Fluid Control System

E-7.4




ROTEX

Engineering For The Future

INTRODUCTION : SOLENOID VALVE

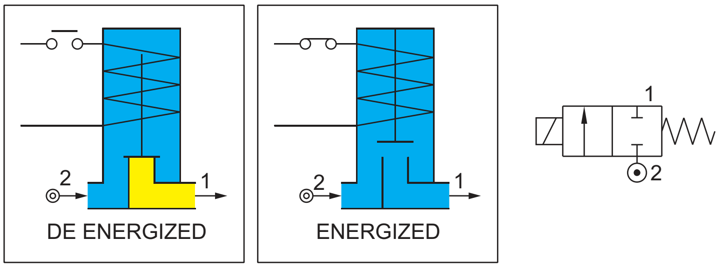
Solenoid valve is an electro-mechanical device used for Fluid Control application.
Using the Electro magnetic force (generated due to the passage of Electric current in the coil), it converts the Electrical energy into a mechanical movement of the Plunger and closing, opening of the valve seat (part of the plunger). The resulting action starts or stops the flow.
The solenoid valve in most cases is either ON or OFF, there by creating two states or positions as more commonly referred to. As is evident from the construction, pressure plays an important part in the valve operation.
All ROTEX solenoid valves are of pack less construction and have zero leak characteristics due to the soft elastomer sealing.
Based on their operating principle, the valves are classified as direct acting and internal/ external pilot operated Valve.

DIRECT ACTING

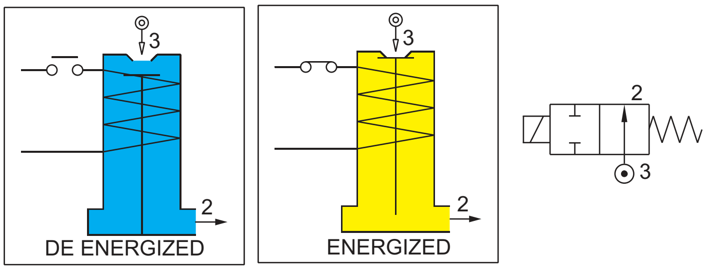
These are the most basic variation in the ROTEX Solenoid Valve program.
Since the solenoid is directly responsible for the operation of these Valves, they are called Direct acting. Refer the diagram.
In the de-energized condition Plunger seat is resting on the Orifice. There by blocking the flow.
On energization, the current flowing generates a magnetic field that couples with the Core and the plunger. This creates sufficient force to overcome all resistance and lifts the plunger. This action opens the blocked orifice and thus allows the flow to start. On switching OFF the current to the Solenoid, the current level drops below the holding level. Spring pulls down the plunger and plunger seat blocks the orifice, blocking the flow. Direct acting solenoid Valves are available in two basic varieties, 2 port valve and 3 port Valve. Based on the Flow connection in the de-energized and energized condition of the Solenoid, these are further classified as Normally Closed, Normally Open or Universal.

2 PORT VALVE

Solenoid valves with 2 ports
Ports: Inlet and outlet.
Normally Closed:
Port 2 (Inlet) and port 1 (outlet) are disconnected in the de-energized condition. On energization, the ports are connected.



Normally Open:
Port 3 (Inlet) and Port 2 (Outlet) are connected in the de-energized condition. On energization, the ports are disconnected.



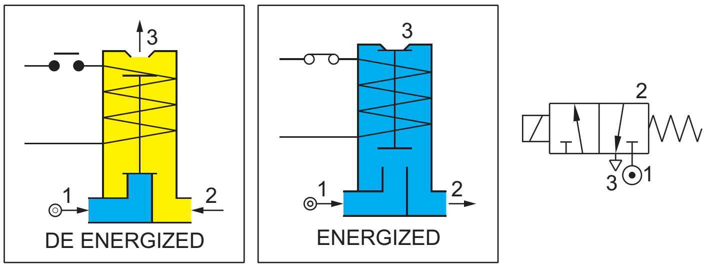
All ROTEX 2 Port Valves are positively sealed with the operating pressure. This ensures that the Valves are tight shut even against pressure surges.
In general the 2 port Valves are uni-directional, thus holding pressure in the flow direction only.
However ROTEX also has a range of bi-directional shut off Valve for special application.

INTRODUCTION : SOLENOID VALVE

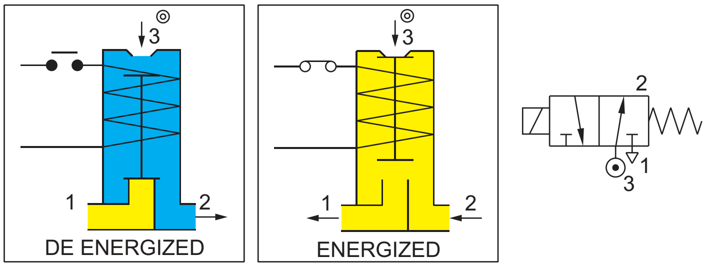
3 PORT VALVE

Solenoid valve with 3 ports, are configured depending on the operation.

Normally Closed:
This configuration is most commonly used for the operation of single acting/ spring return device. In de-energized condition, port 1 (inlet) is disconnected from port 2 (outlet connected to apparatus) port-2 is connected to port 3 (exhaust/ vent). On energizing the solenoid the plunger lifts and closes the port 3. Port 1 is connected to port 2.



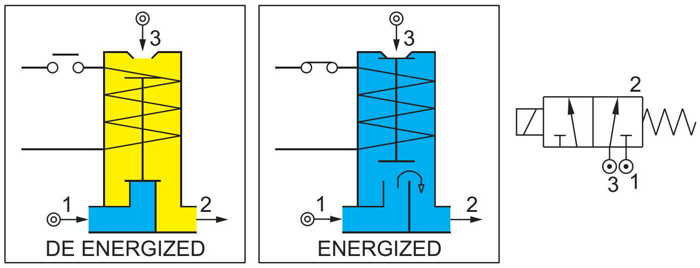
Normally Open:
In the de-energized condition the port 3 (inlet) is connected to port 2 (outlet, connected to apparatus). Port 1 (vent) is blocked by the plunger. On energization, plunger blocks the Port 3. The port 2 is connected to port 1.



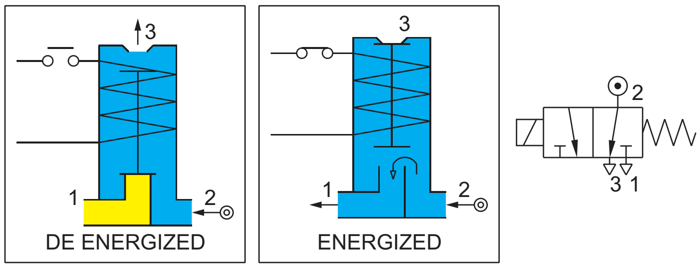
Both these versions use different plunger and consequently can not be reconfigured by merely changing the port connections.

Universal :
This version is basically derived from the above two as a combination, allowing user to connect the valve in various configurations like:
Normally closed, **Normally open**, as described above can also be used for mixing, diverting of the fluid.

Mixing: Inlet at Port 1 and Port 3 are alternately connected to port 2 when The solenoid is energized/ de-energized.



