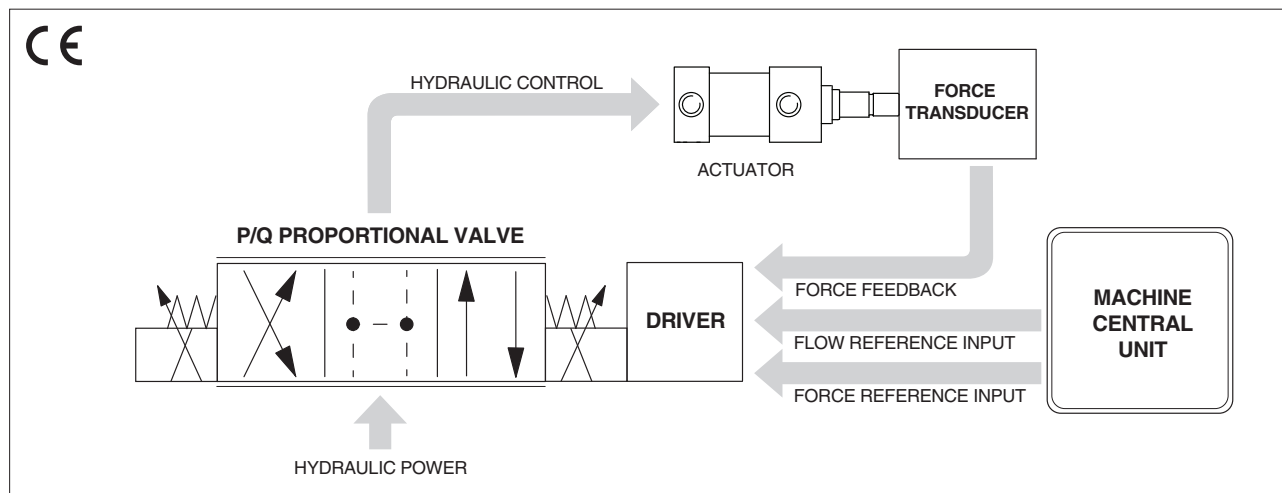


## Digital proportional valves with P/Q control

directional valves with LVDT transducer and on-board driver



### 1 GENERAL DESCRIPTION

Proportional directional valves with P/Q control are identified by option SP, SF or SL and they are designed to perform the alternated regulation of speed/position/force of hydraulic actuators.

These options add the closed loop control of pressure (for SP) or force (for SF and SL) to the standard direction and flow regulation operated by the servoproportional and high performance proportional directional valves.

**Note:** for simplification, the following description always refers to the “force control”, even if for the SP option the control is the “pressure”.

The switching from the flow control to the force control is automatically performed by the valve thanks to a sophisticated algorithm.

The advantage offered by this solution is the high accurate and high dynamic control of the machine actuator in terms of direction, speed, position and force, all performed by a single valve.

### 2 FUNCTIONAL DESCRIPTION

The alternated P/Q control is operated by means of two electronic reference signals sent from the machine central unit to the valve driver: one for flow regulation and one for regulation. The valve driver has to be interfaced to a remote pressure transducer or to a load cell for the measurement and feedback of the actual pressure or force.

The SP option controls the pressure on A user port and it has to be interfaced to a single pressure transducer.

The SF option controls the force by measuring the delta p across A and B user ports and it has to be interfaced to two pressure transducers.

The SL option directly controls the actuator force and it has to be interfaced to a load cell.

See section 4 for configuration examples.

A dedicated algorithm automatically selects which control (flow or force) will be active time by time. The dynamics of the switching between the two controls can be regulated thanks to specific software setting, in order to avoid instability or vibrations.

The flow regulation is active when the actual system force measured by the force transducer is lower than the relevant input reference signal.

The valve normally works to regulate the flow by controlling in closed-loop the spool position through the integral LVDT transducer.

The force control is activated when the actual system force, measured by remote transducers, reaches the setpoint defined by the relevant force reference input signal and meets the regulation requirements defined within the control algorithm.

The flow regulation is consequently reduced to keep steady the closed loop regulation of the force.

If the force decreases below its input reference signal, the flow control returns active.

The dynamic response of the force control can be adapted to different system characteristics, by setting the internal PID parameters using Atos PC software. Up to 4 different PIDs are selectable to optimize the system dynamic response according to different hydraulic working conditions.

