DVC6000 Series Digital Valve Controllers for Emergency Shut Down (ESD) Solutions

The operation of many industrial processes, especially in the chemical and oil & gas industries, involves inherent risk due to the leaking of lethal or flammable chemicals or gases. Safety Instrumented Systems are specifically designed to reduce the likelihood or the severity of the impact of an identified event, thus protecting personnel, equipment, and the environment. These systems involve final control elements, which are mostly in one position and are requested to move only when an emergency situation arises. Typical applications involve Emergency Shut Down Valves, Emergency Blow Down Valves, Emergency Venting Valves, Emergency Isolation Valves, Critical On-Off Valves, etc. Because the final control element remains in one position without mechanical movement, the dependability of the valve is reduced; that is, it may not operate successfully upon demand. This could cause a potentially dangerous condition leading to an explosion or fire and the leaking of lethal chemicals and gases to the environment.

Fisher offers a solution for Emergency Shut Down (ESD) valves that uses FIELDVUE® DVC6000 Series digital valve controllers. Using DVC6000 Series instruments for ESD solutions permits partial stroking of the valve to minimize the chance of valve failure and, consequently, the possibility of catastrophic situations. Partial stroking tests valve movement with a small ramp. This ramp is small enough not to disrupt production, but is large enough to confirm that the valve is working. DVC6000 Series instruments in ESD solutions also provide state-of-the-art testing methods, which reduce testing and maintenance time, reduce initial investment cost, improve system performance, and provide diagnostic capabilities.

Figure 1. FIELDVUE® Type DVC6030 Digital Valve Controller in ESD Solution Mounted on a Quarter-Turn Valve

Features

- **Increased System Availability**—The simple and secure method of partial stroke testing allows end users to perform more frequent valve mechanical movement tests. This reduces the PFD (Probability of Failure on Demand) factor. Because the test procedures are flexible, they can be conducted at any time, providing more assurance the system will be available upon demand. In addition, continuous valve monitoring through AMS ValveLink® Software provides awareness of the valve's status. To assure availability, the digital valve controller continuously checks that all its internal components are functioning correctly.

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- **Reduced Cost of Ownership**—Lower base equipment cost with considerable reduction in testing time and a reduced manpower requirement makes this solution economically feasible. DVC6000 Series digital valve controllers in ESD solutions offer an economic alternative to expensive pneumatic test panels and skilled personnel presently required for testing emergency shutdown valves.

- **Valuable Time Savings**—Remote testing capability requires fewer maintenance inspection trips to the field thus saving considerable time. Using AMS ValveLink Software's Batch Runner to establish an automatic test routine also can provide increased time savings.

- **Predictive Maintenance**—DVC6000 Series instruments in ESD solutions permit using AMS ValveLink Software to provide Valve Degradation Analysis, which is important for critical valves in shut down systems. This also reduces the amount of scheduled maintenance.

- **Valve Stuck Alert**—While performing the partial stroke test, if for any reason the valve is stuck, the digital valve controller will not completely exhaust the actuator pressure. This assures that, should the valve become unstuck, it will not slam shut. The digital valve controller will abort the test and will set an alert indicating that the valve is stuck. The alert is accessible through either the Field Communicator or AMS ValveLink Software,

- **System Audit Documentation**—Using AMS ValveLink Software provides a time and date stamp on all tests and reports, which is important for compliance with the requirements of statutory authorities.

- **Verification**—AMS ValveLink Software provides the capability for comparing and interpreting diagnostic data.

- **Stroke Testing While the Process is Running**—DVC6000 Series instruments allow a partial stroke test while the valve is online, which ramps valve travel a small amount. Should a demand arise during the test, the test is overridden immediately and the valve moves to the safe state.

- **Built-In Redundancy**—When used in conjunction with a solenoid valve as shown in figures 5 and 7, DVC6000 Series digital valve controllers in ESD solutions provide an inherent redundant pneumatic path. Should an emergency situation arise, the actuator pressure exhausts through either the solenoid valve or through the digital valve controller, allowing the valve to move to the safe position.