Diverting: Inlet at Port 2 is alternately connected to Port 1 or Port 3 depending on the energization/ de-energization of the solenoid.



This Valve can also be used as 2 Port bidirectional Normally Closed by plugging port 3 and as 2 Port bidirectional Normally Open by plugging port 1.
The universal Valve uses a special plunger and can not be directly converted at user end from a pre ordered Normally Closed / Open Valve to Universal without affecting the operating pressure rating and change of plunger assembly
Variations to the above Valve construction are family of ROTEX Valves using pressure balanced plunger technology. This greatly negates the effect of pressure in the Valve operation. This allows for better pressure holding and flow characteristics in the Direct acting range of solenoid Valve.

Specifications are subject to change without notice

INTRODUCTION : SOLENOID VALVE

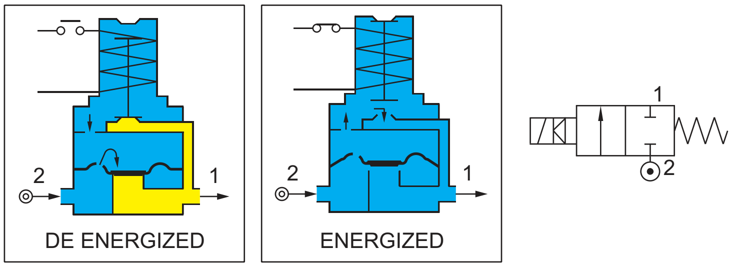
PILOT OPERATED

For application where sufficient media pressure is not available or requires a combination of high flow capacity and pressure rating, the media pressure / external pilot pressure is used to operate the Valve. This group of valves uses a differential area principle (for both Poppet and Diaphragm construction), utilizing the media pressure or external pressure to operate the main valve.
All of ROTEX Pilot operated Solenoid Valves are pressure assisted positively sealed, there by sealing the Valve against pressure surges. Integral Direct acting solenoid Valve acts as a Pilot valve controlling the application of the media pressure/ release of the media pressure from the operating area of the main valve and hence the name Pilot operated solenoid Valve.
Internal Pilot operated solenoid Valve uses the media pressure itself to operate the Valve.
External Pilot operated solenoid Valve uses an external pressure source for Valve operation. The applications where media pressure is insufficient or media is unsuitable for the pilot solenoid Valve operation.

Based on the number of ports, the Valves are classified as:

2 PORT NORMALLY CLOSED DIAPHRAGM VALVE

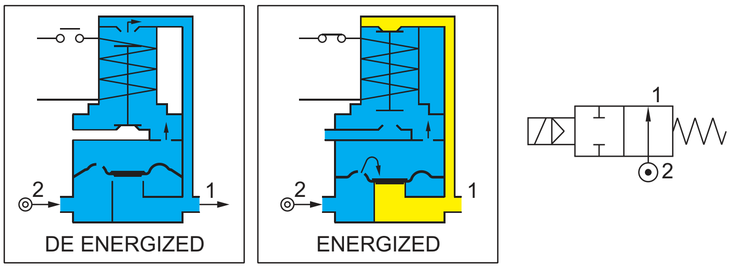
In de-energized state, the media pressure connected to Port 2 (inlet) acts under the diaphragm and through the Bleed orifice, acts on top of the diaphragm. Since the diaphragm area is larger above, It maintains the valve closed disconnecting port 1 (outlet) from supply inlet media pressure. Same pressure also acts in the pilot solenoid over the main Pilot orifice.
On energizing the solenoid, the pressure above of diaphragm is released through the Pilot orifice (which is larger than the bleed orifice), thus lifting the diaphragm with the help of the media pressure under the diaphragm.



The Pilot chamber pressure is released into the downstream of the valve near the outlet port. With the solenoid de-energized, the Pilot orifice is blocked by the plunger. The media pressure now builds up on top of the diaphragm. With the help of inherent material stiffness, the diaphragm returns to the de-energized state, ensuring tight shut off.

2 PORT NORMALLY OPEN DIAPHRAGM VALVE

In the de-energized state, the media pressure connected to Port 2(inlet) lifts the diaphragm as the pilot orifice is open to the downstream, there by not allowing required pressure build up above the diaphragm, thus maintaining flow to Port 1(outlet).
On energizing the solenoid, plunger blocks the pilot orifice there by allowing build up of pressure above the diaphragm, which is then closed by the inherent material stiffness of the diaphragm, stopping the flow.
On de-energizing the solenoid, the pilot orifice opens and vents the pressure from the pilot chamber to the downstream, there by lifting the diaphragm with the media pressure below.



INTRODUCTION : SOLENOID VALVE

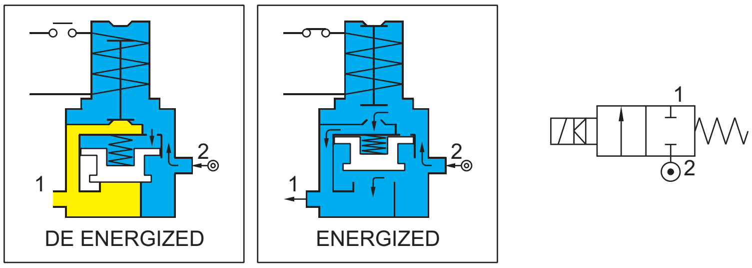
2 PORT NORMALLY CLOSED POPPET VALVE

In de-energized state, the media pressure connected to Port 2 (inlet) acts under the Poppet and through the Bleed orifice in the piston, acts on top of the Poppet. Since the above Poppet area (piston seal area) is larger then the seat area, it maintains the valve closed disconnecting port 1 (outlet) from supply. Same pressure also acts in the pilot solenoid over the main Pilot orifice.

On energizing the solenoid, the pressure from the top of Poppet is released through the Pilot orifice (which is larger than the bleed orifice), thus lifting the Poppet with the help of the media pressure below. The Pilot chamber pressure is released into the downstream of the valve near the outlet port. Port 2 is connected to Port 1.

With the solenoid de-energized, the Pilot orifice is blocked by the plunger. The media pressure now builds up on top of the Poppet. With the help of the main Valve spring, the Poppet returns to the de-energized state, ensuring tight shut off.

It is important to note that, if the differential pressure across the Valve falls below the minimum required level, the Valve will start to close / completely close even if the solenoid is energized continuously. For certain applications, ROTEX offers a special execution to overcome such conditions. Please contact ROTEX local office for more details.



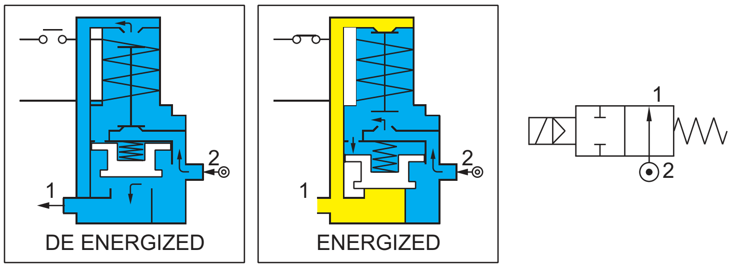
2 PORT NORMALLY OPEN POPPET VALVE

In the de-energized state, the media pressure connected to Port 2(inlet) lifts the Poppet as the pilot orifice is open to the downstream, there by not allowing required pressure build up above the poppet. This maintains the flow to Port 1(outlet).

