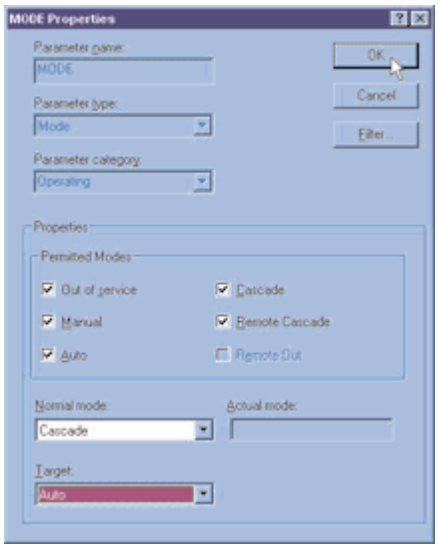
• • Click “OK“.



Follow the same procedure to enable ReadBack for DO2.

Set mode_block of DO1 and DO2 to “Auto“ or “CAS“

• • Select “Auto“ or “CAS“ from the drop down list and click “OK“.



Appendix B

Connecting the FPAC to the Delta-V DCS for the First Time

The following instructions describe a procedure that may be required the first time the FPAC module is connected to the Delta-V as the Delta-V only supports OOS and Auto modes for the Transducer Block (TB).

Note

This procedure is only necessary if the TB is in Man Mode.

Restarting the device may cause loss of process control. Confirm that you fully understand what the effect on the process will be if the device is being restarted. A device undergoing restart will be offline during the restart process and may force the valve to a preconfigured fault state.

Go to the TB.

• Under the "Process" tab confirm the mode of the FPAC.

Note

If TB is in OOS or Auto mode the device is ready to use and this procedure is not required.

• If TB is in Man proceed to next step.

Go to the Resource Block (RB)

• Under the "Hardware" tab locate the **restart** parameter.
• From the drop down list select the "Factory Defaults" option.
• Click "Apply" and then "OK" on the warning screen to write to the device.
• Wait for "Run" to appear in the **restart** parameter drop down window.

Go to the TB

• Under the "Process" tab confirm that the TB mode is OOS.
• If the desired operation of the FPAC is a single acting fail close device, transition the TB mode to Auto and proceed with your configuration of the device.
• If the desired operation of the FPAC is other than the factory default (single acting fail close device) proceed to the next step.

Confirm the TB is OOS.

• Under the "Others" tab in the TB, approximately half way down through the list, locate the parameter **action_element**.
• Select the mode of device operation desired for the FPAC from the drop down list (Double Acting, etc.).
• Click "Apply" and then "OK" on the warning screen to write to the device.
• Transition the TB mode to Auto and proceed with your configuration of the device.

Appendix C

Transducer Block Views

Table 33(a)- Transducer Block Views

Parameter	Relative Index	VIEW_1	VIEW_2	VIEW_3(1)	VIEW_4(1)	VIEW_4(2)	VIEW_4(3)
st_rev	1	1	2	3	4	4	4
tag_desc	2						
strategy	3				4		
alert_key	4				4		
mode_blk	5	1		3			
block_err	6	1		3			
update_evt	7						
block_alm	8						
xd_error	9	1		3			
final_value_d	10	1		3			
sp_d	11	1		3			
final_position_value_d	12	1		3			
final_value_d	13	1		3			
sp_d2	14	1		3			
final_postion_value_d2	15	1		3			
act_fail_action	16				4		
act_man_id	17				4		
act_model_num	18				4		
act_sn	19				4		
valve_man_id	20					4	
valve_model_num	21					4	

Table 33(b) - Transducer Block Views							
Parameter	**Relative Index**	**VIEW_1**	**VIEW_2**	**VIEW_3(1)**	**VIEW_4(1)**	**VIEW_4(2)**	**VIEW_4(3)**
valve_sn	22					4	
valve_type	23					4	
xd_cal_loc	24						4
xd_cal_date	25						4
xd_cal_who	26						4
discrete_state	27	1		3			
maskable_signal	28		2		4		
signal_mask	29				4		
block_alms_act	30						
action_element	31						
open_lim_switch	32						
close_lim_switch	33						
aux_input_1	34						
aux_input_2	35						
start_up_state	36						
fault_state1	37						
fault_state2	38						
collect_cycle_time	39						
cycle_time_collect_type	40						
cycle_time_history	41						
breakaway_time	42						
clear_cycle_count	43						
clear_cycle_count2	44						
cycle_count	45						
cycle_count_alm	46						
cycle_count_pri	47						

