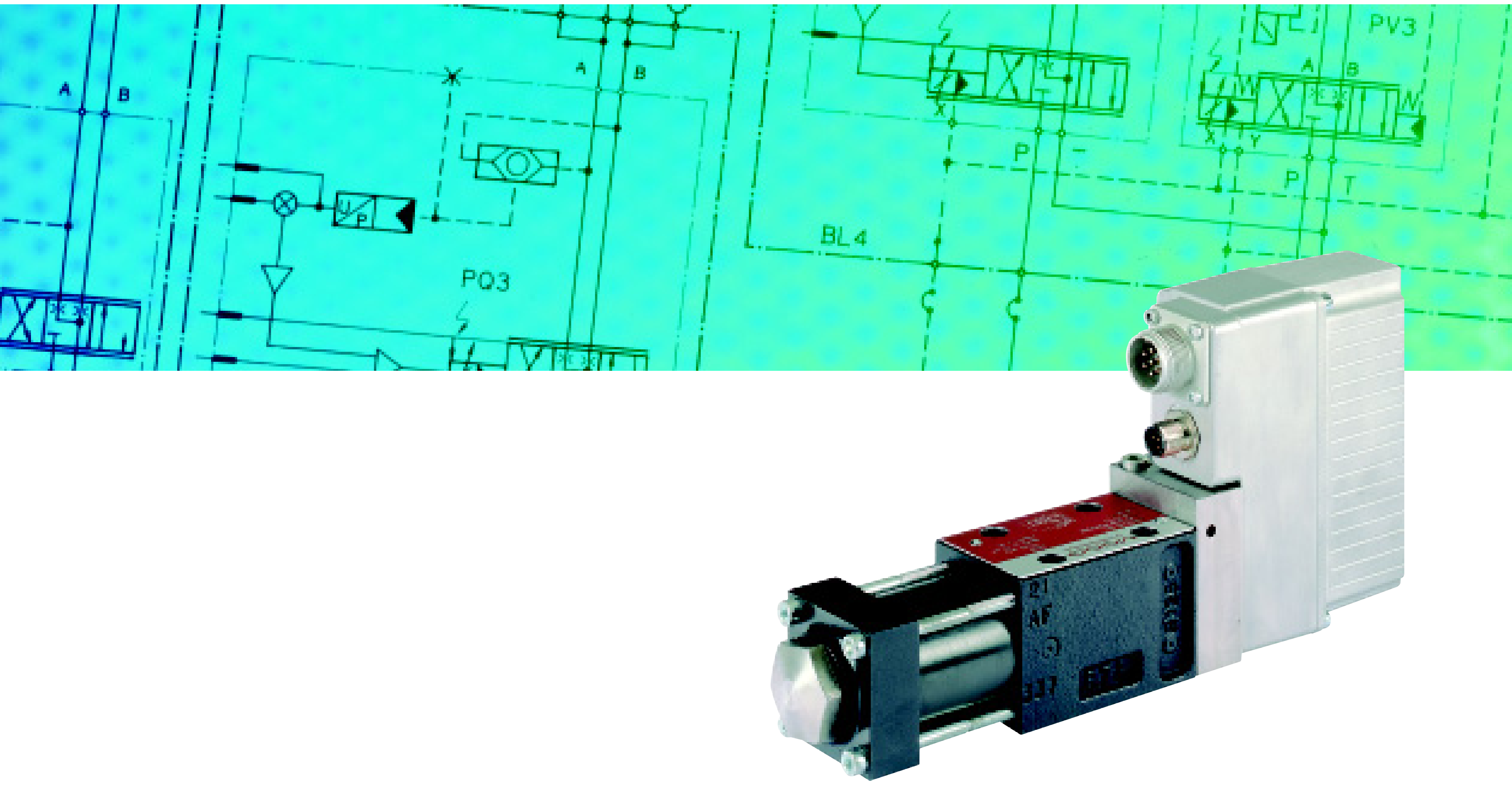
Operating Instructions

D636/D638 Series

Direct Drive Servo-Proportional Valves
with Integrated Digital Electronics
and CAN Bus Interface



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Part Number of the D636/D638 Operating Instructions

Please contact us at the above address and indicate the following part number when ordering these operating instructions:

B95872-001

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For your notes.

1 General Information

1.1 Using the Operating Instructions

Using the operating instructions

These operating instructions apply only to Direct Drive Valve series D636 (flow control valves) and D638 (pressure control valves) with integrated digital electronics and CAN bus interface. The instructions contain the most important information for ensuring safe operation of servo-proportional valves.

The operating instructions must be stored near the servo-proportional valve or the upper level machine so that they are readily accessible at all times.

All persons responsible for mechanical planning, assembly, and operation must read, understand, and follow all points contained in these operating instructions. This requirement applies especially to the safety instructions.