On energizing the solenoid, plunger blocks the pilot orifice there by allowing build up of pressure above the Poppet, which is then closed by the main Valve spring above the Poppet. This stops the flow.

On de-energizing the solenoid,the pilot orifice opens and vents the pressure from the pilot chamber to the downstream, thereby lifting the Poppet with the media pressure below. Similar to Normally Closed version, when differential pressure dropsbelow the minimum required, the valve will get closed in the de-energized state even though the solenoid is OFF. For certainapplications,ROTEX offers a special execution to overcome such conditions.

Please contact ROTEX local office for more details.

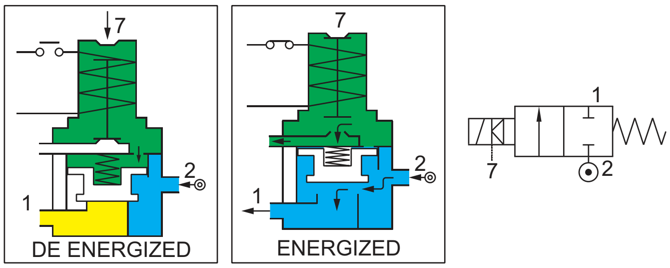


2 PORT EXTERNAL PILOT OPERATED POPPET VALVE

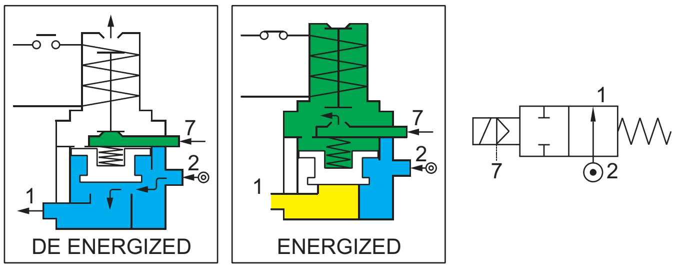
In case of application where media pressure is below the minimum required or when the media is aggressive, external pilot Valve is used. External pressure media is connected to Port 7, which directly acts on the Poppet keeping it closed. On energizing the solenoid, the Pilot orifice is blocked, blocking the external pressure to the Pilot chamber. The media pressure under the Poppet helps to open the valve. For application where media pressure is below the required operating pressure, an extra assistance is provided in the form of a spring to push the Poppet up.

The external pressure has to be minimum 3 bar or greater than the media pressure, which ever is higher.

2 Port External Pilot operated Normally Closed Valve, Pilot air failure to open



2 Port External Pilot operated Normally Open Valve

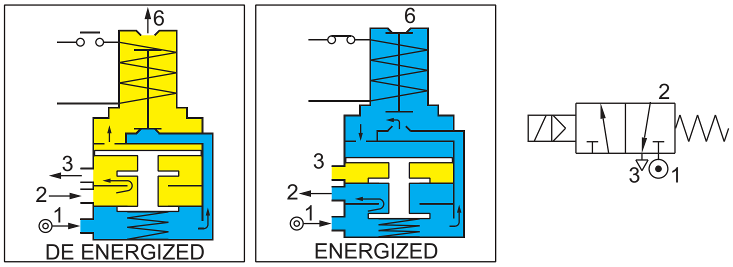


INTRODUCTION : SOLENOID VALVE

3 PORT POPPET TYPE INTERNAL PILOT OPERATED NC SOLENOID VALVE

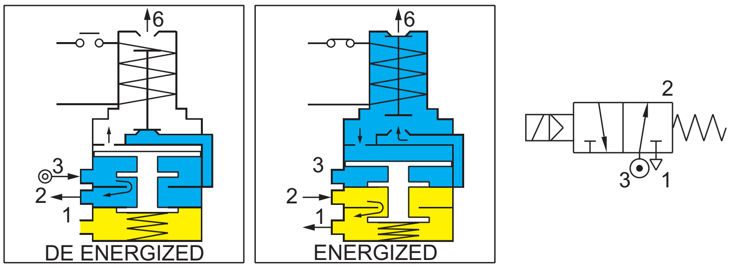
Inlet Pressure is connected to Port 1 (inlet) and blocked by the bottom valve seat assisted with spring. Port 2 (outlet) and Port 3 (vent) are connected. A pilot line is drawn from the inlet chamber to the Pilot solenoid valve and is blocked at the Pilot orifice by the Plunger.
On energizing the solenoid, the Pilot pressure is directed to the Pilot chamber, there by applying the pressure to the top of the Poppet.

The Piston seal area being larger than the Seat area at the bottom, the resultant force moves the Poppet assembly down. Port 3 is blocked as a result and Port 1 and 2 are connected.
On de-energizing the solenoid, Plunger blocks the Pilot orifice and opens the Pilot chamber to the Pilot vent. Release of pressure, forces the Poppet assembly up with the pressure acting at Port 3 and the spring together, eventually blocking Port 1 and connecting Port 2 to Port 3.



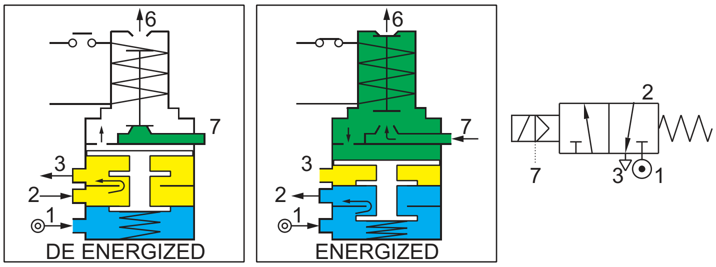
3 PORT POPPET TYPE INTERNAL PILOT OPERATED NO SOLENOID VALVE

Inlet Pressure is connected to Port 3 (inlet). Port 2 (outlet) and Port 3 are connected. A pilot line is drawn from the inlet chamber to the Pilot solenoid Valve and is blocked at the Pilot orifice by the Plunger. Port 1 is blocked at the bottom Valve seat by media pressure and assisted with Valve spring.
On energizing the solenoid, the Pilot pressure is directed to the Pilot chamber, there by applying the pressure to the top of the Poppet.
The Piston seal area being larger than the Seat area at the bottom, the resultant force moves the Poppet assembly down. Port 3 is blocked as a result and Port 1 and 2 are connected.
On de-energizing the solenoid, Plunger blocks the Pilot orifice and opens the Pilot chamber to the Pilot vent. Release of pressure, forces the Poppet assembly up with the pressure acting at Port 3 and the spring together, eventually blocking
Port 1 and connecting Port 2 to Port 3.



3 PORT POPPET TYPE EXTERNAL PILOT OPERATED SOLENOID VALVE

Inlet Pressure is connected to Port 1 (inlet) and blocked by the bottom valve seat assisted with spring. Port 2 (outlet) and Port 3 (vent) are connected. A pilot pressure line (min. 3 bar greater or equal to main line pressure) is connected to Port 7 (Pilot port) of Pilot solenoid Valve and is blocked at the Pilot orifice by the Plunger.
On energizing the solenoid, the Pilot pressure is directed to the Pilot chamber, there by applying the pressure to the top of the Poppet. The Piston seal area being larger than the Seat area at the bottom, the resultant force moves the Poppet assembly down. Port 3 is blocked as a result and Port 1 and 2 are connected.
On de-energizing the solenoid, Plunger blocks the Pilot orifice and opens the Pilot chamber to the Pilot vent. Release of pressure, forces the Poppet assembly up with the pressures acting at Port 3 and the spring together, eventually blocking Port 1 and connecting Port 2 to Port 3.
With this version, the Valve can be configured to work in either Normally Closed or Normally Open, Mixing or Diverting mode thus making it a Universal valve.