### 3 VALVES RANGE

Options SP, SF, SL are available for high performance proportional directional valves and servoproportional valves with TES/LES on-board digital driver or TEZ/LEZ on-board digital driver + axis card.

Valve's performance characteristics and overall dimensions remains unchanged as per standard valve models, refer to specific FS\*\* technical tables.

#### Servoproportionals:

**DLHZO-TEZ, DLKZOR-TEZ** - direct, zero spool overlap, sleeve execution - technical tables **FS180**

**DHZO-TEZ, DKZO-TEZ** - direct, zero spool overlap - technical tables **FS168**

**DPZO-LES** - piloted, zero spool overlap - technical table **FS178**

**LIQZO-LES, LIQZP-LES** - 3-way servocartridges - technical table **FS340**

**Servoproportionals with TEZ/LEZ on-board digital driver + axis card:**

**DLHZO-TEZ, DLKZOR-TEZ** - direct, zero spool overlap, sleeve execution - technical tables **FS610**

**DHZO-TEZ, DKZOR-TEZ** - direct, zero spool overlap - technical tables **FS620**

**DPZO-LEZ** - piloted, zero spool overlap - technical tables **FS630**

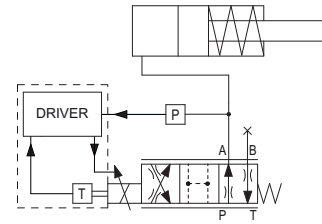
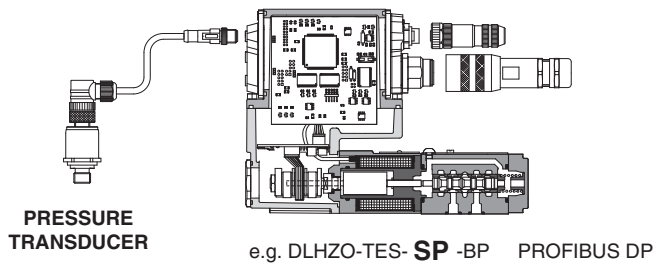
#### High performance proportionals:

**DHZO-TEZ, DKZOR-TEZ** - direct, positive spool overlap - technical table **FS165**

**DPZO-LES** - piloted, positive spool overlap - technical table **FS175**

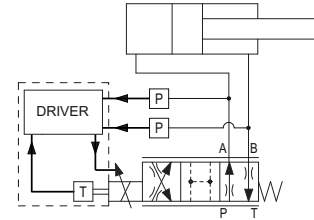
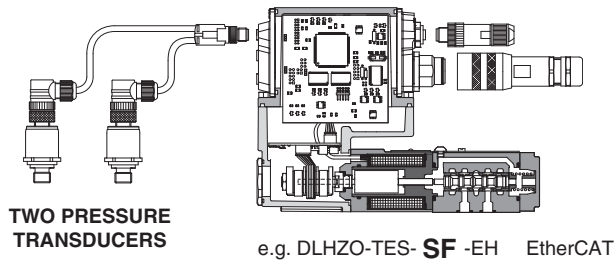
#### 4 SP, SF, SL CONFIGURATION EXAMPLES

##### SP - Pressure Control - 1 pressure transducer



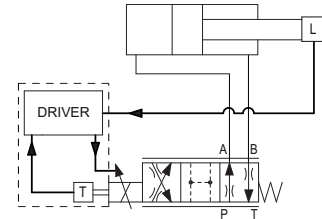
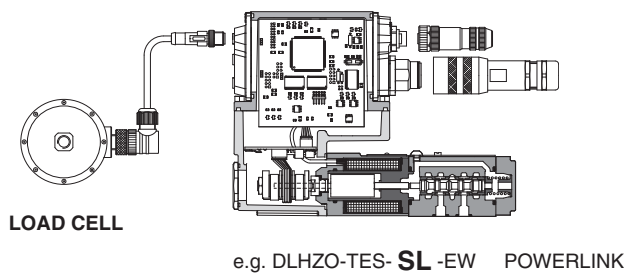
one remote pressure transducer has to be installed on the actuator's port to be controlled. In this example the SP option regulates the pressure on port A