- **Reduced Wiring Cost**—DVC6000 Series instruments in ESD solutions eliminate the need for position transmitters and separate wiring from the transmitter. Through HART protocol, the valve position is communicated over the same 4 to 20 mA analog loop that provides the valve control signal. A HART Tri-Loop™, or other HART-to-analog signal converter in the control room can provide a 4 to 20 mA signal that is proportional to valve position. The HART-to-analog signal converter can also provide discrete contact outputs to the logic solver, which may replace hard-wired limit switches.

- **Device Integrity Continuously Checked**—When pressure control mode is enabled, the digital valve controller remains constantly in control while the valve is at its normal position (either fully open or fully closed); it is not allowed to reach a dormant or saturated state. The digital valve controller constantly tests its internal components, and if any component fault is detected, it sets an alert which may be accessed through either the Field Communicator or AMS ValveLink Software.

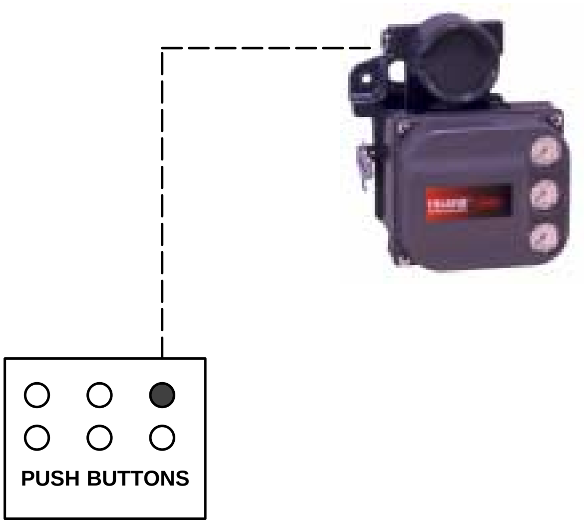

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Figure 2. Initiate the Partial Stroke Test from a Push Button Remotely Located from the Valve

Capabilities of DVC6000 Series Digital Valve Controllers in ESD Solutions

1. **Partial Stroke Testing**—This test checks for valve movement. The partial stroke test can be initiated by an authorized technician with the Field Communicator or AMS ValveLink Software.

The technician also may initiate the test in the field with a push button remotely located from the valve (figure 2). Initiating the test does not require removing any instrument covers or being near the valve during the test. Once initiated, the automated test moves the valve to a predetermined value then returns the valve to its original position. The default value for valve movement is 10% from its original position, but can be custom set to any value up to 30% to meet plant safety guidelines.

The partial stroke test eliminates costly, labor intensive testing techniques. The simplicity of this automated test allows for more frequent online testing. More frequent testing enhances loop availability and increases the reliability of the system.

2. **Valve Signature**—A valve signature obtained with AMS ValveLink Software can be used to easily determine packing problems (through friction data), leakage in the pneumatic pressurized path to the actuator (through the Pressure vs Travel graph), valve sticking, actuator spring rate, and bench set.

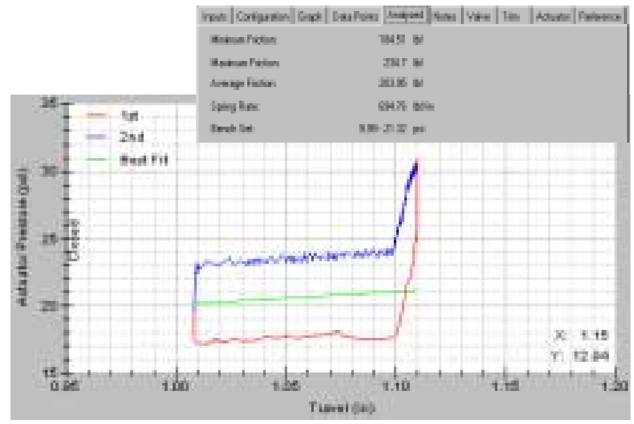

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Figure 3. Valve Signature and Analysis Obtained from Partial Stroke Test on an ESD Valve

Any time a partial stroke test is run on the valve, a partial stroke valve signature and analysis, shown in figure 3, is available. Comparing valve signature results can be used to determine if valve response has degraded over time.