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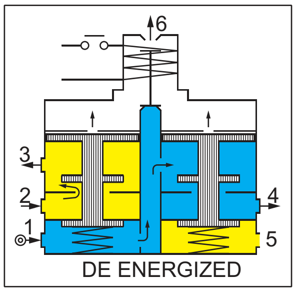
INTRODUCTION : SOLENOID VALVE

5 PORT POPPET TYPE SINGLE SOLENOID VALVE

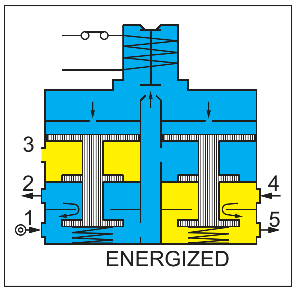
Inlet Pressure is connected to Port 1 (inlet). Through an internal passage the inlet is connected to the Port 4 (which acts as a Normally open port). Inlet is blocked at the bottom valve seat assisted with spring. Port 2 (Normally closed outlet) and Port 3 (vent) are connected. A pilot line is drawn from the inlet chamber to the Pilot solenoid valve and is blocked at the Pilot orifice by the Plunger. On energizing the solenoid, the Pilot pressure is directed to the Pilot chamber, there by applying the pressure to the top of both the Poppets. The Piston seal area being larger than the Seat area at the bottom, the resultant force moves the Poppet assemblies down.

Port 3 is blocked as a result and Port 1 and 2 are connected the same time Port 4 and Port 5 are connected.

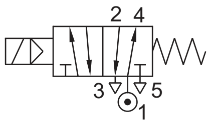
On de-energizing the solenoid, Plunger blocks the Pilot orifice and opens the Pilot chamber to the Pilot vent. Release of pressure, forces the Poppet assemblies up with the pressure and the spring together, eventually blocking Port 1 and connecting Port 2 to Port 3 and connecting Port 1 with Port 4 and blocking Port 5.



DE ENERGIZED



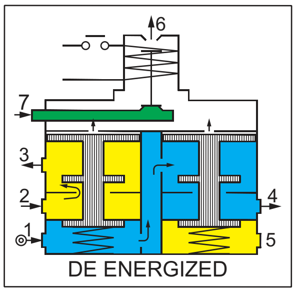
ENERGIZED



5 PORT POPET TYPE EXTERNAL PILOT OPERATED SINGLE SOLENOID VALVE

Inlet Pressure is connected to Port 1 (inlet). Through an internal passage the inlet is connected to the Port 4 (which acts as a Normally open port). Inlet is blocked at the bottom valve seat assisted with spring. Port 2 (Normally closed outlet) and Port 3 (vent) are connected. A pilot pressure line (min. 3 bar or equal or greater than main line pressure) is connected to Port 7 (Pilot port) of Pilot solenoid Valve and is blocked at the Pilot orifice by the Plunger. On energizing the solenoid, the Pilot pressure is directed to the Pilot chamber, there by applying the pressure to the top of both the Poppets.

The Piston seal area being larger than the Seat area at the bottom, the resultant force moves the Poppet assemblies down. Port 4 is blocked as a result and Port 1 and 2 are connected and at the same time Port 4 and Port 5 are connected. On de-energizing the solenoid, Plunger blocks the Pilot orifice and opens the Pilot chamber to the Pilot vent. Release of pressure, forces the Poppet assemblies up with the pressure and the spring together, eventually blocking Port 1 and connecting Port 2 to Port 3 and connect Port 1 with Port 4 and blocking Port 5.



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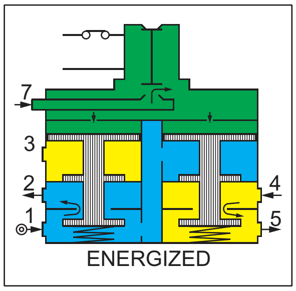
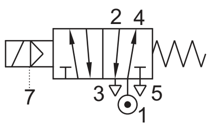


ENERGIZED

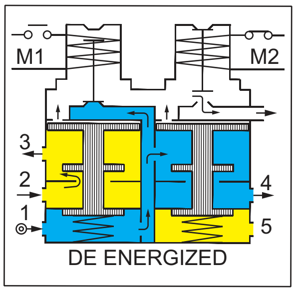


5 PORT POPPET TYPE DOUBLE SOLENOID VALVE

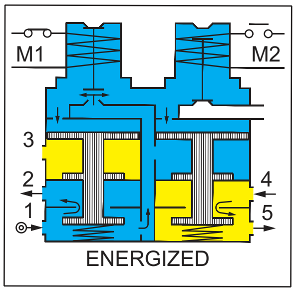
Inlet Pressure is connected to Port 1 (inlet). Through an internal passage the inlet is connected to the Port 4 (which acts as a Normally open port). Inlet is blocked at the bottom Valve seat assisted with spring. Port 2 (Normally closed outlet) and Port 3 (vent) are connected. A pilot line is drawn from the inlet chamber to the Pilot solenoid valve and is blocked at the Pilot orifice by the Plunger.

On energizing the Latch solenoid(M1), the Pilot pressure is directed to the Pilot chamber, there by applying the pressure to the top of both the Poppets. The Piston seal area being larger than the Seat area at the bottom, the resultant force moves the Poppet assemblies down. Port 3 is blocked as a result and Port 1 and 2 are connected and at the same time Port 4 and Port 5 are connected. After energization of the Valve, the bleed orifice connected to the Port 2 latches the Poppets. This allows the Latching solenoid to be switched off (impulse operation).

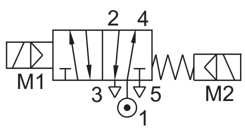
On energizing the De-latching solenoid(M2), Plunger opens the Vent orifice and releases the Pilot pressure from the Pilot chamber to Pilot vent port 6. Release of pressure, forces the Poppet assemblies up with the pressure and the spring together, eventually blocking Port 1 and connecting Port 2 to Port 3 and connecting Port 1 with Port 4 and blocking Port 5 and Since this valve is pneumatically latched, the Loss of Air pressure will cause the Valve to reset.