Complying with the safety instructions helps to avoid accidents, problems, and errors.

It is absolutely essential for the user to know the safety instructions as well as nationally and internationally applicable safety regulations in order to handle the servo-proportional valve safely and operate it trouble-free.

1.2 Proper Use

Proper use

D636 and D638 Direct Drive Valves are always operated as a component of a complete upper level system, for example in a machine.

They must be used only as control elements to control flow and/or pressure in hydraulic circuits that regulate position, speed, pressure, and power. The valves are intended for use with mineral oil-based hydraulic oils. The use of other media must be approved by Moog.

Use for other purposes or for purposes that extend beyond this description is not allowable.

Operation is allowable only in industrial environments in accordance with the DIN EN 50081-2 standard.

Operation in potentially explosive areas is not allowable.

Proper use also includes observation of the operating instructions and compliance with the inspection and maintenance regulations.

1.3 Selection and Qualification of Personnel

Selection and qualification of personnel

Only properly trained and instructed personnel with the necessary knowledge and experience must work with and on servo-proportional valves.

1.4 Electromagnetic Compatibility (EMC)

Electromagnetic compatibility (EMC)

The D636 and D638 servo-proportional valves comply with the following standards:

DIN EN 50081-2	Electromagnetic compatibility (EMC) - Generic emission standard - Part 2: Industrial environment
DIN EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
DIN EN 55011	Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurements

The D636 and D638 servo-proportional valves must not be used in residential, commercial and light industry as defined by the DIN EN 50081-1 and DIN EN 50082-1 standards.

1.5 Guarantee and Liability

Guarantee and liability

In general, our "General Terms and Conditions for Sales" apply. These conditions are given to the operator upon contract closure.

Among other things, guarantee and liability claims for personal and property damages will not be considered if they are caused by one or more of the following:

- Improper use of the servo-proportional valve
- Improper mounting, start-up, and maintenance of the servo-proportional valve
- Improper handling of the servo-proportional valve, such as the use in a potentially explosive, excessively hot, or excessively cold environment
- Failure to follow the operating instructions regarding transport, storage, mounting, start-up, and maintenance of the servo-proportional valve
- Unauthorized structural changes to the servo-proportional valve
- Improperly performed repairs
- Disasters caused by foreign objects or force majeure

1.6 Explanation of Symbols

Symbols used

The following symbols are used in these operating instructions

Important information

Danger of damage to machine or material

General danger of injury and death

Specific danger of injury and death

Regulatory symbols

1.7 Abbreviations

The following abbreviations are used in these operating instructions: **Abbreviations used**

β_x	Symbol for filter fineness
ν	Symbol for viscosity
µP	Microprocessor
CAN	**C**ontroller **A**rea **N**etwork
CiA	**C**AN **i**n **A**utomation user's association
DDV	**D**irect **D**rive **V**alve
DIN	**D**eutsches **I**nstitut für **N**ormung e. V. (German **I**nstitute for Standardization)
DS	**D**raft **S**tandard (published by CiA)
DSP	**D**raft **S**tandard **P**roposal (published by CiA)
DSP	**D**igital **S**ignal **P**rocessor
EMC	**E**lectro**m**agnetic **C**ompatibility
EMI	**E**lectro**m**agnetic **I**nterference
EN	**E**uropa-**N**orm (European standard)
FPM	Fluorocarbon rubber
F.S.	**F**ull **S**cale output of transducer
GND	**Grou**n**d** (signal ground)
HNBR	**H**ydrogenated **N**itril **B**utadiene **R**ubber
ID	**Id**entifier
ID	**I**nner **D**iameter (of O-rings for example)
ISO	**I**nternational **O**rganization for **S**tandardization
LED	**L**ight **E**mitting **D**iode
LSS	**L**ayer **S**etting **S**ervices
LVDT	**L**inear **V**ariable **D**ifferential **T**ransformer (senses the position of the spool in the valve [position transducer])
MS	**M**odule **S**tatus LED
NAS	**N**ational **A**merican **S**tandard
NS	**N**etwork **s**tatus LED
p	Symbol for **p**ressure
PC	**P**ersonal **C**omputer
PE	**P**rotective **E**arth
PWM	**P**ulse **W**idth **M**odulation
Q	Symbol for volumetric flow
VDMA	**V**erband **D**eutscher **M**aschinen- und **A**nlagenbau e. V. (German Machinery and Plant Manufacturers' Association)

For your notes.

2 Safety Instructions

Safety instructions

⚠ The D636 and D638 servo-proportional valves must only be put into operation and used as described in these operating instructions.

They must be operated only as a component of a complete upper level system, for example a machine, and only in industrial environments as defined by the DIN EN 50081-2 standard.