In addition, when the valve is not online, several full stroke valve diagnostic tests can be run, including valve signature, dynamic error band, and step response. These tests can also be used to evaluate valve performance, such as stroking time and shutoff capability. Running these tests when the valve is first installed in the safety system allows establishing a bench mark for valve performance. The results of these tests can be compared to results from later tests to determine if valve performance has degraded.

3. **Automatic Testing**—The AMS ValveLink Software Batch Runner tool can be used to automate diagnostic testing. It provides the capability of running multiple tasks back to back on multiple valves with no intervention. This permits the user to do other things while Batch Runner does the work.

4. **Travel Record**—The cycle counter and travel accumulator provide a record of the number of cycles and percentage of travel accumulated over time.

5. **Alerts**—All device alerts are available through either the 375 Field Communicator or AMS ValveLink Software. Alerts are immediately available, and logged if AMS ValveLink Software is setup for alert scanning. Alerts are also stored in an

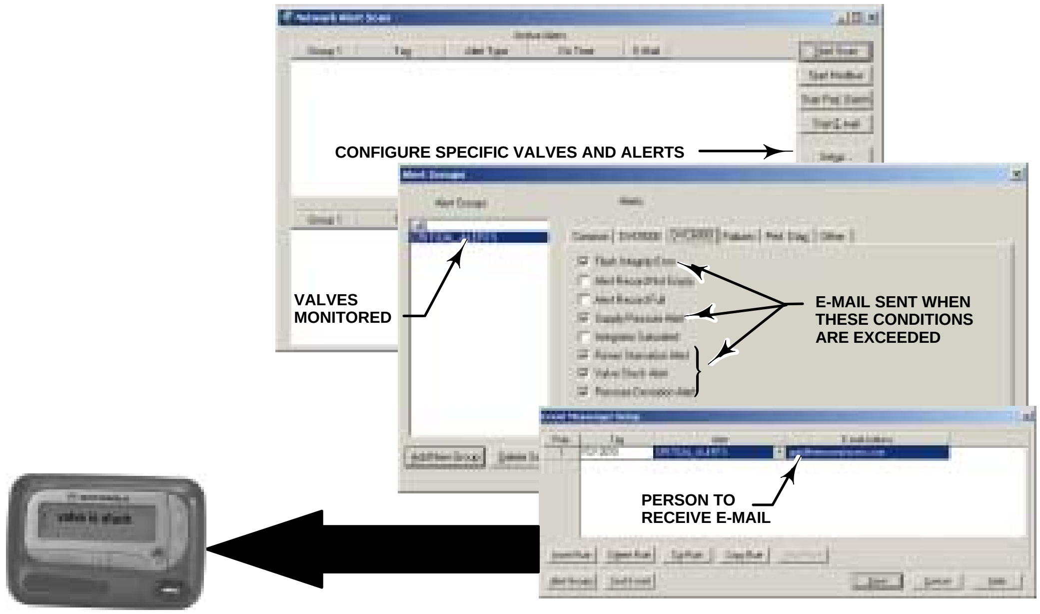

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Figure 4. Notify Key People via E-Mail whenever a Specified Alert Occurs on a Safety Shutdown Valve

alert record in the instrument. Alerts in the alert record can be retrieved by connecting a Field Communicator or AMS ValveLink Software to the device. Each alert is recorded with a time and date stamp so that you know the nature of the alert and when it occurred.

6. **Alert Notification**—AMS ValveLink Software Event Messenger allows notifying key people of critical alerts via e-mail. AMS ValveLink Software can be setup to automatically send an e-mail when a specified alert occurs on a final control element in a Safety Instrumented System (figure 4). This e-mail could also be setup to trigger a pager. The capability can be setup to notify a designated technician if a specific alert, or sets of alerts, occurred on a predefined set of safety shutdown valves. This means key plant operation personnel can be continuously informed of alert status, no matter where they are, enabling them to provide timely and precise corrective action.