DE ENERGIZED



ENERGIZED



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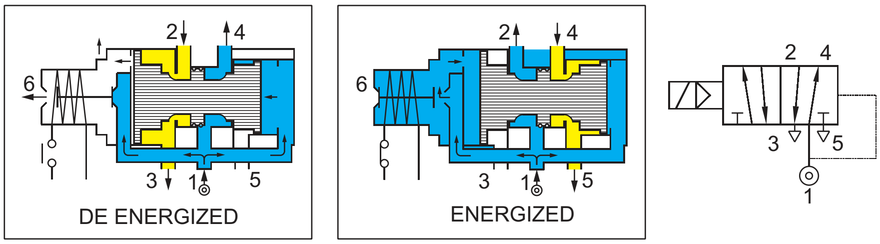
INTRODUCTION : SOLENOID VALVE

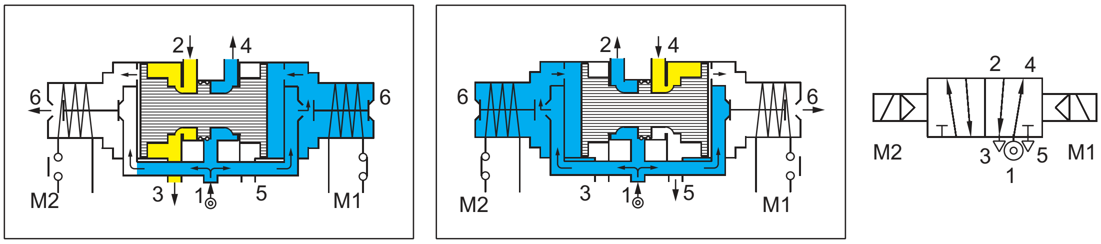
5 PORT INLINE POPPET INTERNAL PILOT OPERATED SOLENOID VALVE

Inlet pressure is connected to the Port 1(inlet). Port 1 is connected to Port 4 (Normally open outlet) with the Port 5 (vent) blocked by the Poppet seat. Port 2 (Normally closed outlet) is connected to Port 3 (vent). Inlet air is connected to the bottom of the Poppet and acts on the bottom piston which works as a return spring keeping the Poppet assembly up.
On energization, inlet air is drawn from the Pilot line and connected to the Top piston chamber. Since the Top piston is larger than the bottom piston, resultant force moves the entire Poppet assembly down.
With the inlet seal crossing over the port, port 1 which is disconnected from port 4 and is connected to port 2. The Poppet seat closes Port 3 and opens Port 4. On de-energization the force from the bottom piston pushes the Poppet assembly up to its original condition. Breather port is provided to vent the air under the top piston. This hole should not be plugged.



5 PORT INLINE POPPET DOUBLE SOLENOID VALVE

Inlet pressure is connected to the Port 1(inlet). Port 1 is connected to Port 4 (Normally open outlet) with the Port 5 (vent) blocked by the Poppet seat. Port 2 (Normally closed outlet) is connected to Port 3 (vent).
On energization of the latching solenoid(M1), inlet air is drawn from the Pilot line and connected to the Top piston chamber. The resultant force moves the entire Poppet assembly. With the inlet seal crossing over the port, port 1 is disconnected from port 4 and is connected to port 2. The Poppet seat closes Port 3 and opens Port 5.
De-energizing the latch solenoid does not change the valve position. To reset the Valve to original state, de latching solenoid (M2), is energized. Inlet air is connected to the bottom piston. The force from the bottom piston pushes the Poppet assembly up to its original condition. Breather port is provided to vent the air under the top piston. This hole should not be plugged.



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DEFINITION

Solenoid Enclosure

Metal housing around the coil for electrical and mechanical protection. It also gives protection against environmental hazards.

Maximum Operating Pressure Differential

This refers to the difference in pressure between inlet and the outlet. If the pressure at the outlet is not known, conservative approach suggests to treat inlet pressure as maximum operating pressure differential.

Minimum Operating Pressure Differential

This is the pressure that is required to open the Valve and keep it open. For 3 ports and 5 ports pilot Valves, the minimum operating pressure is measured between the inlet pressure and exhaust ports and must be maintained through out the operation cycle for smooth operation of the Valve. At minimum operating pressure differential, Rotex Valve have 80 % of the flow factor.

Proof Pressure

It is the pressure which Valve can withstand before bursting/ causing permanent physical deformation.

Maximum Ambient Temperature

Maximum ambient temperature determines safe working limit for coil insulation in energized condition , with maximum fluid temperature in the existing Valves.

Response Time

It measures the time lapse after energizing or de energizing a solenoid Valve until the outlet pressure reaches a specific percentage of its maximum steady value, the outlet being connected to a circuit having specified flow parameters . Response time depends on mainly five factors like electrical supply, type of the Valve ie. direct or pilot operated, fluid handled, size of the moving parts of the main Valve mechanism, circuit in which the time is measured.

Response ON

Time taken for the pressure at the outlet port to reach 80% of the inlet pressure, from the moment electrical supply to the solenoid is applied.

Response OFF

Time taken for the Valve to exhaust (pressure shall be 20% of the inlet pressure at its outlet port) from the moment supply to the solenoid is cut off.

The response time of Rotex valve , under average condition is ;

	Response ON		Response OFF	
• Small direct acting Valve	6 - 8	ms	8 - 10	ms
• Large direct acting Valve	6 - 10	ms	10 - 15	ms
• Diaphragm Valve ≤25 mm	300	ms	800	ms
• Diaphragm Valve ≥25 mm	600	ms	1800	ms
• 3/2, 5/2 Pilot operated Valve	15-50	ms	25-90	ms

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DEFINITION

Solenoid

It is an electrical part of a Valve which includes a bobbin wound with insulated copper wire, magnetic core, enclosure. This creates a magnetic flux when energized.

Inrush current

When solenoid is energized with AC supply, the plunger moves and creates a momentary surge of current , known as inrush current. Inrush current is observed in AC circuit and not in DC circuit.

Holding current

For AC supply Solenoid, Once plunger completes the travel and rest in a position, current drawn by Solenoid is known as holding current.

Insulation class

The selection of insulation is a function of ambient temperature and the internal temperature rise of the solenoid. The temperature limit for class F insulation is 155 °C and for class H insulation, is 180 °C. Rotex solenoid Valve is fitted with class F insulation and class H is available as an option.

Temperature class

This is the highest temperature any part or the entire surface of an electrical device can reach under the most unfavorable operating conditions, capable of igniting a surrounding explosive atmosphere.

Pick up voltage

Is a minimum voltage at which the Valve operates at minimum/ maximum operating pressure.

Drop down voltage

Is minimum voltage at which Valve does not remain actuated once energized

Temperature rise

It is a maximum temperature that the solenoid attains when the same is kept energized continuously.

Leakage port

When the unneeded fluid passing out from the out let port/ s or exhaust ports of the valve at energized/ de energized condition of the Valve

Leakage joint

Is the fluid coming out from various joints of the valve assembly

TB

It is a weather proof Terminal Box solenoid having IP67 protection and integrated junction box for terminating cable.

FPJB

It is a Flame Proof solenoid suitable for hazardous locations having integrated Junction Box for termination of cable.

