Solenoid directional valves: user's guidelines

Atos solenoid valves have been designed and tested with innovative concepts to satisfy the advanced needs of modern machines: rapid or damped switching, quiet operation, reduced power absorbed, versatility, reliability and safety of use.
This table gives engineers, in condensed form, a series of useful information for the choice and the use of modern solenoid valves.

1 DESCRIPTION OF FUNCTION

Solenoid directional valves are used for changing flow direction in hydraulic systems.
Main features are:

1.1 New integrated design between hydraulic and electrical parts with more compact construction and better efficiencies.
1.2 Wet solenoids for maximum reliability, also available in flame-proof, intrinsically safe and stainless steel execution.
1.3 All seals are static and all the moving parts are protected and lubricated by the fluid.
1.4 Smoother switching with effective regulation thanks to optional switching control devices.
1.5 Plastic encapsulated coils easily interchangeable and UL certified.
1.6 Electric or electronic connectors, depending on the application and on electric control board interface.
1.7 Cored oil passages with low pressure drops.
1.8 Interchangeable spools for various directional functions.

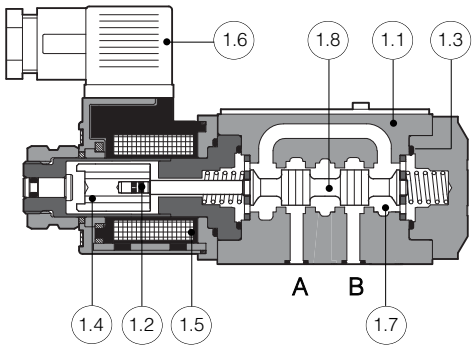


Fig. 1 Cross-section of direct operated solenoid valve

2 SOLENOID IDENTITY

According to European Convention solenoid "A" is close to "A" port and solenoid "B" is close to "B" port of the direct operated valves.
When pilot operated, the solenoids are identified according to following practice: solenoid "A" is at port A end of pilot valve and solenoid "B" at port B end, independent of main stage valve port location or spool type.

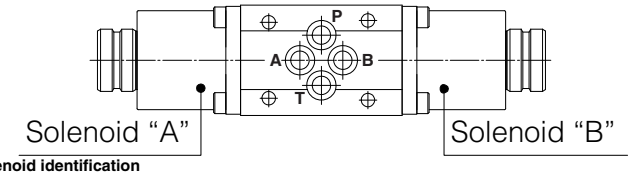


Fig. 2 Solenoid identification

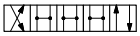
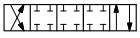
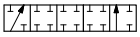
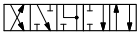
3 SPOOLS CHARACTERISTICS

Standard interchangeable spools are available in a wide range of configurations, as indicated in table 3.

Specific spools to reduce water hammer-shocks during switching: variants 1/1, 4/8 and 5/1. Their special shape reduces water hammer-shocks during switching. Use of these spools is not recommended with maximum flow greater than 80% of the nominal values, because of higher pressure drops generated in the valve.

Response times and control of switching time: direct operated solenoid valves.
The solenoid valve response times can be controlled by the use of specific devices (option L); associated with the spools */1 and */8 it is possible to control smooth acceleration/deceleration of the connected actuator. The L* devices allow an effective control of the solenoid valve switching time, slowing down the spool speed without reducing the solenoid force.
They are available in different configurations.
For correct use a slight backpressure (2 bar) on solenoid valve T port is recommended.
Valve response time is also influenced by operating conditions (oil characteristics and temperature), elasticity of the hydraulic circuit and by use of electronic connectors.

Response time and control of switching time: pilot operated solenoid valves.
The response time of the piloted valves can be adjusted by means of the options /H (meter-out control) or /H9 (meter-in control). This options provide the installation between the main stage and the pilot valve of a modular throttle valve, type HQ-*/U specific for fine pilot flow control.
Associated with */1 and */8 spools, smooth acceleration/deceleration can be controlled on loads.

Type	Scheme	Intermediate passages
0		
1		
2		
3		
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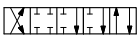
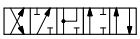
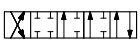
58		
6		
7		
8		
0/2		
1/2		
2/2		
16		
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Table 3 Basic spools, schemes and intermediate passages between central and external positions. **The spools are not available for all the directional valves. For their availability see the relevant valve table.**

***P spools for direct operated solenoid valves to reduce leakage.**
They are normally used on pilot valve for pressure and directional control valves, for cartridge valves and systems with specific requirements.
Use of these spools is not recommended with maximum flow greater than 70% of the nominal values, because of the higher pressure drops generated in the valve.
Following types available: 1P, 3P, 1/2 P, 8P (for ISO size 06 valves).

4 COIL CHARACTERISTICS

Solenoid valves are available both with DC and AC coils. Three main solenoids for use with following supply for DH* valves:
- OI solenoid for AC and DC supply (only replacing coil);
- OU and OO solenoid for DC supply only;

The solenoid OO can be used also with AC supply: in this case it must be coupled with the connector SP-669 having the rectifier bridge.
Coils are fully encapsulated; they are easily replaceable without aid of tools in DHI and DHU valves. AC and DC solenoids are available for DKE* valves. The DC solenoids can be also fed with AC supply, by using SP-669 connector. The coils with different nominal voltages can be interchanged on the same solenoid type.