7. **Adjustable Travel Cutoff**—Travel Cutoffs are adjustable when the DVC6000 ESD is operating with a 4-20 mA current. The Setup Wizard automatically sets travel cutoffs at 50%, making the DVC6000 ESD tier work like an on-off device. At current levels from 4.0 to 11.99 mA, the DVC6000 ESD will provide minimum output pressure, and at 12 to 20 mA, the DVC6000 ESD will provide full output pressure.

A user can customize valve response to the control signal by changing the travel cutoffs. For example, it is possible to have the valve throttle between 10 and 90% open, but work as an on-off valve between 0% to 10% and 90% to 100% opening. The user now has a standard throttling control valve between 10% and 90% opening, but has an ESD outside of this range. While in ESD mode, in this example, partial stroke and pressure control mode can be enabled during travel greater than 90%.

Installing DVC6000 Series Instruments in ESD Systems

DVC6000 Series instruments in ESD solutions can be extended to any valve style configuration including sliding-stem, rotary, quarter-turn, etc. with spring and diaphragm actuators or spring-return piston actuators. The actuator system must be designed so that it will move the valve to the safe state with equal output pressures from the digital valve controller. A spring return actuator is normally used. An extensive number of mounting kits for these instruments are available. These mounting kits may be retrofitted to work with many actuators produced by various manufacturers.

Two types of installation are possible:

- 2-wire system
- 4-wire system

Installations with the digital valve controller in 2-wire systems (multidrop mode) are shown in figures 5 and 6. In installations that include a solenoid valve with the digital valve controller, the logic solver provides a single 24 volt dc source to provide power for both the solenoid valve and the digital valve controller. Installations with the digital valve controller in a 4-wire system (point-to-point mode) are shown in figure 7. These installations require the logic solver to provide two separate sources: a 24 volt dc source for the solenoid valve and a 4 to 20 milliamp dc current source for the digital valve controller.

In installations that include a solenoid valve, a redundant pneumatic path exists, i.e., the actuator pressure will always be able to exhaust to allow the valve to move to the safe position. If the solenoid valve fails, the actuator pressure will exhaust through the digital valve controller. If the digital valve controller fails, the actuator pressure will exhaust through the solenoid valve. If necessary, the solenoid valve can have larger ports to allow the safety shutdown valve to meet any response time criteria.

2-wire system installations:

- Reduce wiring cost for new installations or no additional wiring cost for existing installations
- Save an I/O card in the control room
- Require a line conditioner that adds an approximate 2 volt dc line drop (in installations that include a solenoid valve)
- Require a low power solenoid valve (if the installation includes a solenoid valve)

4-wire system installations:

- Permit the digital valve controller to continue to communicate even during emergency conditions (on demand). This allows the digital valve controller to provide valuable trending information through AMS ValveLink software. Being able to record the valve action is very important for insurance or plant environment authorities. It proves that the valve did stroke upon demand.
- Require an additional pair of wires
- Permit the use of existing solenoid valves which may be powered with 48 volts dc, 120 volts ac, etc.

