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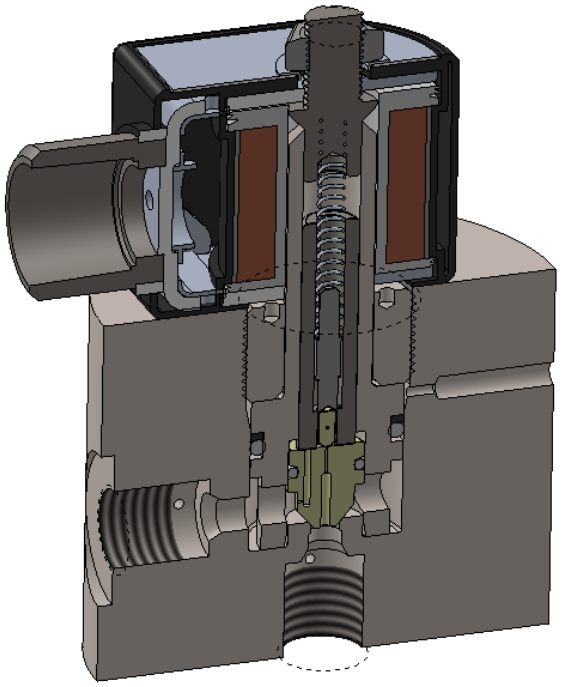
Product Manual

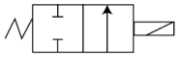
EX40, Version 2016.1
Last Updated: 11/7/16

Product Description:



The EX40 Series encompasses 2-way piloted solenoid valves with a maximum allowable inlet pressure of 15,000 psi [103.4 MPa]. The EX40 is a normally closed (fail closed) valve with a maximum allowable differential pressure ($P_{inlet} – P_{outlet}$) of 15,000 psi. The minimum required differential pressure is 100 psi, but the valve is designed for optimal sealing at pressures greater than 10,000 psi. The valve is designed for both liquids and gases that are compatible with the construction materials.

When the normally closed valve



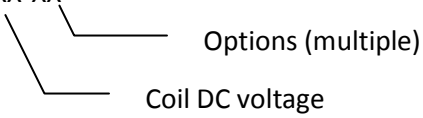
is energized, flow occurs from the inlet to outlet. When de-energized, flow stops. The valve will only stop a fluid in the direction of inlet to outlet. It does not stop fluid from moving in the reverse direction, i.e. P_{inlet} must be greater than or equal to P_{oulet} at all times to prevent back flow.

A normally open valve is currently not available.

Do not use this valve with dirty fluids or solutions that will leave a large amount of deposits.

Configurations:

Part number breakdown: EX40-03-XXXX-XX



Coils:

D012 – 12V DC, 22 watt
D024 – 24V DC, 22 watt
D120 - 120V DC, 22 watt

The standard coils offered are UL listed and CSA certified. Hazardous location approvals are Class I, Division 1 & 2, Groups A, B, C, and D, and Class II, Division 1 & 2, Group E. The NEMA rating is 7 & 9, which allows continuous immersion. Coil wire length is 18", but longer lengths are available at an additional charge and lead time.

The standard coil connection is 1/2" NPT.

Options:

DN – DIN connection on coil

The DIN connection is per DIN 43650A/ISO 4400. Otherwise, the standard coil connection is 1/2" NPT.

GS – General Service

Coil used has NEMA Type 1, 2, 3, 4, 4x protection only. It is not certified as explosion proof.

HY – Class 5 Sealing for hydrogen service

Seat leakage is tested at the factory using helium. The valve must pass Class 5 sealing per FCI 91-2-2001.

OX – Cleaned for oxygen service

The valve undergoes extensive cleaning per internal procedure OP-0475 to remove all oil, microscopic sediment, and particulates from all valve components. Components are black light inspected for trace residue.

VT – Fluorocarbon (Viton) O-Rings

The standard piston and bonnet tube o-ring is Buna-N, and has a suggested temperature range of -35 to 250° F. Selecting the fluorocarbon o-ring option may offer better resistance to certain fluids and gases. We currently do not recommend using the EX40 for fluids beyond 250° F.

T5 – Class 5 Sealing

Leakage tested to Class 5 per FCI 91-2-2001 using air.

Connections:

The standard connection on the EX40 is the Medium Pressure Fitting (MPF) for 3/8" outer diameter tubing. This is a metal to metal cone type connection with a 9/16-18 thread.

