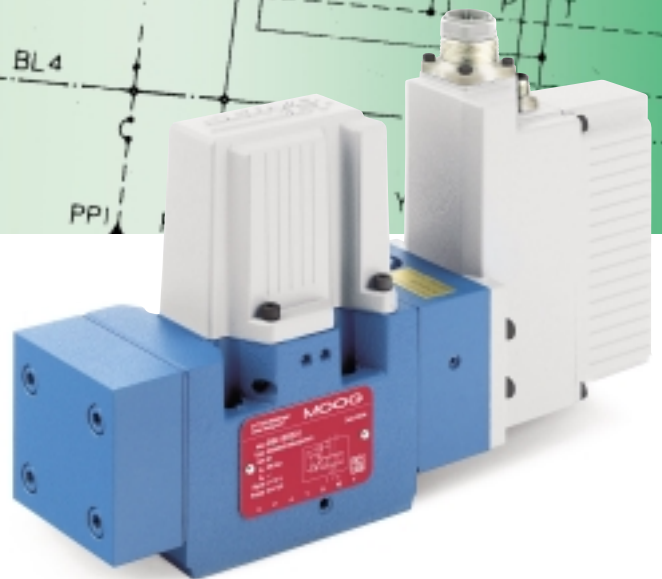


## D941 Series pQ-Proportional Valves with Integrated Digital Electronics and CAN Bus Interface



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General Technical data	5
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Hydraulic with Field Bus/ General	10
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**MOOG SERVO AND PROPORTIONAL VALVES**

For over 30 years Moog has manufactured servo and proportional control valves with integrated electronics. During this time more than 200,000 valves have been delivered. These servo control valves have been proven to provide reliable control, including injection and blow molding equipment, die casting machines, presses, heavy industry equipment, paper and lumber processing, wind turbines and other applications.

**TWO-STAGE pQ-PROPORTIONAL VALVES WITH *SERVO*<sup>®</sup> PILOT STAGE**

The pQ-proportional valves of the D941 series are throttle valves for 2x2-, 3-, 4- or even 5-way applications.

The pQ-valves control a flow and regulate a pressure (upper or lower limiting pressure). Thus, they can be used for both pressure regulation as well as pressure-limit regulation. The regulating electronics for the spool position and the pressure are integrated in the valve as is a pressure sensor.

The valves have been continuously improved. The Jetpipe pilot stage is based on the steel pipe principle which has proven itself in various MOOG valve series over the past 15 years. The Jetpipe has been further developed into the ServoJet<sup>®</sup> pilot stage.

The integrated valve electronics are deliverable with a 24 Volt supply voltage.

Our Quality Management System conforms to DIN EN ISO9901

**NOTES**

- Before installation of the valve into the system, the complete hydraulic system must be flushed.
- Please read the notes in section entitled "Electronics", page 7.
- All inch dimensions are in ( ).

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This catalog is for users with technical knowledge. To ensure that all necessary characteristics for function and safety of the system are given, the user must check the suitability of the products described herein. In case of doubt, please contact Moog.

For the most current information, visit [www.moog.com](http://www.moog.com)

**Q-, p-, pQ-FUNCTIONALITY**

The valves have full pQ-functionality and can be switched between flow function and/or working pressure regulation. With the pQ-function, flow regulation and pressure regulation are possible with just one proportional valve. The switch is performed through appropriate parameterization via the CANopen interface.

**DIGITALE ELECTRONICS**

The digital driver and control electronics are integrated into the valve. The valve electronics contain a microprocessor system which performs all important functions via the valve software it contains. The digital electronics enables the valve to be controlled across the entire working range, without drift and almost regardless of the temperature.

**CAN BUS INTERFACE**

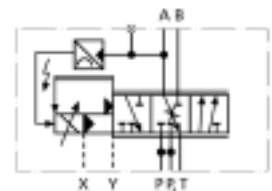
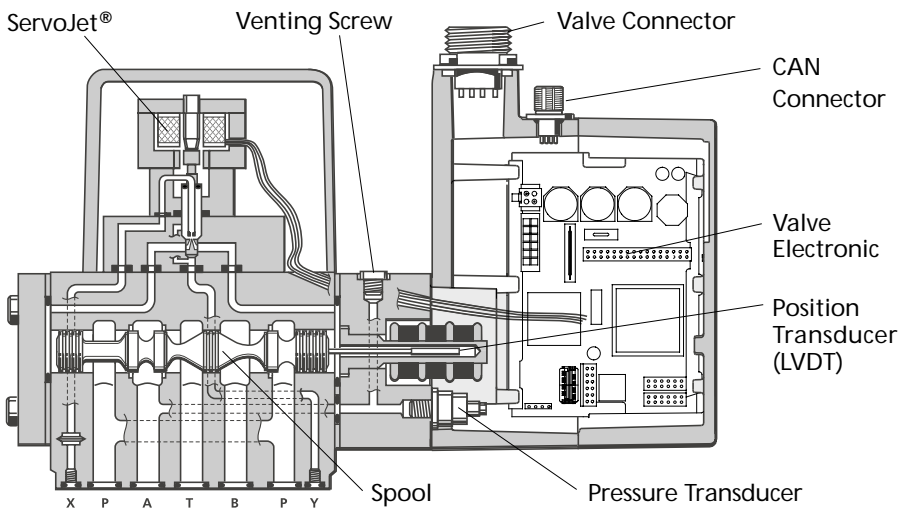
The valves are parameterized, activated, and monitored via the built-in CAN bus interface in accordance with the CiA standard DSP 408 (device profile fluid power technology).

In addition, up to two analog input commands or digital inputs, and up to two analog actual value outputs with programmable functions, are available as options.

**ADVANTAGES OF THE DIGITAL pQ-PROPORTIONAL VALVES OF THE D941 SERIES**

- **CANBus communication:** Diagnostic capabilities, integrated monitoring of key environment and internal data; valve parameters can be changed on-site or from another location.
- **Flexibility:** The ability to download the parameters via the fieldbus connection or directly from the upper PLC program enables optimal tuning of the valve parameters during the machine cycle even when the machine is in operation.
- **Superior control:** The improved frequency response of this version allows high closed-loop position loop gain, providing excellent static and dynamic response and a superior control system performance. The improved valve dynamic performance is due to the extremely high natural frequency of the ServoJet® pilot stage (500 Hz) and the implementation of advanced control algorithms, which is only possible with digital electronics.
- **Energy savings:** Considerably improved flow recovery (more than 90% of the pilot stage internal flow) contributes to energy savings, especially for machines with multiple valves.
- **Reliability:** The high pressure recovery of the ServoJet® pilot stage (up to 80% Δp at 100% command signal) provides higher spool driving forces and ensures enhanced spool position repeatability.
- **Safety:** Fail-safe versions with defined safe spool position using a spring or by external supply cut off ensure operator safety.
- **Cost savings:** Because the pressure control circuit is adjustable via the software and not via passive electronic components, it is now possible to keep a single valve on hand for multiple applications, eliminating the need to keep several valve types in storage.