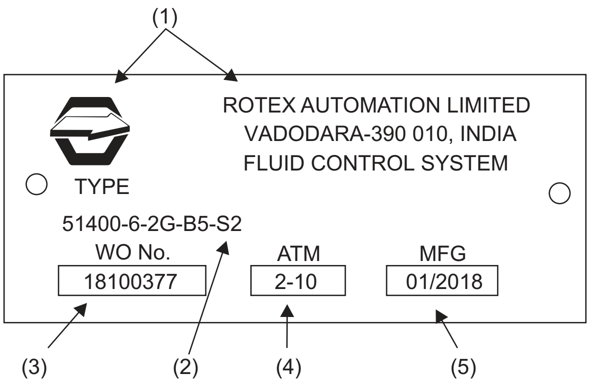
CONTINUOUS DUTY RATED SOLENOID

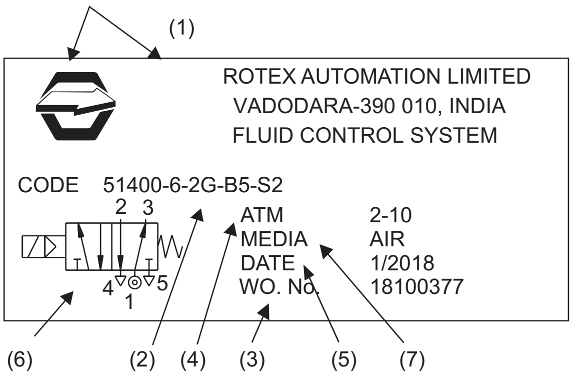
The solenoid when capable of operating continuously at higher rated voltage without affecting any of its parameter is know as continuously rated solenoid.

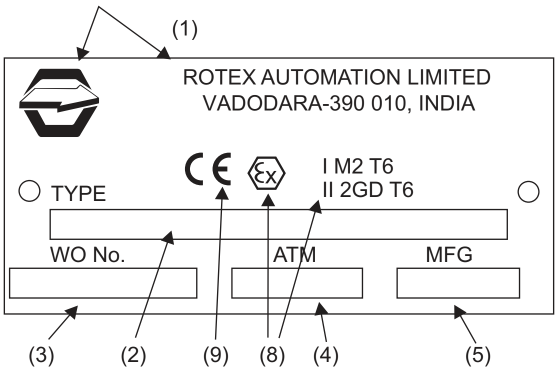
IDENTIFICATION

Valve label

Label on the ROTEX Solenoid Valve shows the following details.





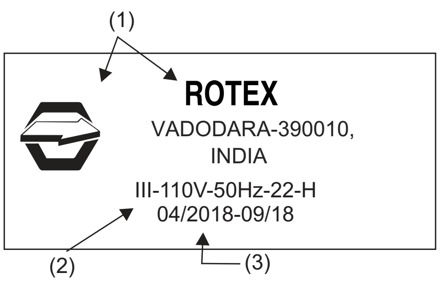


(1) Logo + Manufacture's Name and address
(2) Valve Type / Code

51400	=	Valve Model
Suffix	=	Nil
6	=	Orifice
2G	=	1/4" / BSP Port Connection
B5	=	Body Material (SS 316)
S2	=	Manual Override (Push and Turn)
	=	Seal Material (Viton)
110 V	=	Solenoid Voltage
50 Hz	=	Current (AC)
22	=	Solenoid Construction (Enclosure Plug in)
H	=	Solenoid Class H Insulation

(3) ROTEX Work Order reference/ Sr. No of the valve
(4) Operating Pressure
(5) Month and Year of Manufacture
(6) Valve Symbol
(7) Media
(8) ATEX Ex. GOST mark for Valve (Non Electrical Part)
(9) CE mark for ATEX and/ or PED compliance

Solenoid label



(1) Logo + Manufacture's Name and address
(2) Solenoid Type

III	=	Solenoid Size III
110 V	=	Solenoid Voltage
50 Hz	=	Solenoid Current
22	=	Solenoid Construction (Plug in DIN)
H	=	Solenoid Class H Insulation

(3) ROTEX Plan No. and Month/Year of Manufacture
(4) Also refer to bottom of the solenoid for voltage, current and other marking

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Cable Entry

A solenoid with NPT (F) threading is marked “N” near the Cable entry and with Metric thread is marked “M”. There is no marking for Solenoid having Cable entry with 3/4” ET.

NOTE : The product without label is out of warranty.

ROTEX
Engineering For The Future

SELECTION GUIDE : ORIFICE

ROTEX Solenoid Valves are modular in construction facilitating the user to select valves for various Application from wide range and different construction of solenoids independently

SELECTION OF BASIC VALVE TYPE:

Depending on the application of valve in system select e.g a 2/2 Valve for ON/ OFF application, 3/2 valve for a single acting actuator, mixing, diverting, Universal applications, 5/2 Valve for double acting actuator, cylinder etc.

VALVE SIZE and PORT CONNECTION :

The basic size of the valve is based on the kv (flow factor) of the valve

The kv Value is calculated through basic application information

(A) FLOW REQUIRED

I) Flow data
ii) Calculate flow from time in which a specific volume is to be delivered

(B) INLET PRESSURE - Po

C) Outlet Pressure-P_1 In most of the cases the outlet pressure is not known, the same can be arrived at from back pressure from equipment or based on the load on the equipment under operation
D) ΔP-Pressure drop across the valve (Po-P_1)
E) Operating temperature of media
F) Specific gravity of media

The flow factor (kv) can be calculated using following methods for AIR, LIQUIDS, GASES.

(1) FOR AIR

Refer into the kv chart No.1 (Page 412) for AIR. Select the inlet pressure and differential pressure. The result from chart yields flow in Nm^3/hr. For a value of flow factor kv=1, calculate the flow factor for the specific application.

$$kv = \frac{Q\ (\text{Application specific})}{Q\ (\text{for } kv=1)}$$

Select the valve orifice size having calculated kv or nearest higher kv

TO FIND AN ORIFICE OF A VALVE

EXAMPLE 1

REQUIREMENT: To fill a volume of 100 liters, the inlet air pressure Po is 7 bar. The Volume to be filled in 20 seconds from 0-5 bar. P1 is 5 bar

First calculate m^3/ hr at 5 bar

$$\frac{100}{20} \times \frac{60\text{x}60}{1000} = 18 m^3/\text{ hr.}$$

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SELECTION GUIDE : ORIFICE

So Nm^3/hr= 18 x 5=90m^3 /hr
Pressure drop P across the valve is Po- P1=7-5 = 2 bar (ΔP)
Now refer Chart No1 (Page 412)
For Pressure drop ΔP=2 bar at Po=7 bar the flow rate
Q(Nm^3/hr/kv) for air at ambient temperature is 5.5 Nm^3/hr/kv

$$Kv = \frac{90}{5.5} = 16.36$$

Nearest higher kv= 18 for an orifice of 7 mm
NOTE:
The exact formula for filling in and exhaust time for compressible fluid is different. The above example is most conservative

EXAMPLE 2

REQUIREMENT: To operate a cylinder of Ø100 mm ; stoke 300 mm, to complete travel in 3 seconds, the operating air pressure Po=5 bar

Flow require in Nm^3/ hr

$$\text{Volume of air} = \frac{\pi}{4} \times d^2 \times L$$

$$= \frac{\pi}{4} \times \frac{100\text{x}100}{1000\text{x}1000} \times \frac{300}{1000} = 0.0023571 m^3$$

Volume of air per hour at 5 bar in m^3/hr

$$= 0.0023571 \times \frac{60}{3} \times 60 = 2.82852 m^3/ hr$$

So Volume required at ambient temperature and pressure (Using Formula $P_1 V_1 = P_2 V_2$)

$$= 2.82852 \times 5 = 14.1424 \ Nm^3/ hr$$

Now refer Chart No.1 (Page 412) for ΔP=0.1 bar at Po=5 bar the flow rate Q (Nm^3/ hr/ kv for air at ambient temperature is 1.2 Nm^3/ hr

$$kv = \frac{14.1424}{1.2} = 11.7855$$

Nearest kv= 12 for an orifice of 6 mm

SELECTION GUIDE : ORIFICE

For any other gases and liquids, the kv is calculated as under :

(2) FOR GASES

Q	=	Flow rate in Nm^3/hr
T	=	t+273 °C
t	=	Temperature in °C
Po	=	Inlet Pressure in atmospheric absolute in bar
ΔP	=	Differential pressure, bar
γ	=	Density in kg/m^3
kv	=	Flow factor of valve.