5 ELECTRICAL CONNECTORS TO ISO 4400 (DIN 43650)

The cable entry on electrical plugs can be fitted at 90° intervals by reassembling the contact holder relative to the plug housing.
The cable entry is Pg. 11 suitable for cable Ø 6-10 mm.
Following types are available:
Standard connectors, IP65 protection degree (SP-666);
Connectors with built in LED (SP-667);
Connectors with built in rectifier bridge (SP-669) to supply DC coils by alternating current AC.
In addition to the above DIN connectors, other type of electrical interfaces are available on request:
- Lead Wire connection
- Deutsch connector DT-04-2P (IP67)
- AMP Junior Timer connector (IP67)

6 ELECTRONIC CONNECTORS

Operational principle
E-SE for direct current power supply on DC coils with reduction of power consumption and increase of performance;
E-SD to eliminate electric disturbances when solenoids are deenergized;
E-SR to pilot the solenoid valves with a low power signal (20 mA max);

E-SE main characteristics
They allow a modulation of the power supply voltage and thus an effective control of the solenoid force to obtain increased performance and reduction of power consumption.
The use of electronic E-SE connector allows a considerable increase in solenoid valve performance.

7 OPERATING NOTES

Tightening of the fixing screws to the subplates and of the plastic coil ring-nut.
It is particularly important to check that the tightening of the fixing screws respects the torque limits indicated in table 5.
Higher values may cause anomalous deformations of the body and prevent sliding of the spool. 12.9 class fixing screws are recommended. The plastic coil ring-nuts will be fixed on the solenoid with a torque 3Nm: this deforms properly the seals and protects against external particles and water.

Operation in circuits with flow exceeding the nominal valve flow
In circuits with flow rates greater than the nominal values and in circuits with accumulators, where the instantaneous flow can exceed nominal values, is recommended a throttle valve on P port of solenoid valve to limit the maximum flow on the valve.
Dilatation and contraction of flexible hoses subjected to variations of system pressure can generate high instantaneous flow rates.
The version indicated in fig. 6 can be directly inserted into P port of the valve but also in other valve ports.
Where throttle valve may be required they can be supplied with following codes:
SP-PLUG H-** (for DH* valves)
SP-PLUG K-** (for DKE* valves)
** the double asterisk identifies the dimension in tenths of a millimeter.
Example: SP-PLUG H-05 = 0,5 mm diameter

Limits on two-way and three-way operation for direct operated solenoid valves.
When used as two-way and three-way valves with P, A or B ports blocked or not subject to flow, or with flow much lower than flow on other ports, maximum catalogue performance cannot be assured.

Minimum pilot pressure for pilot operated solenoid valves.
A minimum pressure value must be guaranteed for piloting the valve. This value is 8 bar (or 10 bar in the case of valves with hydraulic centering). In case of circuits with lower pilot pressure on P port, the option /R should be used.

Operation combined with hydraulic cylinders with high section ratios.
Operational limits may occur with cylinders with section ratios (piston/rod) greater than 1.25. In these cases multiplications or demultiplications of flow and pressure may disturb the correct operation of the solenoid valve.

8 SPECIAL VERSION SOLENOID VALVES

- for explosion-proof environments
- for intrinsically safe operation
- stainless steel execution for marine or aggressive environments
- for operation beyond the allowed temperature limits.

Table 3.2 Spools to reduce water hammer shocks associated with switching

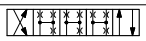
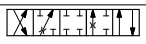
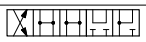
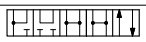
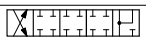
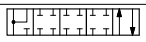
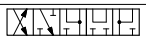
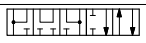
Type	Scheme	Intermediate passages
0/1		
1/1		
3/1		
4/8		

Table 3.3 Specific spools for special uses or in regenerative circuits

Type	Scheme	Intermediate passages
09		
90		
19		
91		
39		
93		
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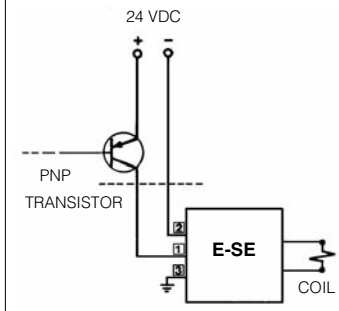

Fig. 4 E-SE electrical connection

Table 5
Recommended torque for the fixing screws

Valve type	Fixing screws class 12.9	Torque
DH*	M5	8 Nm
DKE*	M6	15 Nm
DP**-2	M10 and M6	70 Nm and 15 Nm
DP**-3	M12	125 Nm
DP**-6	M20	600 Nm

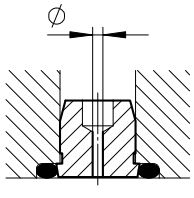

Fig. 6 Throttle valve which can be inserted in port P (or A and B) of the solenoid valve to limit the flow.