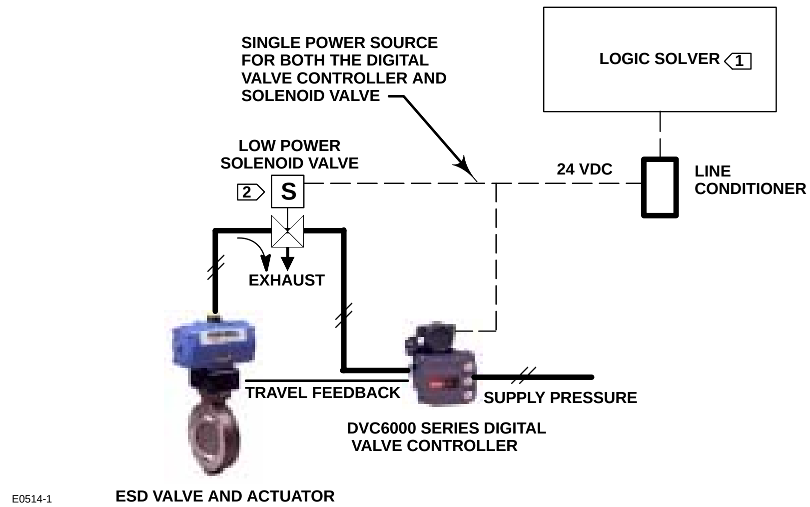
Valve and Actuator Selection

To be compliant in a Safety Integrated System, the valve assembly should be of fire-safe design and should meet the design criterion of API 607 and API 6D. Butterfly valves, such as the Fisher A31D or 8560, are designed to meet the above standards. If the requirement is for a full-bore ball valve with fire-safe design criterion, select an appropriate vender. Actuators from Bettis, El-O-Matic, Hytork, etc. could be selected for the application. These are only guidelines for selecting valves and actuators for an ESD application. For more specific details, contact your Fisher sales office.

TÜV Certification

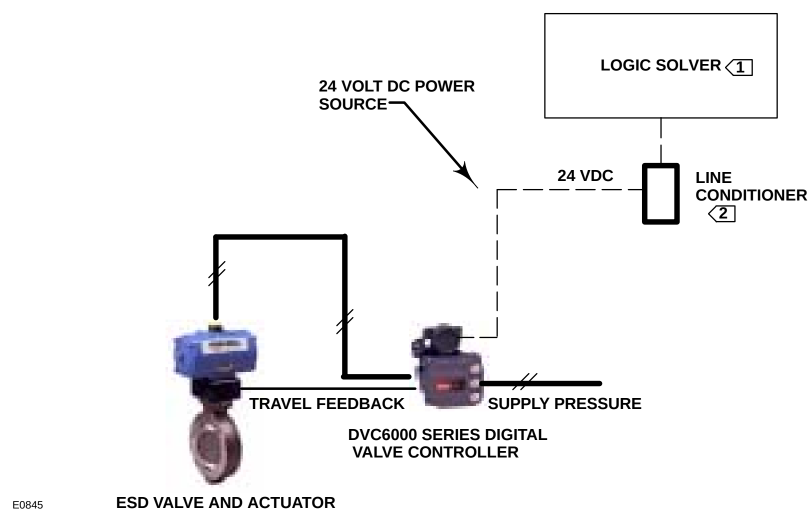
DVC6000 Series digital valve controllers can be incorporated into Safety Instrumented Functions (SIF) that are rated to Safety Integrity Level 3 (SIL3). In addition, to achieve a SIL3 Safety Instrumented System, accepted industry practices generally require redundant final control elements.

A leading safety consultant, exida.com, has participated in a failure modes, effects, and diagnostics analysis (FMEDA) of the DVC6000 Series digital valve controller when used for emergency shut down solutions. A report is available upon request from Fisher that describes the results of this analysis. TÜV, a third-party certifying authority, has reviewed the FMEDA and has certified the DVC6000 Series digital valve controller meets the requirements of IEC 61508 when operating in a safety instrumented system with a 0 to 24 volt dc or 0 to 20 mA dc control signal.



NOTE:
1 LOGIC SOLVER NOT PROVIDED BY FISHER.
2 IF SHARING 24 VOLT DC SIGNAL IS NOT PERMISSIBLE, THE SOLENOID VALVE MAY BE ELIMINATED, AS SHOWN IN FIGURE 6.