(1) $$Q = 28.5 \times kv \times \sqrt{\frac{\Delta P \times Po \times Y}{\gamma\,(t + 273)}}$$

Y = Correction factor

(2) $$Y = \frac{1 - \Delta P}{2 \times Po}$$

Y is a correction factor which depends upon the relation between the inlet pressure and the pressure drop through the valve.
Y is always smaller than 1.
Select the valve orifice size having calculated kv or nearest higher kv.
Corresponding to a selected kv value for a given valve type, select an orifice for the valve.

(3) FOR WATER

$Q = kv \times \sqrt{\Delta P}$

For a known flow rate and differential pressure calculate kv using above formula and select the valve Orifice size having calculate kv or nearest higher kv. Alternatively, you may refer Chart No.2 (Page 413)

To FIND AN ORIFICE OF A VALVE

EXAMPLE 1

To fill up an open to atmosphere tank with 10 litres of water in 5 seconds. The inline pressure Po of water is at 10 kg/cm^2.

$$Q = \frac{V}{T} \times 60$$

Q = Quantity of water in litre/min
V = Volume in litre to be filled in
T = Time in seconds

$$Q = \frac{10}{5} \times 60 = 120 \text{ litre/min}$$

Now Refer Chart No.2 (Page 413)

For Pressure drop ΔP of 10 bar for 126 litre/min, the kv=40

Nearest higher kv=75 for an orifice of NW=16 mm

Alternatively, you may select kv= 38 for an orifice of NW=10mm,
Provided reduction in the flow (about 0.2% in this case) is acceptable
Actual kv in this case will be :

$Q : kv\sqrt{\Delta P}$ $\quad kv = \frac{Q}{\sqrt{\Delta P}}$

SELECTION GUIDE : ORIFICE

(4) FOR LIQUIDS

$$Q = kv \times \sqrt{\frac{\Delta P}{\gamma}}$$

Q = Flow rate required in litre/min.
ΔP = Differential pressure in kg/cm2.
γ = Specific gravity of the liquid at the media temperature.

Select the valve orifice size having calculated kv or nearest higher kv.

Corresponding to a selected kv value for a given valve type, select an orifice for the valve

Rotex can provide standard end connection for the selected orifice e.g. 6 mm orifice can be provided with 1/4” BSP/ NPT to 3/4” BSP/ NPT. The valve can also be provided with Flanged End, ANSI B16.5 (or as per your specification) end connection. The end connection selected should not be smaller than the orifice size. The valves can be sub-base mounted for special application

As a user, by selecting an appropriate orifice and end connection, you
- select a product rightly suited to application
- select an economically most viable solution
- can save piping cost by selecting end connection matching nearest to the existing piping system

SELECTION GUIDE : BODY MATERIAL AND INTERNALS

ROTEX offers a wide range of body material and internals to suit the media as well as environment. Users are recommended to use following guide while selecting the body material of the Solenoid Valve for their application. As a standard, Aluminum body valve is supplied with internals of Aluminum, Brass and SS. A Brass body valve is supplied with internals of Brass and SS. SS Body valve is supplied with internals of SS.

ROTEX offers FOUR basic body materials :

1) ALUMINUM HARD ANODIZED

- Treatment produces corrosion resistant, wear resistant and a tough surface
- Increase in surface strength results in stronger threads on ports and mountings
- Achieve surface hardness
- Improves surface finish due to inherent nature of the process
- Port connection BSP/ NPT

2) BRASS (Extruded)

- Grade as per IS 319. Extruded Brass is equivalent to forged Brass specification
- Most suitable for applications for Water, Oxygen Service
- **ROTEX** strongly recommends that the surface treated Aluminum out perform Brass for most of the application
- Port connection usually NPT

3) STAINLESS STEEL (SS 316)

- Ideal for highly corrosive environment involving strong Acid and Alkaline environment
- Ideal for instrumentation application
- Ideal for high temperature application
- Port connection normally NPT, except for 2/2, inline diapharm or piston actuated valve

4) PTFE BODY

- All working parts are fully lined
- Ideal for corrosive media
- Not suitable for frequent changes in mountings

5) PLASTIC BODY

- Suitable for low and medium temperature, corrosive media or commercial application
- Maximum media temperature up to 80 °C
- Not suitable for frequent changes in mountings

Following options are available for selection of Body Material and Internals :

Body	Internals	Code	Remarks
Aluminium	Standard	※	Internal Components of Aluminium, Brass, SS 316
Aluminium	SS 316	B1	Internal Components of SS 316
Brass	Standard	B2	Internal Components of Brass, SS 316
SS 316	Standard	B5	Internal Components of SS 316
Stainless Steel, Cast	SS 316	B12	Internal SS 316

SELECTION GUIDE : SEALS

ROTEX offers variety of solution in seals for various applications. The seals are to be selected on the basis of their compatibility to media., temperature and pressure etc. Seal material will be generally selected by Rotex depending upon media, media pressure and temperature. For best results, it will be better to consult Rotex

(1) NBR (Buna-N, Nitrile etc.)

Fitted as a standard in ROTEX products
Suitable for all general application up to a ambient/ media temperature of -25 °C to 75 °C

(2) EPDM (Ethylene Propylene Di-Methyl) (S1)

Excellent for Nuclear applications, especially for exposure to Radiation. (GRADE R13)
Moderate corrosion resistance
Excellent shelf life
Ideal for high temperature air, water and steam up to -60 °C to 140 °C

(3) Viton (S2)

Ideal for high temperature media/ environment
Ideal for corrosive applications
Excellent shelf life
Media temperature up to -20 °C to 160 °C

(4) NEOPRENE (S3)

Ideal for use with oils
Good shelf life
Suitable for refrigerant application
Should be opted for hydro carbon media
Media temperature -30°C to 100 °C

(5) F.SILICON (S19)

Ideal for high temperature
Good for medical application
Good corrosion resistance
Media Temperature up to -60 °C to 190 °C

(6) PTFE (S4)

Ideal for most media
Do not use as a standard unless application really calls for PTFE
Nearly unlimited shelf life
Not recommended for Radiation Exposure
Media temperature up to -70 °C to 200 °C

(7) SAPPHIRE (S6)

Excellent corrosion resistance
Ideal for high temperature up to 350 °C
Selected for service temperature above -196 °C + 350 °C

ROTEX valve can be provided with seat and seal material other than listed above.