**D941 SERIES TWO STAGE DIGITAL pQ-PROPORTIONAL VALVE**



**Hydraulic symbol:** Symbol shown with pilot pressure, electric supply enable signal on.

## PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

### Maximum operating pressure

Main stage:	
Ports P, A, B	350 bar (5000 psi) (dependent on pressure transducer)
Port T with Y internal	210 bar (3000 psi)
Port T with Y external	250 bar (3500 psi)
Pilot stage: series version	
with integrated throttle (on request)	280 bar (4000 psi) 350 bar (5000 psi)

### Allowable ambient conditions

Ambient temperature	-20 °C to +60 °C (-4 to 140 °F)
Vibration resistance	30 g, 3 axes, frequency: 5 Hz...2 kHz
Shock resistance	60 g, 6 directions

### Seal material

NBR, FPM, others upon request

### Hydraulic fluid

Allowable fluids	Mineral oil-based hydraulic fluid in accordance with DIN 51524 parts 1-3, other fluids upon request
Allowable temperature	-20 °C to +80 °C (-4 to 184 °F)

### Viscosity

recommended	15-45 mm <sup>2</sup> /s (cst)
allowable	5-400 mm <sup>2</sup> /s (cst)

### Cleanliness level, recommended

for functional safety	ISO 4406 < 19 / 16 / 13
for life circle (wear and tear)	ISO 4406 < 17 / 14 / 11

### System filter

Filter level, recommended	
for functional safety	$\beta_{15} \geq 75$ (15 $\mu\text{m}$ absolut)
for life cycle (wear and tear)	$\beta_{10} \geq 75$ (10 $\mu\text{m}$ absolut)

### Shipping plate

Delivered with oilproof shipping plate

### Mounting option

any position, consider air vent location

### Protection type

in accordance with DIN EN60529	IP 65
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**OPERATIONAL MODES FOR PROPORTIONAL VALVES**

**FLOW CONTROL (Q-CONTROL)**

During this operating mode, the spool position is controlled. The predefined command signal is proportional to a particular spool position.

The command signal (spool position command) is fed to the valve electronics. A position transducer (LVDT) measures the spool's actual position and forwards this information to the valve electronics. The electronics compares the actual spool position and command signal, and generates a signal to drive the ServoJet®, which then brings the spool into the correct position.

The position command can be influenced with parameters in the valve software (i.e.: linearization, ramping, dead band, sectionally defined amplification, etc.).

**PRESSURE CONTROL (p-CONTROL)**

During this operating mode of the D941 valve, the pressure in port A<sup>1)</sup> is controlled. The predefined command signal corresponds to a particular pressure in port A.

The command signal (pressure command in port A) is transmitted to the valve electronics. A pressure transducer measures the pressure in port A and feeds this to the valve electronics. The electronics compares the actual pressure signal and command signal and generates a signal to drive the ServoJet®, which then brings the spool into the correct position. The pressure control function can be influenced with parameters in the valve software (i.e.: linearization, ramping etc.). The pressure regulator is carried out as an extended PID controller. In the valve software, you can set the parameters of the PID controller.

**FLOW CONTROL AND PRESSURE CONTROL (pQ-CONTROL)**

This is a combination of flow and pressure control for which both command signals (flow and pressure command) must be present.

The following are examples of possible combinations:

- Flow control with pressure limiting control
- Forced changeover from one operating mode to the other

**VALVE FLOW CALCULATIONS**

The actual valve flow is dependent on the spool and the pressure drop across the spool lands.

At 100% command signal (i.e. +10V DC = 100% valve opening), the valve flow at rated pressure drop  $\Delta p_N = 5 \text{ bar}$  (70 psi) per metering land is the rated flow  $Q_N$ . For other than rated pressure, drop the valve flow changes at constant command signal according to the square root function for sharp edged orifices.

$$Q = Q_N \cdot \sqrt{\frac{\Delta p}{\Delta p_N}}$$

$Q$  [l/min] = calculated flow  
 $Q_N$  [l/min] = rated flow  
 $\Delta p$  [bar] = actual valve pressure drop  
 $\Delta p_N$  [bar] = rated valve pressure drop

**EXTERNAL PILOT PRESSURE**

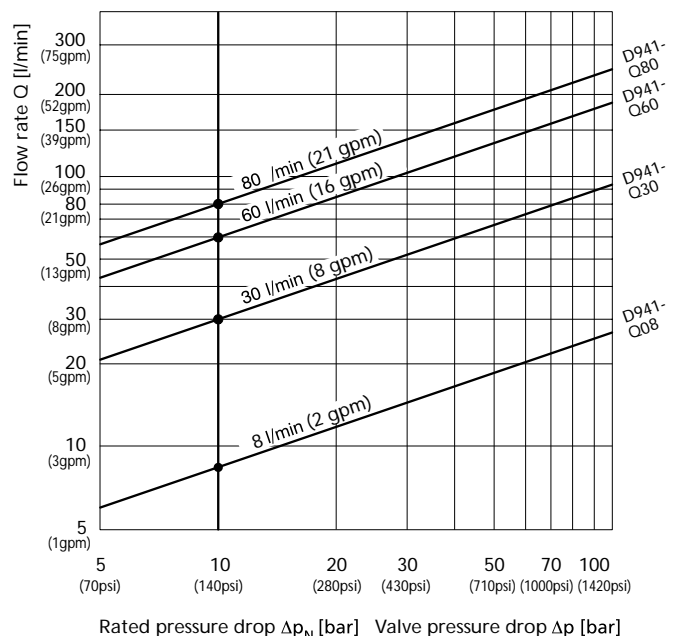
If large flow rates with high valve pressure drop are required an appropriate higher pilot pressure has to be chosen to overcome the flow forces. An approximate value can be calculated as follows:

$$p_x \geq 1,7 \cdot 10^{-2} \cdot \frac{Q}{A_K} \cdot \sqrt{\Delta p}$$

$Q$  [l/min] = max. flow  
 $\Delta p$  [bar] = valve pressure drop with  $Q$   
 $A_K$  [cm<sup>2</sup>] = spool drive area  
 $\Delta p_N$  [bar] = rated pressure drop per spool edge

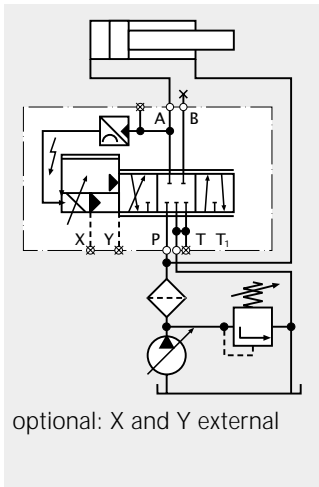
The pilot pressure  $p_x$  has to be at least 25 bar (350 psi) above the return pressure of the ServoJet® pilot stage.

**VOLUME FLOW DIAGRAM (4-WAY-FUNCTION)**



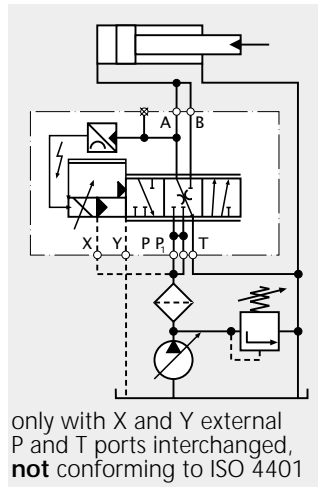
<sup>1)</sup> see page 6 / explanation to 4 way valve in main circuit

3-way valve in main line



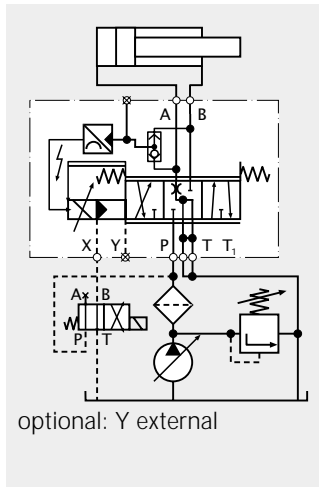
The device operates as a 3-way-pressure reducing valve with flow from P → A or A → T. Only one load port (A) is used.

5-way valve in main line



The device operates like the 3-way pQ-valve but with doubled flow rate into the load. A directional change of the load-motion requires an external force.