Table 33(c) - Transducer Block Views							
Parameter	**Relative Index**	**VIEW_1**	**VIEW_2**	**VIEW_3(1)**	**VIEW_4(1)**	**VIEW_4(2)**	**VIEW_4(3)**
`cycle_count2`	48						
`cycle_time`	49						
`cycle_time_alm`	50						
`cycle_time_lim`	51						
`cycle_time_pri`	52						
`device_err`	53			3			
`travel_time`	54						
`supported_modes`	55						
`shared_data`	56						

Appendix D

Connecting Two Valves to the FPAC

The FPAC will support the operation of two independent valves. The primary valve in Figure 19 is the one that the 7344 housingis mounted on (unit to the left) which is connected to an 877 housing mounted on the secondary valve
(The 877 is a simple switch box with two limit sensors and a solenoid).

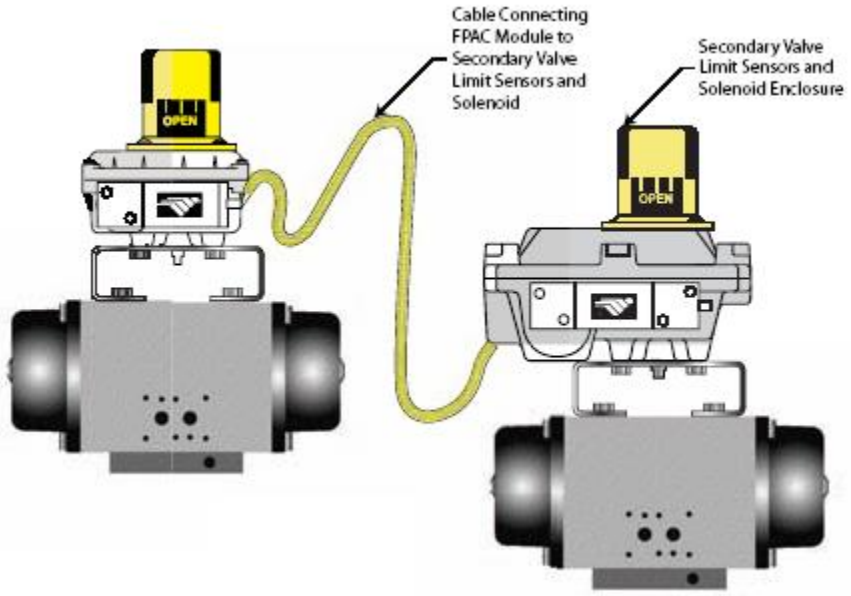


Figure 19

The limit sensors for the primary valve are integral to the FPAC module (Figure 20) and the solenoid for the primary valve is typically integral to the 7344 or 7379 network monitor (7344 shown in Figure 21).