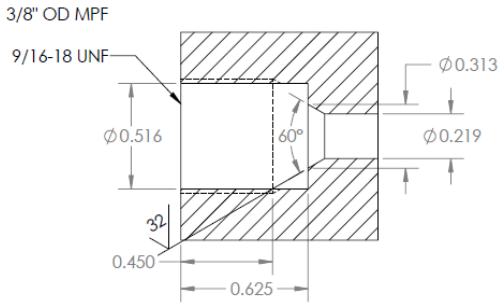


Figure 1 – 3/8" OD Tubing Medium Pressure female connection

Other non-standard valve body connections such as the Medium Pressure Fitting for ¼" OD tubing may be available and in stock. Consult Clark Cooper Sales for lead times.

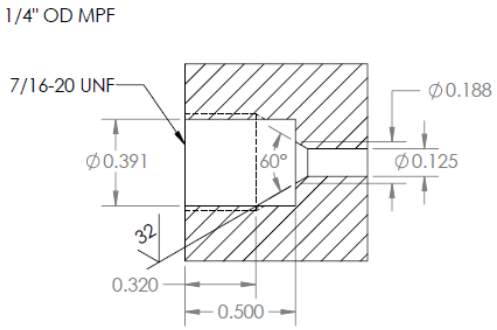


Figure 2 – ¼" OD Tubing Medium Pressure female connection

Pressures:

Orifice:	3/16"
Maximum Differential & Inlet Pressure (psi)	15,000

A minimum pressure differential of 100 psi is required on the EX40 Series to move the valve piston to open and close the valve fully.

The EX40 Series will not burst at pressures approaching four times the maximum allowable inlet pressure at room temperature. However, the inlet pressure should NEVER be allowed to exceed 15,000 psi. Exceeding the pressure limit will shorten the life of the piston and pilot pin.

Open/Close times will depend upon the differential pressure and fluid. The response time is generally around 0.3 seconds to be considered fully open. The pilot is open in less than 0.1 seconds.

Standard Materials:

Valve Body – 316 Stainless Steel
Bonnet Tube – 316 and 430 Stainless Steel
Piston - Polyether ether ketone (PEEK)
Other wetted components – 302, 303, and 430 stainless, PTFE
Various spring materials available, but standard is 302 SS
Seals – Buna-N is standard. Viton is optional.

Flow Rate:

The flow rate of a fluid through a valve is a function of the inlet and outlet conditions, liquid or gas properties, and properties of the specific valve. Pressure, temperature, and piping geometry are inlet and outlet conditions. Pertinent liquid properties are composition, density, vapor pressure, viscosity, surface tension, and thermodynamic critical pressure. Pertinent gas properties are composition, density, and ratio of specific heats. Valve characteristics such as flow path, valve travel, and of course size influence flow rate. ANSI/ISA-75.01-1985 (R1995) provides equations to approximate flow.

Through a standard test procedure, a Valve Flow Coefficient "C_v" can be assigned to a particular valve. This coefficient can then be used to approximate flow rates with reasonable accuracy for different fluids and gases at any inlet and outlet conditions. C_v is essentially the number of gallons of water that will flow through a particular valve in 1 minute at exactly 1.0 psi of differential pressure between the inlet and outlet.

	Orifice (in)	Approximate C_v
EX40-03	0.188	0.5

The flow rate through an EX40 valve can be **approximated** as follows:

P1 = Inlet Pressure (psi)
P2 = Outlet Pressure (psi)
C_v = Valve flow coefficient (no units)
SG = Specific Gravity (no units) at standard conditions

For a gas:

Calculate $P_{Critical}$ = 0.53*P1
For a constant P1, flow will increase as P2 decreases until reaching $P_{Critical}$. As P2 falls below $P_{Critical}$, no further increase of flow rate occurs.