4-way valve in main line

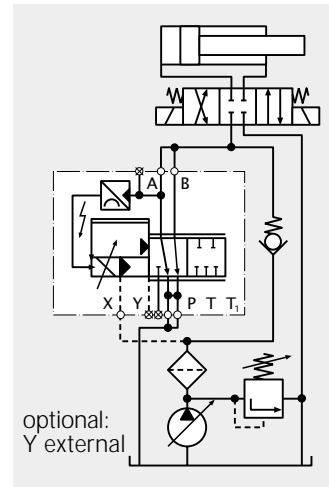


**Without shuttle valve.**  
The device operates from P → A like a 3-way pQ-valve. In the opposite direction P → B it allows only flow modulation. By this means the direction of load motion can be reversed (open loop velocity control for load retract).

**With shuttle valve.**

The device operates as an electrically adjustable 4-way throttle valve, i.e. the load can be operated with pressure control in both directions of motion. Only one of the load ports is pressure controlled. The shuttle valve transmits the driving (higher) load pressure to the single pressure transducer. An electronic logic circuit provides for the coordination of motion direction and pressure control depending on the polarity of the flow rate command signal. The other port is more or less open to tank line which is provided by the special spool land location. The spring centered fail-safe version requires external pilot supply port X to be used.

2x2-way valve in by-pass line (bleed off)



The device has parallel flow paths and operates as electrically adjustable pressure relief valve from A → T and B → T<sub>1</sub>, respectively. At zero command signal the valve is fully open, i.e. the pressure in the load ports is zero apart from minor pressure build up due to line losses. A minimum pilot pressure ( $p_x > 25 \text{ bar (350 psi)}$ ) has to be secured. This can be achieved by a check valve with 25 bar (350 psi) cracking pressure (as shown) or by a separate pilot supply pump.

**Venting of pressure transducer**

Before first operation of the valve the internal lines of the pressure transducer must be carefully vented. When selecting the installation position of the valve care must be taken that the bleeding screw can become effective. If the load is located higher than the PQ-Valve the load also must be vented at its highest point.

**Caution: Vent only at reduced pressure! Danger of injury!**

**GENERAL REQUIREMENTS FOR VALVE ELECTRONICS**

- Supply 24 V DC, min. 18 V DC, max. 32 V DC.  
Current consumption max. 350 mA for valve electronics.  
Current consumption 24 V DC for electrical failsafe valve and current consumption 1,35 A on pin 1 ➔ 2
- All signal lines, also those of external transducers, shielded.
- Shielding connected radially to  $\perp$  (0 V), power supply side, and connected to the mating connector housing (EMC)
- EMC: meets the requirements of emission of EN55011:1998 (limit class: B+A1:1999) and immunity according to EN61000-6-2:1999
- External protection 0,5 A inert
- Duty ratio 100%
- Max. power input 8,4 W (350 mA at 24 V DC)
- Minimum cross-section of all leads  $\geq 0,75 \text{ mm}^2$  (AWG 18). Consider voltage losses between cabinet and valve.
- Note: When making electric connections to the valve (shield, protective earth) appropriate measures must be taken to ensure that locally different earth potentials do not result in excessive ground currents.  
Also see Moog Technical Note TN353.

**SIGNAL AND WIRING FOR VALVES WITH ANALOGUE ACTIVATION / CONTROL DRIVE POSSIBILITY WITH 11+PE-POLE CONNECTOR**

**Command signal 0 to 10 mA (p-function), floating,**  
**Command signal 0 to  $\pm 10$  mA (Q-function), floating,**  
**Valves with current command input**

The spool stroke of the valve for the volume flow function is proportional  $I_4 = -I_5$  (at  $I_7 = 0$  ).  
The command signal  $I_4 = +10 \text{ mA}$  equals 100 % valve opening  $P \rightarrow A$  und  $B \rightarrow T$  .  
At 0 mA command the spool is in center position.  
In pressure function (0 to 10 mA), the pressure is at port A of the valve proportional resp.  $I_7 = -I_5$  (at  $I_4 = 0 \text{ mA}$ ).  
 $I_7 = +10 \text{ mA}$  equals 100% regulated pressure in port A.

**Command signal 0 to 10 V (p-function), floating,**  
**Command signal 0 to  $\pm 10$  V (Q-function), floating,**  
**Valves with voltage command input**

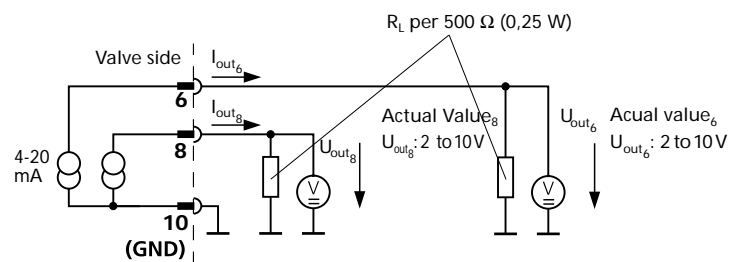
The spool stroke of the valve at volume flow function is proportional  $(U_4 - U_5)$ .  
The command signal  $(U_4 - U_5) = +10 \text{ V}$  equals 100 % valve opening  $P \rightarrow A$  and  $B \rightarrow T$  .  
For 0 V command the spool is in central position. In pressure function (0 to 10V) the pressure at port A of the valve is proportional  $(U_7 - U_5)$ .  
 $(U_7 - U_5) = +10 \text{ V}$  equals 100% regulated pressure in port A.

**Actual value 4 to 20 mA**

The actual spool position value (not valve) for flow volume resp. pressure at port A at pressure function, can be measured at 6 and 8 at 11+PE pole connector (see diagrams below). Those signals can be used for monitoring and fault detection purposes. The spool stroke resp. pressure range corresponds to 4 to 20 mA.  
At 12 mA spool position signal the spool is in centered position. 20 mA equals 100% valve opening  $P \rightarrow A$  and  $B \rightarrow T$  .

The position signal output 4 to 20 mA allows to detect a cable break when  $I_F = 0 \text{ mA}$ .

**Circuit diagram for measurement of actual value  $I_6$  (position of spool) and  $I_8$  (pressure in port A)<sup>1)</sup> for valves with 11+PE pole connector**



**Note: Enable input**

With enable signal of  $< 6,5 \text{ V}$  the main spool will move to a safe position.

- Defined centered position, spool position  $\pm 3\%$  (unbiased pilot valve). Function code  $K^2$
- End position (biased pilot valve). Function code  $L^2$

<sup>1)</sup> see page 6 / Explanation to 4 way valve in main circuit

<sup>2)</sup> see ordering information

**WIRING FOR VALVES WITH 11+PE-POLE CONNECTOR**

to EN175201 part 804, mating connector (metal) with leading protective earth connection (⊕).

Pin	Input Function	Voltage floating ±10 V, 0 to 10 V	Current floating ±10 mA, 0 to 10 mA, 4 to 20 mA
1	Not used		
2	Not used		
3	Release Input	8.5 to 32 V DC based on pin 10: operation of the proportional valve enabled < 6.5 V DC based on pin 10: proportional valve failsafe condition	
4	Input Valve flow function	$U_{in} = U_{4-5}$ $R_{in} = 300 \text{ k}\Omega$	$I_{in} = I_4 = -I_5$ (with $I_7=0$ ) <sup>1)</sup> $R_{in} = 200 \Omega$
5	Reference Input rated command	Reference to ground for pin 4 and 7	common feedback for Pin 4 and 7
6	Output Actual valve spool position	$I_{out} = 4$ to 20 mA based on GND ( $I_{out}$ is proportional to the position of the spool; the output is short circuit protected); $R_L = 0$ to 500Ω	
7	Input command Pressure function	$U_{in} = U_{7-5}$ $R_{in} = 300 \text{ k}\Omega$	$I_{in} = I_7 = -I_5$ (with $I_4=0$ ) <sup>2)</sup> $R_{in} = 200 \Omega$
8	Output Actual pressure	$I_{out} = 4$ to 20 mA based on GND ( $I_{out}$ is proportional to the actual pressure in port A <sup>3)</sup> ; the output is short circuit protected); $R_L = 0$ to 500Ω	
9	Supply voltage	24 V DC (18 to 32 V DC)	
10	Supply ground	0 V (GND)	
11	Digital output	Error control <sup>4)</sup>	
⊕	Protective conductor contact		

The potential difference from pin 4, 5 and 7 (measured against pin 10) each must be between -15 V and +32 V.