##### SF - Force Control - 2 pressure transducers



two remote pressure transducers have to be installed on the actuator's ports A and B. The bore and rod dimensions of the actuator have to be input into the valve software, which calculates the relevant areas: A1 = bore area; A2 = ring area. The SF option directly controls the actuator force (F) as result of the following calculation:  $F = (P_a \times A_1) - (P_b \times A_2)$

##### SL - Force Control - 1 load cell



one load cell transducer has to be installed between the actuator and the controlled load. The SL option directly control the actuator force

#### 5 GENERAL NOTES

Atos digital proportionals valves are CE marked according to the applicable directives (e.g. Immunity and Emission EMC Directive). Installation, wirings and start-up procedures must be performed according to the general prescriptions shown in tech table **FS900** and in the user manuals included in the E-SW-\* programming software.

#### 6 VALVE SETTINGS AND PROGRAMMING TOOLS



**WARNING:** the below operation must be performed in a safety area

Valve's functional parameters and configurations, can be easily set and optimized using Atos E-SW programming software connected via USB port to the digital driver (see table **FS900**). For fieldbus versions, the software permits valve's parameterization through USB port also if the driver is connected to the central machine unit via fieldbus.

The software is available in different versions according to the driver's options (see table **GS500**):

**E-SW-BASIC/PQ** supports: NP (USB)

**E-SW-FIELDBUS/PQ** and **Z-SW-FULL** support:

NP (USB)

BC (CANopen)

EW (POWERLINK)

BP (PROFIBUS DP)

EI (EtherNet/IP)

EH (EtherCAT)

EP (PROFINET)

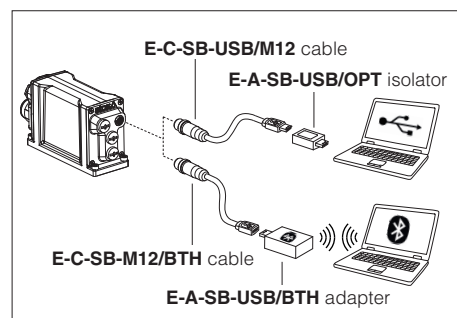


**WARNING: drivers USB port is not isolated!** For E-C-SB-USB/M12 cable, the use of isolator adapter is highly recommended for PC protection



**WARNING:** see tech table **GS500** for the list of countries where the Bluetooth adapter has been approved

##### USB or Bluetooth connection



## 7 FUNCTIONAL EXAMPLES

The following functional examples are just generic reference of the possible applications of with proportional directional valves with alternated P/Q control, **SP**, **SF**, **SL**.

Please contact Atos technical department for additional evaluations related to specific applications usage.

### 7.1 High-dynamic pressure reducing controls - only for SP

Directional proportional valves with zero spool overlap and SP control, are operated in 3-way hydraulic configuration to obtain high-dynamic pressure reducing control on the A (or B) user port:

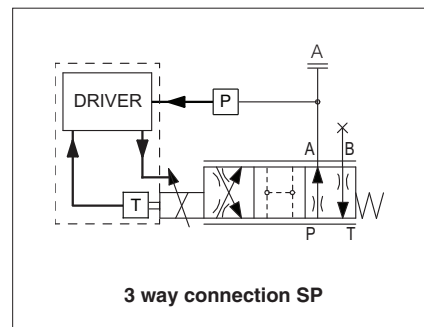
- flow reference signal is used to limit the maximum flow during the pressure regulation
- pressure reference signal is used to regulate the pressure on the valve's A user port; the rapid/repeatable response of the pressure control is performed in high dynamics by the directional valve's closed loop regulation

#### Requirements:

- an remote pressure transducer has to be installed in the hydraulic system on the controlled user port (when using 4 way valves either A or B port can be used while the not controlled port must be plugged)
- zero overlap valves without fail safe position are recommended;

⚠ Positive overlap valves with PABT ports closed in central position are not suitable for this application

### High-dynamic - only for SP



### 7.2 Single effect actuators with speed/pressure/force controls - only for SP or SL

Directional proportional valves with SP or SL control, are operated in 3-way hydraulic configuration to control speed/pressure (force) on single effect actuators:

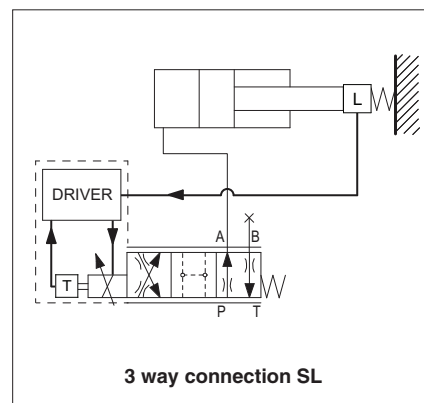
- flow reference signal is used to regulate the actuator's forward and backward speed while pressure (force) reference signal is used to limit the maximum pushing pressure (force) to the actuator  
or
- pressure (force) reference signal is used to regulate the actuator pushing pressure (force) while flow reference signal is used to limit the maximum actuator speed

#### Requirements:

- for SP control a remote pressure transducer has to be installed in the hydraulic system on the actuator pushing port
- for SL control a remote force transducer has to be installed between the actuator and the controlled load
- zero overlap valves without fail safe position are recommended;

⚠ Positive overlap valves with PABT ports closed in central position are not suitable for this application

### Single effect - only for SP or SL



### 7.3 Double effect actuators with speed/pressure controls - only for SP

Directional proportional valves with SP control, regulate speed/pressure on double effect actuators:

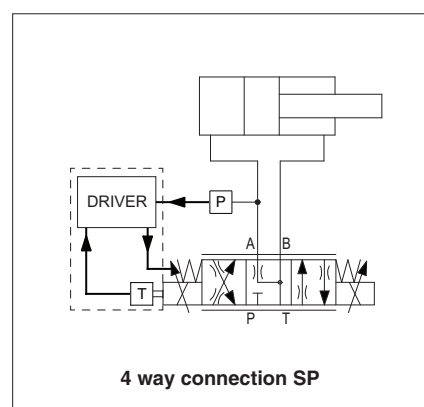
- flow reference signal is used to regulate the actuator's forward and backward speed while pressure reference signal is used to limit the maximum pushing pressure of the actuator  
or
- pressure reference signal is used to regulate the actuator pushing pressure while flow reference signal is used to limit the maximum forward and backward actuator speed

#### Requirements:

- a remote pressure transducer has to be installed on the actuator's pushing port
- a dedicated Q5 spool with strong "meter-in" characteristic in central position has to be used; during pressure regulation, the not controlled port remains connected to T line to avoid any back pressure - see section 7.4

⚠ Positive overlap valves with PABT ports closed are not suitable for this application

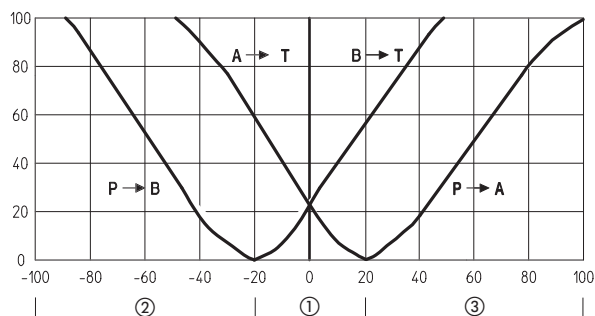
### Double effect - only for SP



### 7.4 Q5 spool for 4 way connection with SP control

Spool type **Q5** allows fast direction reverse during motion phases (e.g. ejector motion with max strain limitation)

- ① depressuring (pressure control active)
- ② backward movements (flow control active)
- ③ forward movements (flow or pressure control active)



### 7.5 Double effect actuators with force limit/regulation - only for SF or SL

4 way directional proportional valves with SF or SL control, regulate speed/force on double effect actuators:

- flow reference signal is used to regulate the actuator's forward and backward speed while force reference signal is used to limit the maximum pushing and pulling force of the actuator or
- force reference signal is used to regulate the actuator pushing and pulling force while flow reference signal is used to limit the maximum actuator speed

#### Requirements:

- for SF two remote pressure transducers have to be installed on the both actuator's ports
- for SL one push/pull load cell transducer has to be installed between the actuator and the controlled load
- zero overlap valves are recommended;



positive overlap valves with PABT ports closed in central position are not suitable for this application

#### Advantages:

- force control is possible in both push and pull directions
- SL allows a more precise force control despite of a more complex installation of the load cell transducer
- SF allows to add force control also into existing systems thanks to the simple installation of pressure transducers