Figure 5. Emergency Shutdown Schematic with DVC6000 Series Digital Valve Controller in 2-Wire System



NOTE:
1 LOGIC SOLVER NOT PROVIDED BY FISHER.
2 LINE CONDITIONER OR 250 OHM IMPEDANCE TO PERMIT HART COMMUNICATION

Figure 6. Emergency Shutdown Schematic with DVC6000 Series Digital Valve Controller in 2-Wire System
(See figure 5 for alternate installation with solenoid valve)

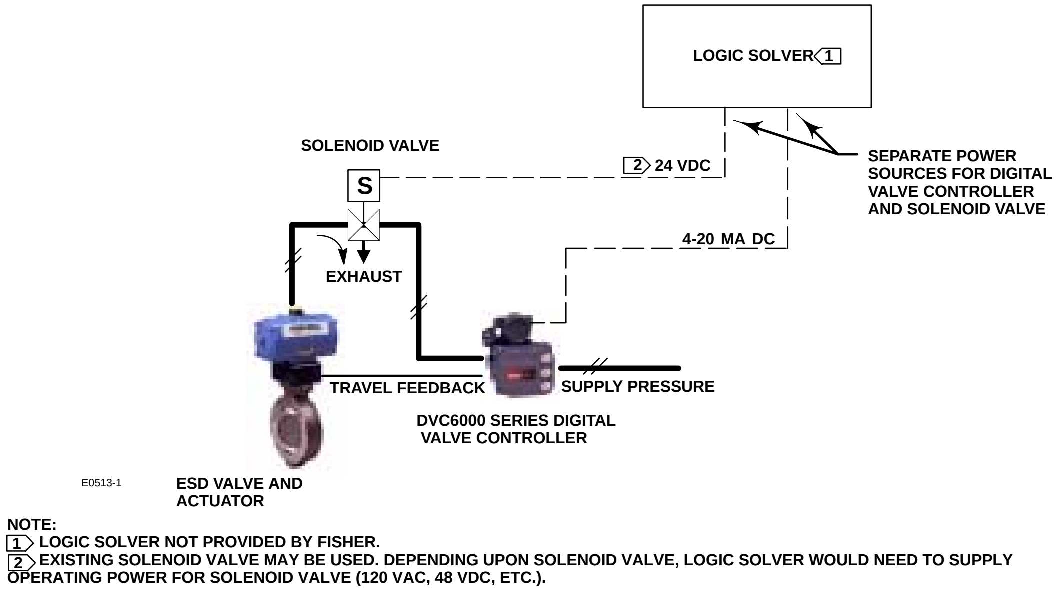


Figure 7. Emergency Shutdown Schematic with DVC6000 Series Digital Valve Controller in 4-Wire System

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Figure 8. DVC6000 Series Digital Valve Controller with Mechanical Position Indicator

Position Indicator

A mechanical position indicator, shown in figure 8, is available for Type DVC6020 digital valve controllers on limited size quarter-turn rotary valves. Normally a Type DVC6030 digital valve controller is used on quarter-turn valves, however if a position indicator is required, a Type DVC6020 must be selected. Contact your Fisher sales office for further details.

Ordering Information

Note: Fisher does not assume responsibility for the selection, use, or maintenance of any product. Responsibility for proper selection, use or maintenance of any Fisher product remains solely with the purchaser and end-user.

Refer to the Specifications section. Carefully review each specification and indicate your choice whenever a selection is to be made.

When ordering, specify:

1. Digital valve controller type number

2. Type of system [4-wire system (point-to-point) or 2-wire system (multidrop)]

3. Valve style (sliding-stem or rotary)

4. Actuator (spring and diaphragm or piston with spring return)

5. Actuator manufacturer (Fisher or other)

6. Actuator type and size

7. Valve action (air-to-open or air-to-close)

8. Valve failure action (fail open or fail closed)

9. Mechanical position indicator, if required.

Specifications, Requirements, and Functionality

DVC6000 Series Digital Valve Controller

Type DVC6010 for sliding-stem applications
Type DVC6020 for rotary and long-stroke sliding stem applications
Type DVC6030 for quarter-turn rotary applications
All units can be used in either 4-wire or 2-wire system installations
DVC6000 Series digital valve controllers for ESD solutions must have the Emergency Shutdown Application (ESD) option
Hazardous Area: Explosion proof and intrinsically safe constructions are available. Refer to bulletins 9.2:001 series and 9.2:002 for approvals
Electrical Housing: Meets NEMA 4X, CSA Type 4X, and IEC 60529 IP66
Auxiliary Terminal Contact: Electrical Rating 3V, <1 mA; It is recommended that the switch be sealed or have gold plated contacts to avoid corrosion.
For additional specifications on DVC6000 Series digital valve controllers, refer to Bulletin 62.1:DVC6000

Low Bleed Relay

The Low Bleed Relay is the standard relay for DVC6000 ESD tier, used for On/Off applications. Performance may be affected in throttling applications.