<sup>1)</sup> Nominal valve signal  $I_{in} < 3 \text{ mA}$  (for example from conductor break) means defect for signal range 4 to 20 mA. For safety, the valve is disconnected and goes to failsafe position.

<sup>2)</sup> As pin 5 is the common feedback for pin 4 and pin 7,  $-I_5 = I_4 + I_7$  applies.

<sup>3)</sup> See page 6 / explanation to 4 way valve in main circuit.

<sup>4)</sup> Output could be programmed by factory, „low“ signal means defect (for example nominal-actual deviation).



**CAN CONNECTOR M12 x 1**  
 To CiA Draft Recommendation DR-303-1

Pin	Signal	
1	CAN_SHLD	shield
2	CAN_V+	No connection in the valve
3	CAN_GND	
4	CAN_H	Transceiver H
5	CAN_L	Transceiver L

**STATUS DISPLAY**

The valve's operating mode and the network status are displayed on multicolor light emitting diodes (status display LEDs) on the electronics housing.

**MODULE STATUS LED (MS)**

The Module Status LED displays operational and error states.

MODULE STATUS LED (MS)	CONDITION
off	no supply power
green	normal operation
blinking green	valve standby mode
blinking red	correctable error
red	unrecoverable error
blinking red-green	self-test

**NETWORK STATUS LED (NS)**

The network status LED displays the status of the CAN network.

NETWORK STATUS LED (NS)	CONDITION
off	no supply power / not online
blinking green	online, but not connected to other CAN bus nodes
green	online and connected to other CAN bus nodes
blinking red	time overrun
red	major error
blinking red-green	self-test



Status display LEDs

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## GENERAL

Modern automation technology is characterised by an increasing decentralization of processing functions via serial data communication systems. The use of serial bus systems instead of conventional communication technology,

ensures the increased flexibility of systems in terms of modifications and expansions. It also has a tremendous potential for savings in project and installation costs in many areas of industrial automation.

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## VDMA PROFILE

In one working group within the German Machinery and Plant Manufacturers' Association, a VDMA profile was created in collaboration with numerous well-known hydraulic system

manufacturers. This profile describes communication between hydraulic components via a field bus. It defines uniform functions and parameters in a standardized exchange format.

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## CANopen

The first field bus to be used in the hydraulics system is the CAN bus. It was originally developed for use in automobiles, but has been used in mechanical engineering in a variety of applications. The CAN bus is primarily designed for transmission security and speed.

### The CAN bus has the following overlapping characteristics:

- Multi-master system:  
Each participant can transmit and receive.
- Topology: Linear structure with short stub line.,
- Network extension: 25 meters at 1 Mbit/s up to 5000 meters at 25 kbit/s.
- Addressing type: message-oriented via identifier.  
Priority assignment of the message via identifier.
- Security: Hamming distance = 6, i.e. up to 6 individual errors/messages are recognized.

Based on the short data field of 64 bits (8 bytes), total telegram length is 111 bits. With a maximum transmission rate of 1 Mbit/s this corresponds to a total transfer time of 111  $\mu$ s. The high transmission rate allows for closing the control loop via the field bus.

Other parameterization and improved diagnosis capabilities and the reduction of the number of variants, are some of the benefits possible when using a field bus.

## GENERAL

The Windows®-based configuration software “Moog Valve Configurator” enables fast and convenient commissioning, diagnosis and configuration of the valve. The software communicates with the valve via the CANopen field bus. This requires a PC-installed CAN interface card. Data from the PC can be transferred to the valve or the most current valve settings can be saved on the PC and output. The valve can be controlled

via graphic control elements. Status information, set values and actual values as well as characteristic lines, are displayed graphically.

System parameters can be recorded and visualized via an integrated oscilloscope/data logger.

## CONFIGURATION SOFTWARE „MOOG VALVE CONFIGURATOR“

### System requirements:

The configuration software can be configured on a PC with the following minimal requirements:

- IBM compatible PC with at least 133 MHz
- Windows® 95/98/ME, Windows® NT/2000/XP
- 64 MB RAM
- 5 MB free hard disk memory
- Monitor 640x480 pixel resolution
- Keyboard, mouse

### Recommended requirements:

- IBM compatible PC with 300 MHz
- Windows® NT/2000/XP

To use the software in online mode, the following additional equipment is required:

- A free PCI or PCMCIA slot
- CAN interface card (PCI or PCMCIA) from National Instruments
- A power supply 24 V DC / 2 A with CAN and valve connection cable with exclusion resistor, Moog order number see page 19.



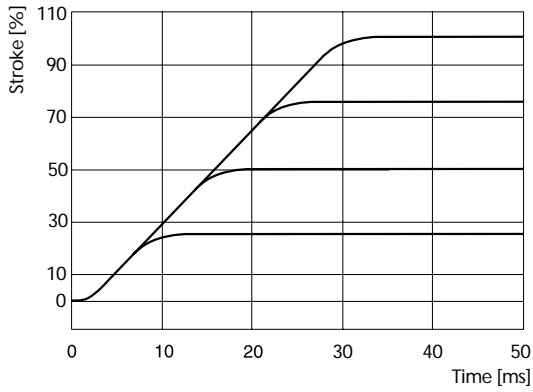
PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

Valve construction type	Spool version, two stage
Mounting pattern	In accordance to ISO, additional with 2. tank port ISO 4401 - 05 - 05 - 0 - 94
Ø of the ports	11,5 mm (0.44 in)
Valve configuration	2-way, 3-way, 4-way, 5-way and 2x2-way function
Pilot stage	ServoJet®
Pilot oil supply	Optional external or internal (see page 6)
Rated flow $Q_N$	l/min 8 / 30 / 60 / 80 / 2 x 80    gpm 2 / 8 / 16 / 21 / 2 x 21 ±10% at $\Delta p_N = 5 \text{ bar (70 psi)}$ per control edge
Max. leakage flow $Q_L$ <sup>1)</sup>	Total maximum        3,5 l/min (0.91 gpm) Pilot stage alone        1,7 l/min (0.44 gpm)
Step response time for 0 to 100% stroke <sup>1)</sup>	27 ms (typical)
Threshold <sup>1)</sup>	< 0,05 % (in Q-function) < 0,1 % (in p-function), dependent from optimization
Hysteresis <sup>1)</sup>	< 0,3 % (in Q-function) < 0,2 % (in p-function), dependent from optimization
Null shift <sup>1)</sup>	< 1,0 % (in Q-function) < 1,0 % (in p-function)
Linearity of pressure control	< 0,5 %
Spool stroke	± 3 mm (0.11 in)
Spool front surface	2 cm <sup>2</sup> (0,76 in <sup>2</sup> )

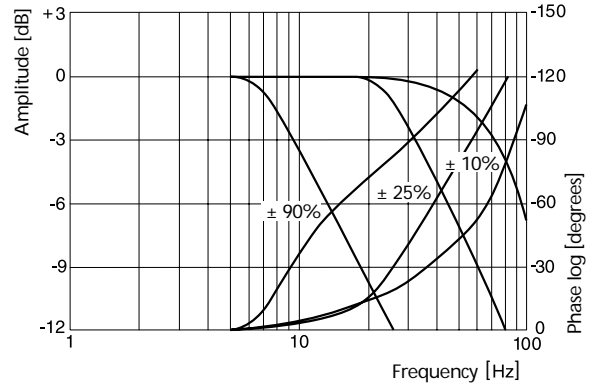
<sup>1)</sup> Operating pressure  $p_x = 210 \text{ bar (3000 psi)}$ , oil viscosity  $\nu = 32 \text{ mm}^2/\text{s (32 cst)}$  and an oil temperature of  $40^\circ \text{ C (92 }^\circ\text{F)}$

Typical characteristic curves for step response and frequency response at 140 bar (2000 psi) pilot or operating pressure, fluid viscosity  $\nu=32 \text{ mm}^2/\text{s}$  (1,22 cst) and oil temperature of 40 °C (92 °F).