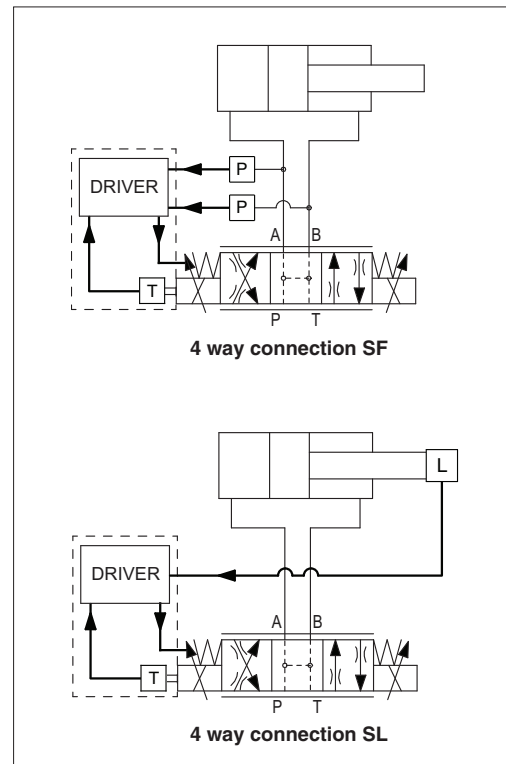
#### Control modes:

- Flow priority: flow reference signal is used to move forward and backward the actuator while force is limited/regulated in both push and pull direction
- Force priority: force reference signal is used to control both push and pull forces while flow is limited/regulated in both direction

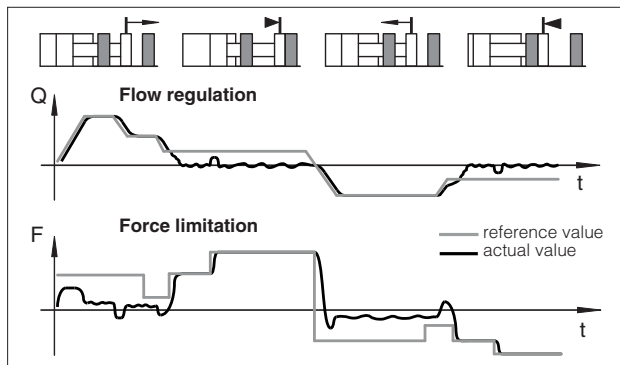
#### Notes:

auxiliary check valves are recommended to intercept A and B lines in case of specific hydraulic configuration requirements in absence of power supply or fault

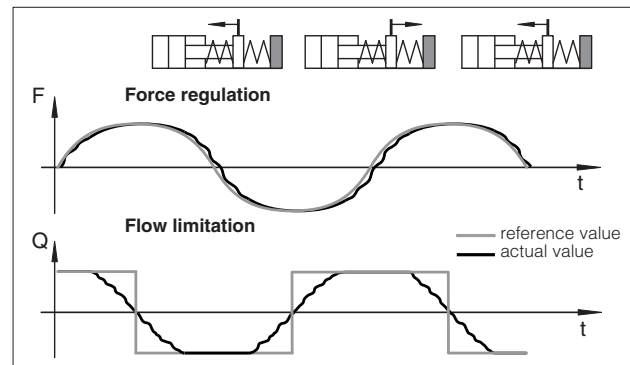
### Double effect - only for SF or SL



### 7.6 Flow priority



### 7.7 Force priority



## 8 PRESSURE/FORCE TRANSDUCER CHARACTERISTICS

The accuracy of the pressure/force control is strongly dependent to the selected pressure/force transducers.

Pressure/force controls require to install remote pressure transducers or load cell to measure the actual pressure/force values:

- **Pressure Transducers:** allow easy system integration and cost effective solution for both pressure and force controls, see tech table **GS465** for E-ATR-8 pressure transducer details
- **Load Cell Transducers:** allow the user to get high accuracy and precise regulations for force control, but it increases the complexity of the mechanical installation

The characteristics of the remote pressure/force transducers must be always selected to match the application requirements and to obtain the best performances: transducer nominal range should be at least 115÷120 % of the maximum regulated pressure/force.