If P2 > $P_{Critical}$:

$$Q_m = C_v * \sqrt{\frac{P*(P1-P2)}{SG}} * \sqrt{\frac{520}{T}}$$ SCFM (14.7 psi and 60°F)

If P2 < $P_{Critical}$:

$$Q_m = C_v * \frac{P1}{\sqrt{2*SG}} * \sqrt{\frac{520}{T}}$$ SCFM

For liquid:

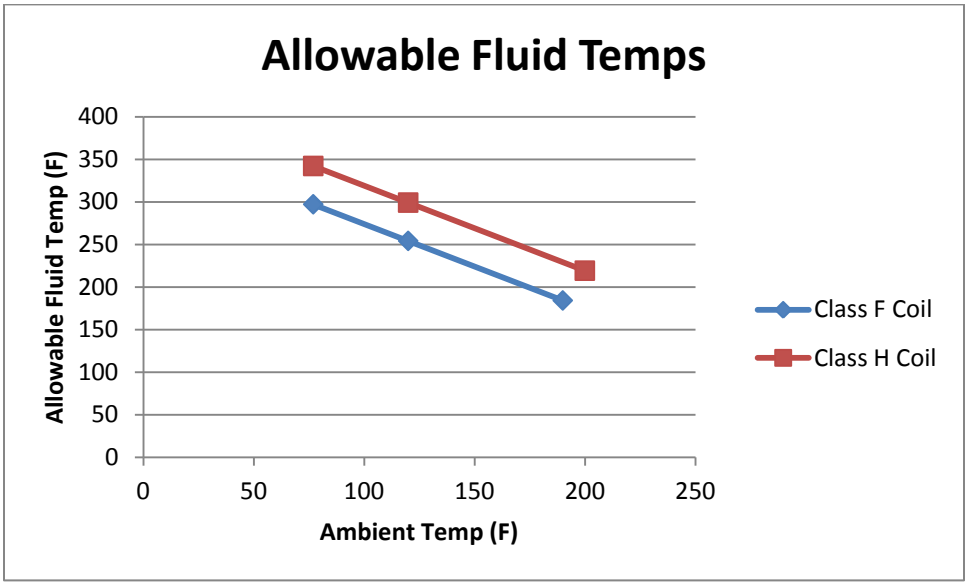
$$Q = C_v * \sqrt{\frac{P1-P2}{SG}}$$ gal/min

Operating Temperatures:

Solenoids will get very hot from normal usage (>200°F). The high temperature limit of the coil is based upon the coil wire insulation or an internal fuse. If the temperature limit is exceeded, permanent and self-perpetuating damage will occur to the insulation, or the fuse may trip.

As solenoid coil wire temperature rises, electrical resistance goes up and less current flows. Since pull force of a solenoid is directly proportional to amperage, a solenoid operating at its upper temperature limit may produce less pull force.

The wiring inside the 22 watt coils used on the EX40 is temperature Class H, which means it can handle up to 356° F. The charts below give guidelines for allowable fluid temperature for a given ambient temperature assuming that the coil is being **held in the energized state**. The EX40 should not be used with fluids beyond 250° F.



There are other factors that determine maximum allowable fluid temperature. It is suggested that if a fluid temperature is going to be near the high limit, the application should be thoroughly tested to ensure a robust design.

Installation:

The EX40 must be mounted in the vertical orientation with the coil on top. This is because gravity is used to reset an internal component upon closing. If this orientation is not used, the maximum allowable differential pressure for which the valve will open against drops to around 11,000 psi (with coil still cold).

Pipelines or tubing needs to be adequately supported to prevent strains on the valve body connections.

The Medium Pressure Connection is a metal to metal cone type design that is becoming a standard for both liquids and gases at elevated pressures and temperatures. Do not use PTFE tape or sealant on this connection. Make sure the cone faces and threads are clean before assembling. Consult the connector manufacturer for application torque.

Make sure that connecting pipes or tubes are clean and free of particulates.

Install a filter upstream and close to the solenoid valve (see details in Filter section).

No lubrication is required. Do NOT add grease to internal components or connections of the EX40 valve.

Filters:

Foreign matter such as particulates, rust flakes, PTFE tape, pipe dope, etc., can jam moving parts within a solenoid valve, clog the small orifices, or damage softer sealing surfaces. The result can be a failure to open, close, and/or seal. A filter with 200 mesh (0.0029" gaps) or finer is recommended for the EX40 Series.

The filter should be placed upstream (inlet side) and as close to the valve as possible. Be sure to select a model that is safe for the inlet pressure. Size the filter so that the pressure drop across it is acceptable for the flow rate.

Sealing:

Six different valve seat leakage classifications are defined by ANSI/FCI 91-2-2004. All valves must pass the Class 2 leakage test prior to the leaving the factory by default unless the customer

specifies otherwise. If the customer does not specify, the valve is only guaranteed to pass Class 2.