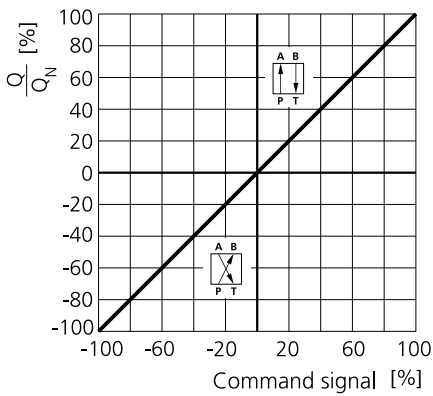
STEP RESPONSE



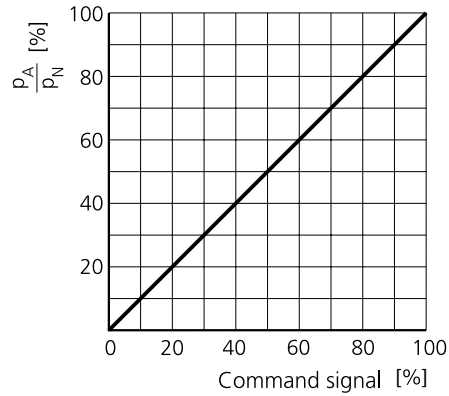
FREQUENCY RESPONSE



VOLUME-SIGNAL CURVE

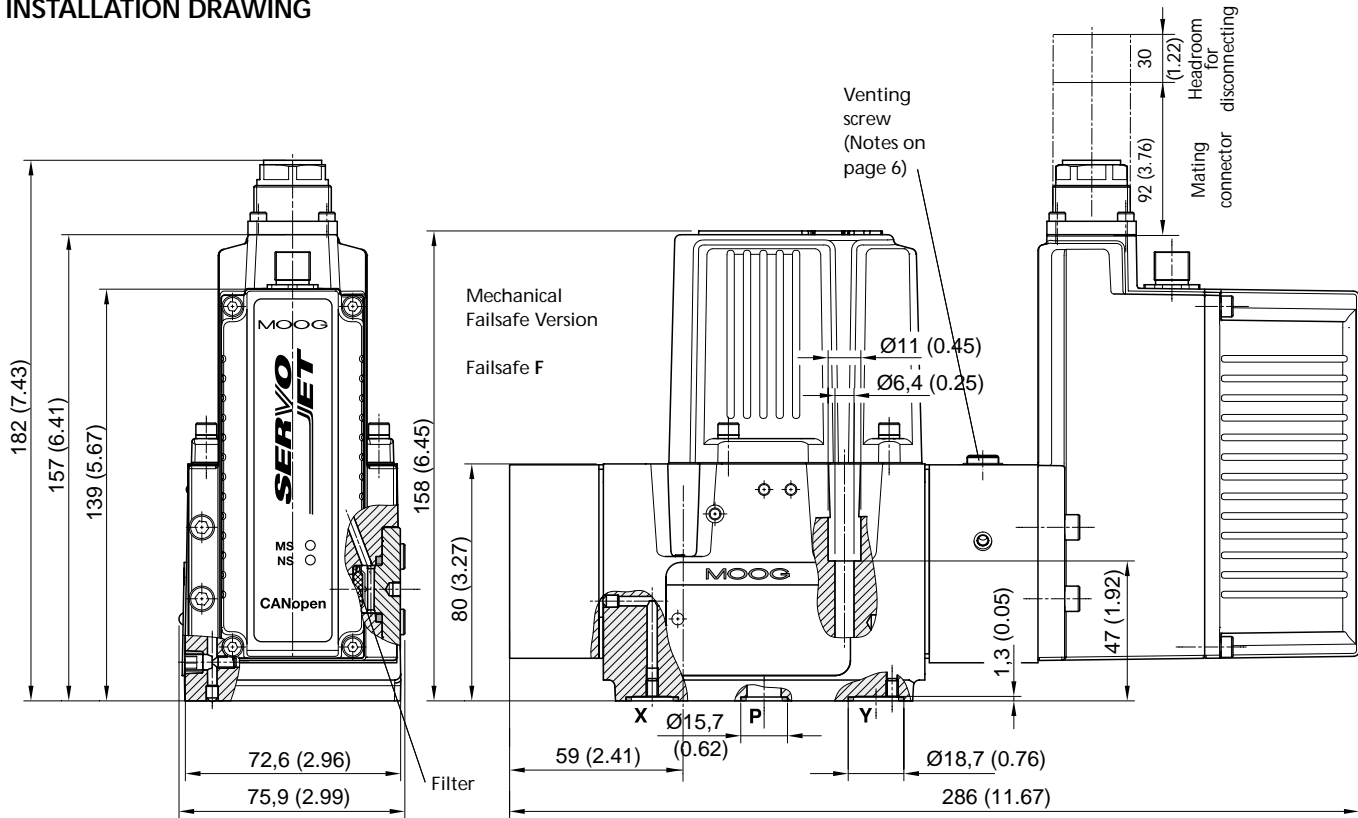


PRESSURE-SIGNAL CURVE  
(PRESSURE CONTROLLED VALVE)



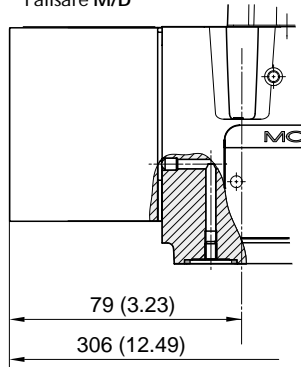
**Note:** It is necessary to adapt the internal pressure control electronics of the valve to the load conditions for any new application. If required please contact Moog for assistance.

INSTALLATION DRAWING



Mechanical Failsafe Version

Failsafe M/D

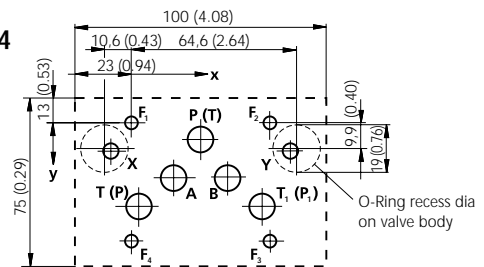


THE MOUNTING MANIFOLD MUST CONFORM TO ISO 4401-05-05-0-94

Attention: Notice O-ring recess dia of X and Y ports. For valves in 4-way version with  $Q_N > 60$  l/min (16 gpm) and in 2x2-way version, the non-standard 2<sup>nd</sup> return port T<sub>1</sub> must be used. With 5-way version, replace T to P.

For maximum flow, the manifold ports P, T, T<sub>1</sub>, A and B are required to have 11,5 mm (0.47) dia (deviation from standard).

Mounting surface needs to be flat within 0,01 mm over a distance of 100 mm. Average surface finish value, R<sub>a</sub> better than 0,8 µm.