Steady State Air Consumption

At 1.4 bar (20 psig) supply pressure: Average value 0.056 normal m^3/hr (2.1 scfh)
At 5.5 bar (80 psig) supply pressure: Average value 0.184 normal m^3/hr (6.9 scfh)

Type LC340 ESD Line Conditioner, figure 10. (Required for 2-wire system installations with solenoid valve)

Input Current:(1) equal to load requirements, not to exceed 100 mA
Input Voltage:(1) load voltage + (30 ohms x load current); nominally 24 volts dc. See figure 9.
Ambient Operating Temperature: -40 to 85°C (-40 to 185°F)

Ambient Relative Humidity: 5-95%

Electrical Classification: Per IEC 61326-1 Complies with test requirements for I/O Signal/Control ports on equipment intended for use in industrial environments

Mounting: standard 35 mm DIN rail

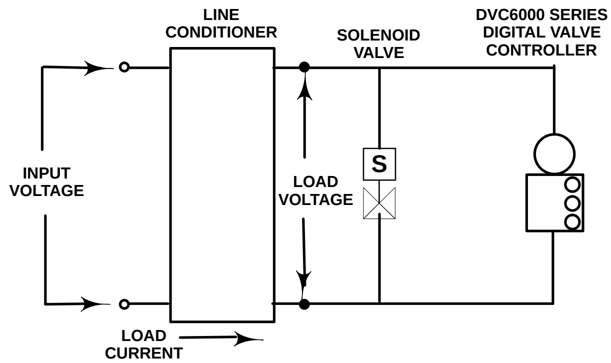
Installation Environment: Marshalling cabinet, I/O cabinet, or junction box

Dimensions: 75 mm (3 inches) long by 12.5 mm (0.5 inches) wide by 60 mm (2.4 inches) deep

Solenoid valve

ASCO Model EF8316G303, EF8316G304, or equivalent low power solenoid valve for a 2-wire system.
ASCO Model EF8316G3, EF8316G4, or equivalent solenoid valve for a 4-wire system.
Body Size: 3/8 or 1/2-inch
Orifice Size: 5/8-inch
Operating Voltage: 24 volt dc
Body Material: brass
Body and orifice selection may vary with actuator type and size, type of media, etc. Solenoid model number will change if size and body material or electrical ratings change.

1 The line conditioner requires no power to operate; its input requirements are driven entirely by its output load requirements.



INPUT VOLTAGE = LOAD VOLTAGE + LINE CONDITIONER VOLTAGE DROP

LINE CONDITIONER VOLTAGE DROP = 30 OHMS x LOAD CURRENT

CALCULATION EXAMPLE:

CALCULATING LOAD CURRENT

FOR THE SOLENOID VALVE,
ASSUME REQUIRES MINIMUM 42 mA AT 22 VOLTS DC TO PULL-IN
(FROM SOLENOID VALVE SPECIFICATIONS)

FOR THE DIGITAL VALVE CONTROLLER,
WHEN OPERATING IN MULTI-DROP, REQUIRES 8 mA
(FROM DIGITAL VALVE CONTROLLER SPECIFICATIONS)

LOAD CURRENT=42+8=50 mA

LINE CONDITIONER VOLTAGE DROP= 30 OHMS x .050 AMPS = 1.5 VOLTS

INPUT VOLTAGE = 22 VOLTS + 1.5 VOLTS = 23.5 VOLTS DC

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Figure 9. Determining Line Conditioner Input Voltage

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Figure 10. Type LC340 ESD Line Conditioner

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