Class 2 (Allowable Leakage/Min)		
Size	Water (cc)	Air (cc)
0.019	0.01	0.38
0.032	0.01	0.64
0.250	0.10	5.00
0.500	0.20	10.00
0.750	0.30	15.00
1.000	0.40	20.00
1.500	0.60	30.00
2.000	0.80	40.00
2.500	1.00	50.00
3.000	1.20	60.00
4.000	1.60	80.00
6.000	2.40	120.00

Class 4 (Allowable Leakage/Min)		
Size	Water (cc)	Air (cc)
0.019	0.10	0.04
0.032	0.10	0.06
0.250	0.10	0.50
0.500	0.10	1.00
0.750	0.10	1.50
1.000	0.10	2.00
1.500	0.10	3.00
2.000	0.10	4.00
2.500	0.10	5.00
3.000	0.10	6.00
4.000	0.10	8.00
6.000	0.10	12.00

Class 5 (Allowable Leakage/Min)		
Size	Water (cc)	Air (cc)
0.019	.1 / 10 Min	0.00
0.032	.1 / 10 Min	0.01
0.250	.1 / 10 Min	0.05
0.500	.1 / 10 Min	0.10
0.750	.1 / 10 Min	0.15
1.000	.1 / 10 Min	0.20
1.500	.1 / 10 Min	0.30
2.000	.1 / 10 Min	0.40
2.500	.1 / 10 Min	0.50
3.000	.1 / 10 Min	0.60
4.000	.1 / 10 Min	0.80
6.000	.1 / 10 Min	1.20

Electrical:

Electrical wiring must conform to the nameplate rating. Wiring, conduit, and conduit connections must comply with National and Local Electrical Codes. The standard solenoid enclosure has a ½" NPT conduit connection. Lead wires supplied are 18" long and are wire gauge size 18 AWG minimum. The wire used to connect to the power source should be the same or heavier gauge.

Unless noted otherwise, all solenoids are designed to operate at ±10% of the nominal voltage. Check the valve nameplate for specific voltage and amperage requirements.

Fuses or circuit breakers are recommended and should be sized according to holding amperage of the solenoid.

If the coil is oriented in an inconvenient direction, it may be re-oriented as described in the SAFETY section of this manual.

Standard AC and DC coil wiring:

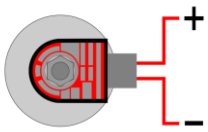


Figure 1. DC coil wiring.

Figure 1 above shows the wiring for the DC coils on the EX40 series valves. For DC coils, one lead wire should be connected to the positive terminal and the other lead wire should connect to the negative terminal. These coils do not have a ground wire. The coil has no polarity so either lead wire from the coil can be the positive lead as both solenoid and valve performance will not be affected.

Optional DC Wiring With Flyback Diode:

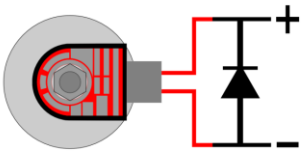


Figure 2. DC coil wiring with flyback diode.

In some systems, it may be useful to install a flyback diode to protect the circuit. The flyback diode prevents sparking between the contacts of the switch that controls power to the DC coil. When the circuit is closed, current flows through the coil and a magnetic field builds inside of the coil winding. Current does not flow through the diode as long as the breakdown voltage of the diode is higher than the voltage across the coil. When the switch is opened, the magnetic field inside of the coil starts to dissipate and in doing so generates current in the coil and can create a very large negative voltage spike. Because of the large potential, sparks can jump between the contacts of the switch if there is no flyback diode. With the flyback diode, there is still a closed circuit for the current to flow through even though the switch is open. The current will flow through the loop between the diode and the coil until all of the energy is lost and will not spark across the switch.

The UF4001-UF4007 series of diodes may be used as flyback diodes for circuit protection from DC coils. These diodes will handle the low current that is created by the magnetic field after the coil is turned off. Because they are fast acting, the decay time of the flyback current will be relatively shorter compared to other diodes. The table below shows what specific diode should be used for certain coil voltages.

The table of diodes is a suggestion ONLY. The entire circuit should be designed and analyzed by a licensed Professional Electrician or an Electrical Engineer. The Clark Cooper Division of Magnatrol Valve Corporation is not responsible for electrical system damage due to faulty wiring or inadequate protections.