	P	A	B	T	T <sub>1</sub>	X	Y	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>
	Ø11,5 (0.47)	Ø11,5 (0.47)	Ø11,5 (0.47)	Ø11,5 (0.47)	Ø11,5 (0.47)	Ø6,3 (0.26)	Ø6,3 (0.26)	M6	M6	M6	M6
x	27 (1.10)	16,7 (0.68)	37,3 (1.52)	3,2 (0.13)	50,8 (2.07)	-8 (-0.33)	62 (2.53)	0	54 (2.20)	54 (2.20)	0
y	6,3 (0.26)	21,4 (0.87)	21,4 (0.87)	32,5 (1.33)	32,5 (1.33)	11 (0.45)	11 (0.45)	0	0	46 (1.88)	46 (1.88)

**VALVES FOR APPLICATIONS WITH SAFETY REQUIREMENTS (FAILSAFE) WITH 11+PE CONNECTOR**

For applications with proportional control valves where certain safety regulations are applicable, a safe metering spool position is needed in order to avoid potential damage. Therefore, a failsafe version is offered as an option for the two-stage Moog Proportional Control Valves.

After switching off the 24 V supply to the safety solenoid valve, this failsafe function causes a safe metering spool position, overlapped centered position or fully opened A➔T or B➔T.

In order to move the spool to the safe centered position with D941 Series failsafe valves, the two control chambers of the main stage are hydraulically short circuited via a 2/2-way solenoid valve. The spring force moves the spool into the overlapped centered position.

With failsafe valves, it is possible to check whether the main spool is in safe position. If the main spool is within the defined safe range, the logic output signal at pin 11 is  $> + 8.5 \text{ V}$ . If this signal is  $< + 6.5 \text{ V}$ , then the main spool is outside the safe range. This logic signal may be delayed up to 500 ms. To reduce the failsafe switching time, it is advised to both switch off the supply of the 2/2 way valve and the enable signal at the same time.

**NOTE:**

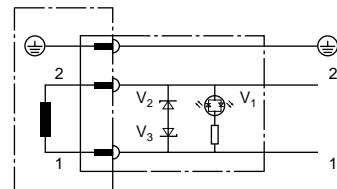
According to DIN-EN 954-1, a higher safety category can be achieved if a failsafe valve is used. On this attention should be paid to appropriate machine safety standards.

**ELECTRIC CHARACTERISTICS**

2/2-way solenoid valve for the failsafe version.  
For more information on failsafe versions, see Moog Application Note AM 423 E.

Valve version	2/2-way solenoid valve
Function	electro magnetic
Nominal voltage $U_N$	24 V DC (min. 22,8 V DC, max. 26,4 V DC)
Nominal power $P_N$	26 W

Connector wiring



DIN EN 175301 Part 803  
with free wheel- and light diode

**WIRING FOR VALVES WITH 11+PE-POLE CONNECTOR WITH INTEGRATED FAILSAFE SUPPLY**  
 to EN 175201 part 804, mating connector (metal) with leading protective earth connection (⊕).

Pin	Input		Voltage floating ±10 V, 0 to 10 V	Voltage floating ±10 mA, 0 to 10 mA, 4 to 20 mA <sup>1)</sup>
	Function			
1	Supply, 2/2-way solenoid valve		24 V DC (min. 22,8 V DC, max 26,4 V DC, max 1,20 A)	
2	Supply, 2/2-way solenoid valve		⊥ (0 V)	
3	Release Input		8,5 bis 32 V DC based on pin 10: operation of the proportional valve enabled < 6,5 V DC based on pin 10: proportional valve failsafe condition	
4	Input Valve flow function		$U_{in} = U_{4-5}$ $R_{in} = 300 \text{ k}\Omega$	$I_{in} = I_4 = -I_5$ (bei $I_7=0$ ) <sup>1)</sup> $R_{in} = 200 \Omega$
5	Reference Input rated command		Reference to ground for pin 4 and 7	common feedback for Pin 4 and 7
6	Output Actual valve spool position		$I_{out} = 4$ to 20 mA based on GND ( $I_{out}$ is proportional to the position of the spool; the output is short circuit protected); $R_L = 0$ to 500 $\Omega$	
7	Input command Pressure function		$U_{in} = U_{7-5}$ $R_{in} = 300 \text{ k}\Omega$	$I_{in} = I_7 = -I_5$ (bei $I_4=0$ ) <sup>2)</sup> $R_{in} = 200 \Omega$
8	Output Actual pressure		$I_{out} = 4$ to 20 mA based on GND ( $I_{out}$ is proportional to the position in port A <sup>3)</sup> ; the output is short circuit protected); $R_L = 0$ to 500 $\Omega$	
9	Supply voltage		24 V DC (18 to 32 V DC)	
10	Supply ground		0 V (GND)	
11	Digital output		Error control <sup>4)</sup>	
⊕	Protective conductor contact			

The potential difference from pin 4, 5 and 7 (measured against pin 10) each must be between -15 V and +32 V.

<sup>1)</sup> Nominal the valve signal  $I_{in} < 3 \text{ mA}$  (for example from conductor break) means defect for signal range 4 to 20 mA. For safety, the valve is disconnected and goes to failsafe position.

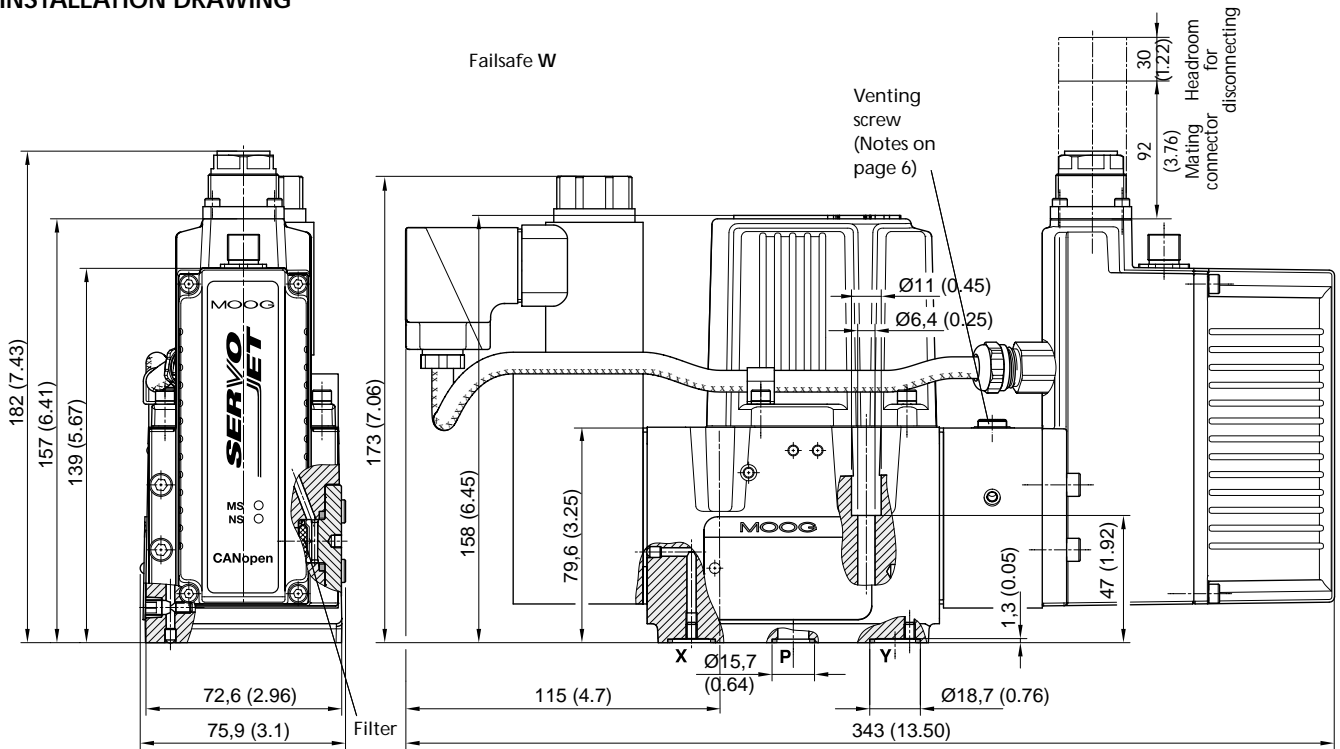
<sup>2)</sup> As pin 5 is the common feedback for pin 4 and pin 7,  $-I_5 = I_4 + I_7$  applies.