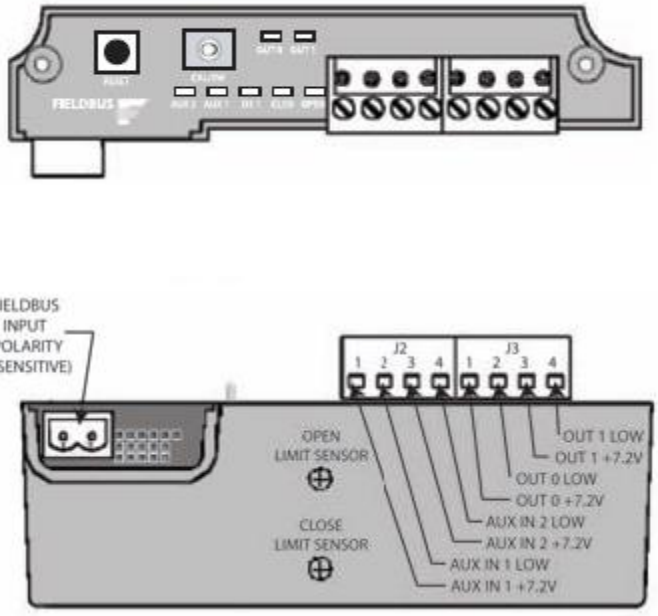


Figure 20

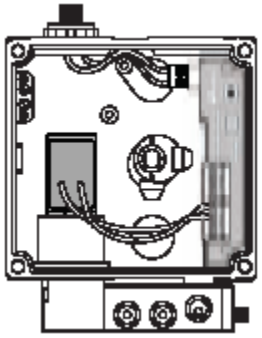
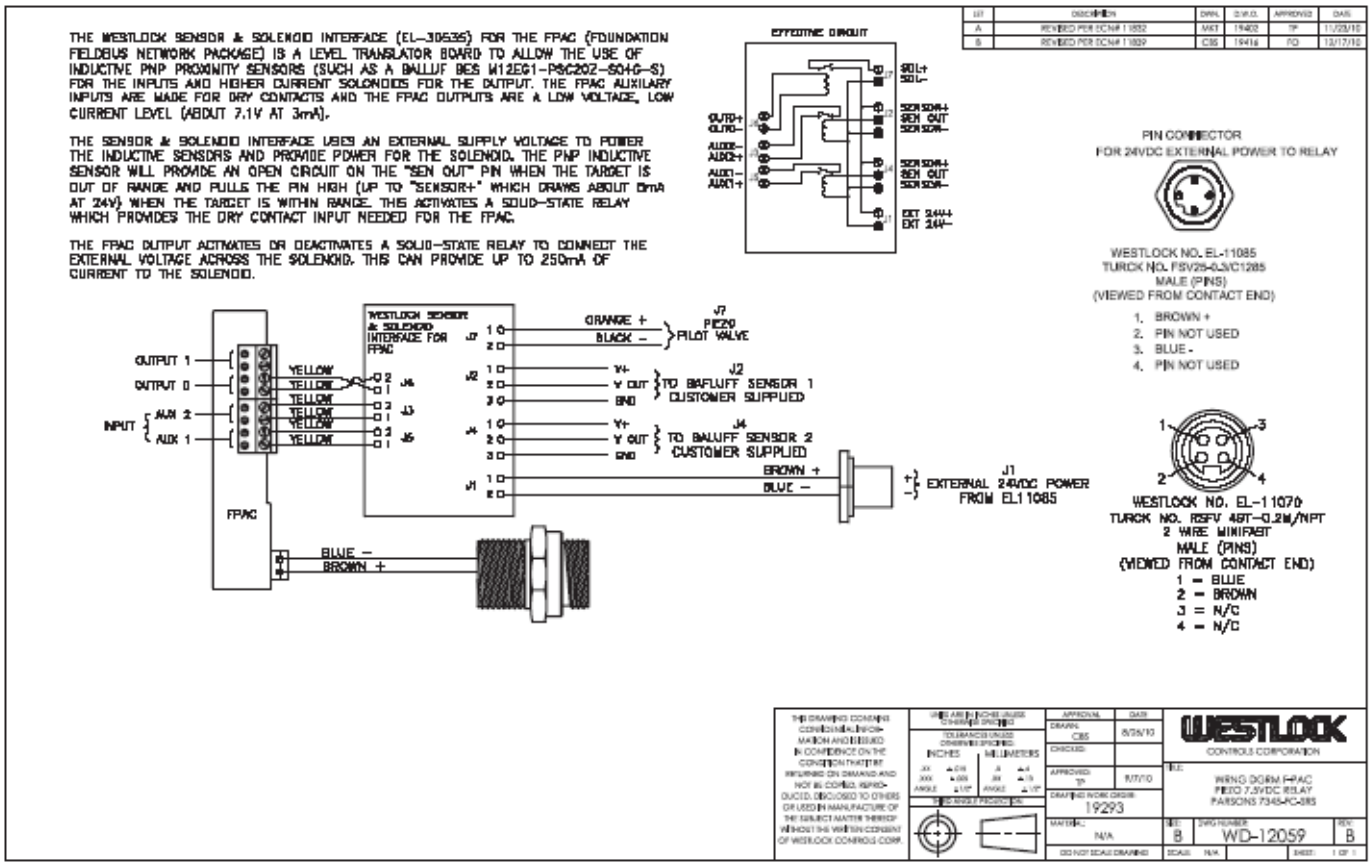


Figure 21

The limit sensors for the secondary valve must be wired to the AUX Inputs of the FPAC module and the solenoid for the secondary valve is must be wired to the OUT 1 terminals of the FPAC (Figure 20).

Appendix E

Wiring Instructions for 7345-FC-SRS Parsons Coax Units