(8) Viton GLT (S2G)

Ideal for high temperature media/ environment
Ideal for corrosive applications
Excellent shelf life
Media temperature up to -40 °C to 160 °C

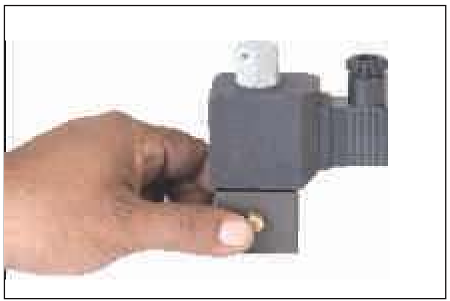
(9) Hytrel (S11)

Used for replacing NBR diaphragm.
Excellent Resistance to most Chemicals and provides long life.
Media temperature up to 0 °C to 80 °C

SELECTION GUIDE : MANUAL OVERRIDE

PUSH AND TURN (M6) UP TO 20 bar

With this manual override, valve can be operated by pushing Manual Override. The valve will reset when Manual Override is released. The valve can be latched by pushing Manual Override and turning Clockwise(CW). To release, to turn Manual Override anticlock wise(ACW). Suitable up to 20 bar pressure



PUSH (M8) UP TO - 20 bar

With this type of Manual Override the valve can be actuated by pushing Manual Override. This type of Manual Override is supplied for double solenoid valve. The valve will reset when Manual Override is released. Suitable up to 20 bar pressure

PUSH AND TURN (M2) WITH KNOB UP TO 20 bar

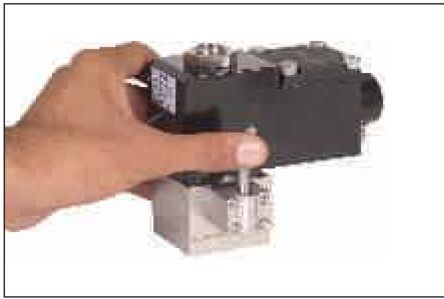
This Manual Override is same as M6 however it has a knob for operating Manual Override

This type of manual override can be opted for valve type which can be supplied with manual override type M6 or M8

PUSH WITH KNOB (M8K) UP TO 20 bar

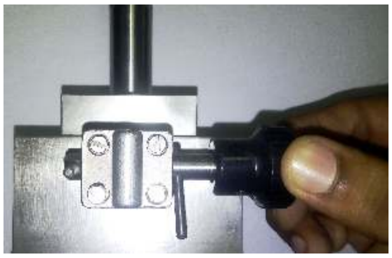
Same as M8 but with knob

SELECTION GUIDE : MANUAL OVERRIDE



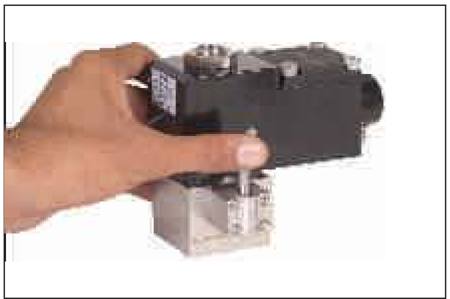
LEVER TYPE (M5) UP TO 40 bar

This is momentary type Manual Override suitable up to 40 bar pressure. The valve can be actuated by pressing lever. Releasing lever shall reset valve



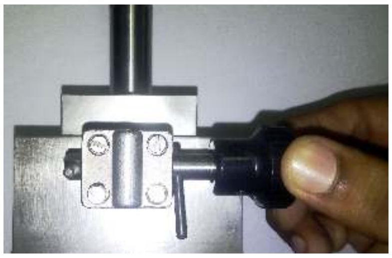
MALA (M12/ M17) UP TO 40 bar

This is a stayput type Manual Override. Suitable up to 40 bar pressure. The valve can be actuated by turning lever CW, and to release turn lever ACW The manual override operated by hand (MR). This manual override can be provided with knob. (M17)



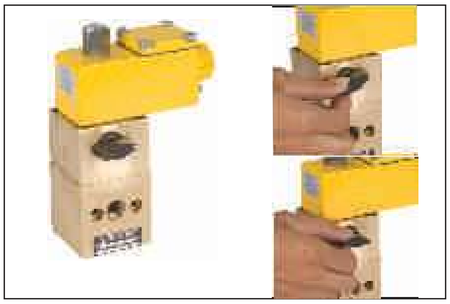
HIGH PRESSURE LEVER TYPE (M4) UP TO 150 bar

This is similar to M5 but suitable for pressure up to 150 bar



HIGH PRESSURE MALA (M11/ M16) UP TO 150 bar

This is similar to M12 but suitable for pressure up to 150 bar
Select (M16) when this type of manual override is required with knob



KNOB TYPE LATCHED MANUAL OVERRIDE (M7/M13) UP TO 20 bar

M7 (For Latch Valve):-In normal condition manual override is to be kept in horizontal. To latch the valve, Turn Manual Override anti clock wise. Then brings to normal position. To delatch the valve, Turn the Manual Override clock wise. Then bring to normal position.

M13 (Manual Reset OFF Valve):-In normal condition Manual Override is to be kept in horizontal. To delatch the valve, turn the Manual Override clock wise. Then bring to normal position.

CLASS OF INSULATION AND SOLENOID LIFE

Life of the Solenoid depends on ambient temperature, duty cycle, temperature rise and class of insulation used for the solenoid. Temperature rise depends on design, current density and insulation system of the coil. Rotex ensures that for all its design of the coil, temperature rise above ambient is less than 70 °C
As per IS 4800 standard, insulation system is designed for minimum life of for 20000 Hours When used continuously. Using the half life decay principle, every 10 °C reduction of the coil temperature, twice the life can be extra polated. Considering worst temperature rise of the coil at 1.2 times the rated voltage, continuously energized coil shall be less than 70 °C. For a ambient temperature of 55 °C, the maximum temperature of the coil will be 55 + 70 = 125 °C
For a Solenoid having class F insulation minimum life expected shall be as under:
20000 Hours at 155 °C
40000 Hours at 145 °C
80000 Hours at 135 °C
160000 Hours at 125 °C
Which means, Life of a Continuously energized Solenoid having Class F Insulation, i.e. (ambient of 55 °C) is Minimum of 160000 Hrs ie 18 Yrs.
In case if more life is expected then Solenoid with better insulation or lower temperature rise is to be used (e.g. Low Power Solenoid)

ELECTRICAL SPECIFICATION

STANDARD

CURRENT	AC	DC	AC/ DC
PICK UP (Cold	≤ 70%	≤ 70%	≤ 70%
% of rated voltage)			
DROP DOWN	≤ 50%	≤ 10%	≤ 10%
(% of rated voltage)			
RESPONSE 'ON'	≤ 10ms	≤ 8ms	≤ 8ms
VOLTAGE VARIATION	± 20%	± 20%	± 20%

ELECTRICAL SPECIFICATION FOR SOLENOID FEATURES LC, LW, ML

CURRENT	AC	DC
PICK UP	≤ 80%	≤ 80%
(% of rated voltage)		
DROP DOWN	≤ 10%	< 10%
(% of rated voltage)		
RESPONSE 'ON'	≤ 10ms	≤ 8ms
VOLTAGE VARIATION	±10%	±10%

POWER (Watt)

SOLENOID SIZE	AC	DC
8	6	5
10	6	8
13	0.3	0.3
14	6	8
18	13	13

HUMIDITY

95% rh @ 95 °C

Specifications are subject to change without notice