<sup>3)</sup> see page 6 / explanation to 4 way valve in main circuit

<sup>4)</sup> Output could be programmed by factory, "low" signal means defect (for example nominal-actual deviation).

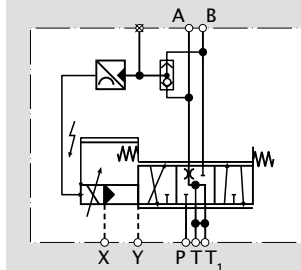


INSTALLATION DRAWING



The mounting manifold must conform to ISO 4401-05-05-0-94 (see page 14)

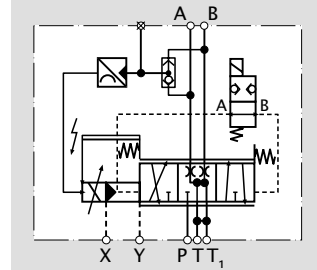
optional X and Y external



Version with spring centering

Version with 2/2-way solenoid valve and spring centering

optional X and Y external



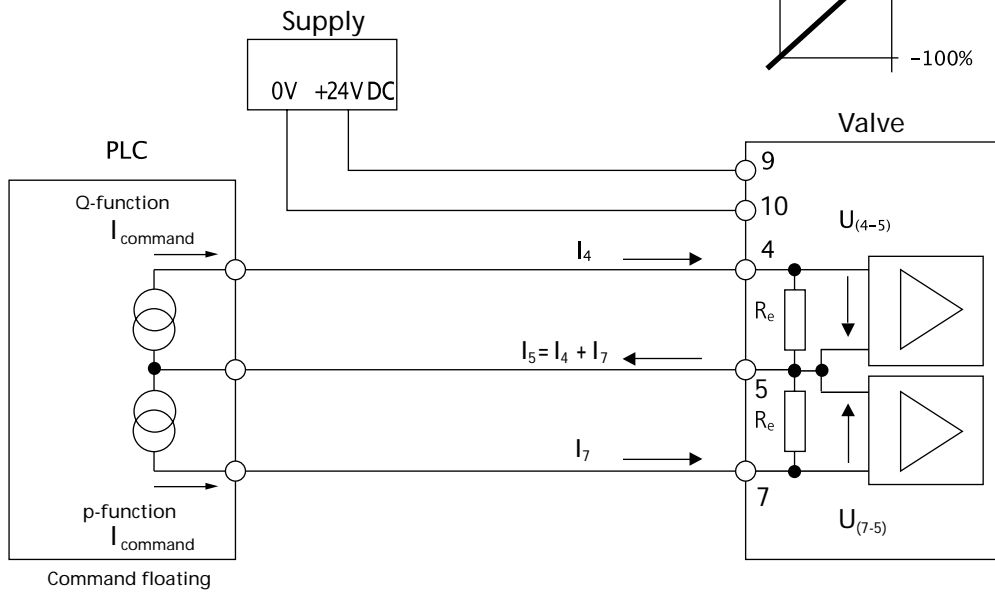
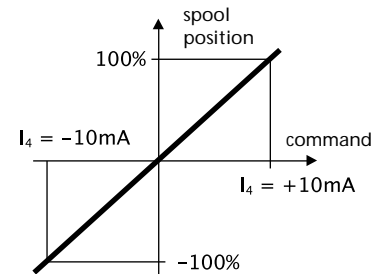
**SINGLE ANALOG INPUT 11+PE**

**0 to ± 10 mA floating input signal**

The spool stroke of the valve is proportional to  $I_4 = -I_5$ , if pressure limiting command signal  $I_7$  max. is supplied.

At  $I_4 = +10$  mA command signal the spool is 100% open  $P \rightarrow A$  and  $B \rightarrow T$ .

At  $I_4 = 0$  mA, the spool is in the defined centered position.

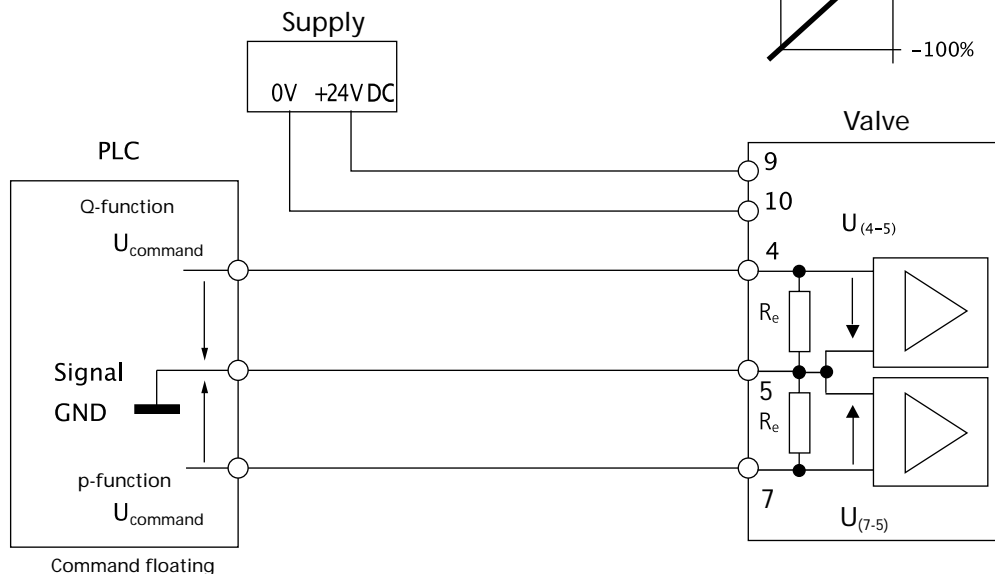
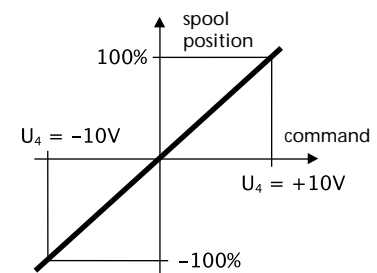


**0 to ± 10 V differential input signal**

The spool stroke of the valve is proportional to  $U_4$ , if pressure limiting command signal  $I_7$  max. is supplied.

$U_4 = +10$  V input moves spool 100%  $P \rightarrow A$  and  $B \rightarrow T$ .

At nominal value  $U_4 = 0$  V, spool in defined centered position.