Coil Voltage	Flyback Diode
12V DC	UF4001
24V DC	UF4001
120V DC	UF4004

DIN Connector Option Pin-out

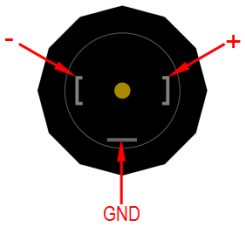
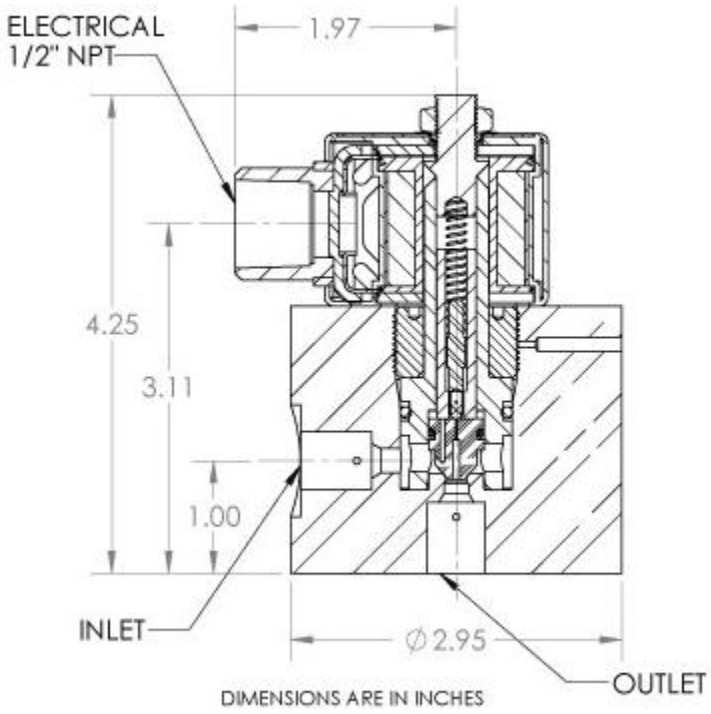


Figure 3. DIN Type A male pinout.

Coils can come with an optional Type A male DIN Connector. The pinout can be seen above. The coil has no polarity so the positive and negative terminals on the DIN connector are interchangeable. The ground pin is not used in these coils.

Do NOT twist the DIN connector.

Schematic:



Safety:

Depressurize a system before trying to remove the valve.

Do not pressurize the valve without the coil installed. While the valve is designed to not burst at pressures approaching four times the rated maximum inlet pressure, the coil actually provides a portion of that inherent strength.

If the wires from the coil need to be directed a certain way, loosen the nut on top of the coil before trying to position. Do not grab any portion of the bonnet tube with a wrench or pliers. Doing so can damage the tube, loosen the retainer causing leakage, or damage an o-ring. The surface temperature of some coils may be >200 degrees Fahrenheit (!) when held in the energized state. Use caution when handling a coil that has just been in use.

Troubleshooting:

1. NEVER attempt to disassemble a valve that is under pressure. This may result is a serious injury or death(!).

2. The valve must be mounted in a horizontal pipe run with the solenoid vertical and on top. Other orientations will prevent proper operation.

3. The valve must be mounted in the correct 'flow direction' indicated by the arrow on the side of the valve body. The valve should be mounted with the high-pressure side piping at the back of the arrow (inlet) and the low-pressure side piping at the front of the arrow (outlet).

4. This valve will not act as a check valve. It only blocks flow in the direction of inlet to outlet.

5. Foreign matter such as particulates, PTFE tape, pipe dope, etc., can jam moving parts within the valve or clog very small orifices. The result can be a failure to open and/or close completely. See the section on filters in this manual.

6. The operating pressure must not exceed the pressure rating on the valve nameplate.

7. Verify that the power supplied to the solenoid matches the specification that is displayed on the valve nameplate.

8. Check the coil leads for continuity. If there is no continuity or no resistance at all, you will need to replace the coil. Replacing the coil may temporarily cure the symptom but not the actual cause.

9. This valve is designed and tested for use with gases, water, and fluids with viscosity similar to water. Viscous fluids may slow or inhibit operation.

Solenoid Replacement:

1. Disconnect the solenoid from the power supply.
2. Remove the top solenoid nut and washer.
3. Remove the solenoid and replace with new one.
4. Replace washer and nut loosely.
5. Position the conduit connection as necessary and tighten the nut just until the wave washer is flat.
6. Reconnect the power supply.

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