## SPARE PARTS AND ACCESSORIES

Part designation	Quantity	Comments	Part number
<b>O-rings</b>		included in delivery	
for P, T, T <sub>1</sub> , A, B	5	ID 12,4 x Ø 1,8: (0.49) x Ø (0.07)	NBR 85 Shore FPM 85 Shore -45122-004 -42082-004
for X, Y	2	ID 15,6 x Ø 1,8: (0.61) x Ø (0.07)	NBR 85 Shore FPM 85 Shore -45122-011 -42082-011
<b>Service Seal Kit</b>	1		NBR 85 Shore B97215-N661F10
	1		FPM 85 Shore B97215-V661F10
<b>O-rings for filter change for filter</b>	1	ID 12 x Ø 2,0: (0.47) x Ø (0.08)	NBR 85 Shore FPM 85 Shore -66117-012-020 A25163-012-020
<b>for filter cover</b>	1	ID 17,1 x Ø 2,6: (0.67) x Ø (0.10)	HNBR 85 Shore FPM 85 Shore B97009-080 -42082-050
<b>Compatible filter element</b>	1	included in delivery	A67999-200
<b>Dust protection plate</b>	1	included in delivery	A40508
<b>Mating connector for 11+PE pin valve connector, waterproof, IP65 (metal)</b>	1	not included in delivery  DIN EN 175201-804  suitable cable with min. Ø11 mm (0.43), max. Ø 13 mm (0.51)	  B97067-111
<b>Flushing plate for P, A, B, T, T<sub>1</sub>, X, Y</b>	1		B67728-001
<b>for P, T, T<sub>1</sub>, X, Y</b>	1	not included in delivery	B67728-002
<b>for P, T, T<sub>1</sub> und X, Y</b>	1		B67728-003
<b>Installation screws</b>	4	not included in delivery  M 6 x 60 (2.36) DIN EN ISO 4762, quality class 10.9, Tightening torque: 11 Nm	  A03665-060-060
<b>Connection plate</b>		on request	
<b>Configuration software</b>	1	not included in delivery	B99104
<b>PCMCIA-CAN card</b>	1	not included in delivery	B95928-001
<b>PCI-CAN card</b>	1	not included in delivery	B95927-001
<b>Supply voltage 5A</b>	1	not included in delivery	B95925-001
<b>Power supply cable 2m (78.74)</b>	1	not included in delivery	B95924-002
<b>Start-up cable with load resistor 2m (78.74)</b>	1	not included in delivery	TD3999-137

Model number

Type designation

**D 941** . . . . .

1 2 3 4 5  
 . . . . .

<b>Specification status</b>	
-	Series specification
<b>E</b>	Preseries specification
<b>Z</b>	Special specification
<b>Model designation</b>	
-	assigned at the factory
<b>Factory identification</b>	
<b>1 Valve version</b>	
<b>Q</b>	Standard spool
<b>2 Rated flow</b>	
Q <sub>N</sub> (l/min) at Δp <sub>N</sub> = 5 bar per land	
<b>08</b>	8 (2 gpm)
<b>30</b>	30 (8 gpm)
<b>60</b>	60 (16 gpm)
<b>80</b>	80 (21 gpm)
<b>3 Pressure ranges</b>	
Q-control parameters of the valve electronics are adapted to the control pressure	
	Calibrated pressure for 100% signal pressure (bar)
	typical non-linearity (%)
<b>C</b>	105 (1500 psi) < 0,35
<b>D</b>	140 (2000 psi) < 0,25
<b>F</b>	210 (3000 psi) < 0,21
<b>K</b>	350 (5000 psi) < 0,17
<b>X</b>	Special version
<b>4 Spool type</b>	
<b>B</b>	3-way: P→A, A→T; ~critical lap, linear characteristic
<b>U</b>	5-way: P→A, P <sub>2</sub> →B; A→T; ~critical lap, curvilinear characteristic
<b>T</b>	4-way: linear characteristic P→A und P→B: 20% overlap A→T und B→T: 15% underlap
<b>Z</b>	2x2-way: A→T, B→T <sub>2</sub> ; linear characteristic, closed at 90% signal (by-pass mode only)
<b>X</b>	Special version
<b>5 Pilot stage</b>	
Version	Pilot flow (l/min) bei P <sub>X</sub> = 140 bar (2000 psi)
<b>A</b>	ServoJet 1,30

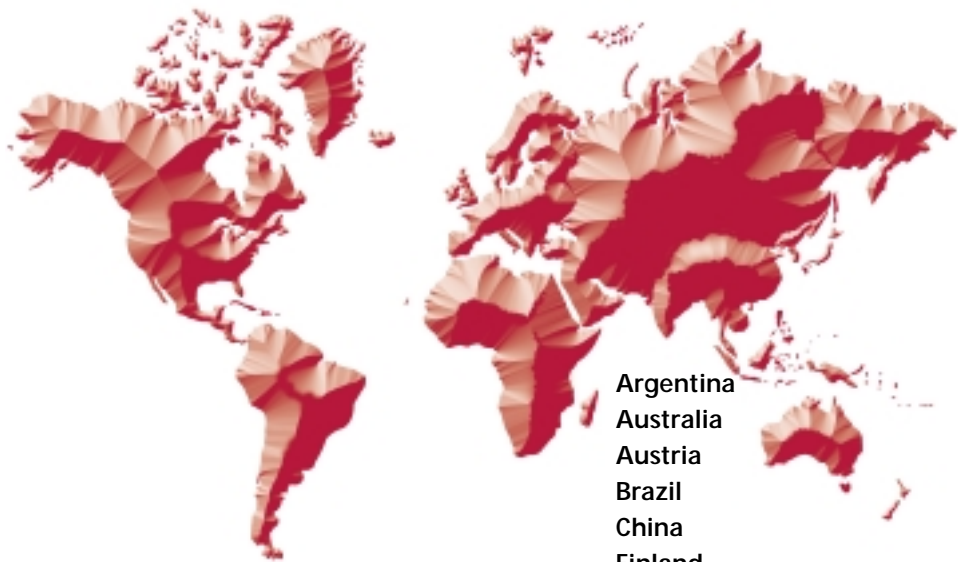
Options may increase price.  
 All combinations may not be available.  
 Preferred combinations are highlighted.

6	7	8	9	10	11	12	13	14	15																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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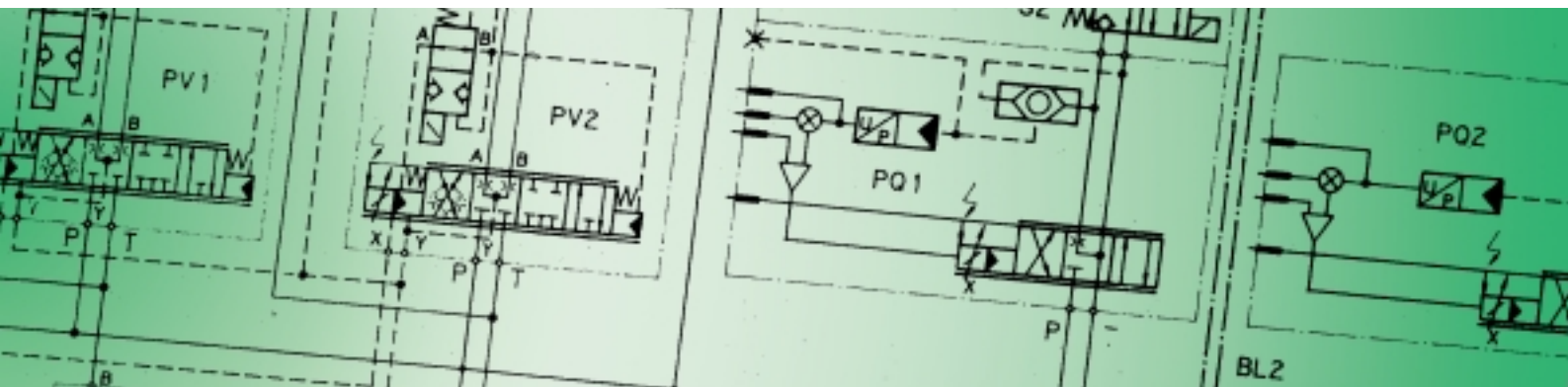
WV\* = 2/2-way solenoid valve / VEL\*\* = valve electronics







Argentina  
Australia  
Austria  
Brazil  
China  
Finland  
France  
Germany  
India  
Ireland



Italy  
Japan  
Korea  
Luxembourg  
Norway  
Philippines  
Russia  
Singapore  
South Africa  
Spain  
Sweden  
United Kingdom  
USA

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