The D636 and D638 servo-proportional valves must not be used in residential, commercial and light industry as defined by the DIN EN 50081-1 and DIN EN 50082-1 standards.

⚠ Operation in potentially explosive areas is not allowable.

⚠ During equipment planning and the use of servo-proportional valves, the safety and accident prevention regulations specific to the type of usage must be followed. These include, for example:

DIN EN ISO 12100	Safety of machinery - Basic concepts, general principles for design
DIN EN 982	Safety of machinery - Safety requirements for fluid power systems and their components - Hydraulics
DIN EN 60204	Safety of machinery - Electrical equipment of machines

⚠ The manufacturer and the operator of the complete upper level system (mechanical equipment, for example) are responsible for compliance with the national and international safety and accident prevention regulations that apply to each particular case.

⚠ Modifying, changing, and interfering in the internal area of the servo-proportional valve may cause serious injuries and as such is forbidden.

⚠ Only properly trained and instructed personnel with the necessary knowledge and experience must work with and on servo-proportional valves.

⚠ The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

⚠ Operating machines with leaking servo-proportional valves or a leaking hydraulic system is dangerous and not allowed.

Safety instructions

When starting-up a servo-proportional valve on a field bus for the first time, we recommend operating the valve in a depressurized state.

The servo-proportional valve must only be operated via the configuration software if doing so does not endanger the machine and its immediate surroundings.

The configuration software must not be operated on a CAN bus if CAN communication is still running.

If the valve cannot be operated safely via the configuration software even when the CAN communication is switched off, it must only communicate via a direct (i.e. point-to-point) connection with the configuration software. The valve must be depressurized for this purpose.
(To create a direct connection between the configuration software and the valve, unplug the CAN bus cable from the valve and connect the valve directly to the PC's CAN bus interface card.)

Hydraulic oil can cause serious injuries, burns, and fires if it squirts out under high pressure.
Before mounting or removing servo-proportional valves, all pressure lines and reservoirs in the hydraulic circuit must therefore be depressurized.

Servo-proportional valves and hydraulic connection lines may become very hot while in operation.

When mounting, removing, or servicing servo-proportional valves, always wear suitable protective equipment such as work gloves.

When handling hydraulic fluids, always follow the safety guidelines applicable to the product.

The instructions in these operating instructions, especially chapter 2 (starting on page 5) and chapter 9 (starting on page 45) must be added to the operating instructions of the complete upper level system.

The allowable environmental conditions (see chapter 4, page 21) must be maintained at all times.

Do not transport or store the servo-proportional valves without first properly installing the shipping plate.

To avoid overheating the servo-proportional valve, mount it in a way that ensures good ventilation.
Do not mount valves directly onto mechanical parts that are subject to strong vibrations or sudden movement.
When mounted on units subject to sudden movement, the spool direction should not be the same as the unit's direction of movement.

The servo-proportional valves must not be immersed in liquid.

3 Function and Operational Characteristics of the Servo-Proportional Valves

3.1 General Information

Function of the servo-proportional valves: throttle valves

The D636 valves (flow control valves) and the D638 valves (pressure control valves) are Direct Drive Valves (DDV). The valves are throttle valves for 3-, 2-, 4-, 2x2-way applications and are suitable for electro-hydraulic control of position, speed, pressure, and power - even under high dynamic requirements.

A permanent magnet linear force motor is used to drive the spool. In contrast to proportional magnet drives, the linear force motor adjusts the spool in both working directions from the spring-loaded middle position. This gives the servo-proportional valve strong actuating power for the spool as well as good static and dynamic characteristics.

Operational modes: Q-, p-, pQ-control

The following operational modes are possible:

- Flow control (Q-control) (D636)
  (see chapter 3.2.1, page 9)
- Pressure control (p-control) (D638)
  (see chapter 3.2.2, page 9)
- Flow control and pressure control (pQ-control) (optional for D638)
  (see chapter 3.2.3, page 9)

Digital valve 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 enable 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 command inputs and up to two analog actual value outputs with programmable functions are available as options.

Benefits of the D636/D638 series

Benefits of using D636/D638 Direct Drive Valves:

- Direct drive with permanent magnet linear force motor that provides high actuating power
- Pilot oil not required
- Pressure independent dynamics
- Minimal hysteresis and high response characteristics
- Minimal current requirement at and close to hydraulic null (hydraulic null is the position of the spool at which the pressures of a symmetrical spool are equally high in both blocked working ports)
- Standardized spool position signal
- Electrical null point adjustment is parameterizable
- If the electrical supply fails, a line breaks, or emergency stop is activated, the spool returns to the predefined spring-loaded position without overshooting a working position (fail-safe).
- Flow control and optional pressure control (on D638) with only one valve
- CAN bus interface
- optional analog inputs and outputs

3.1.1 Representative Depiction of a Direct Drive Valve

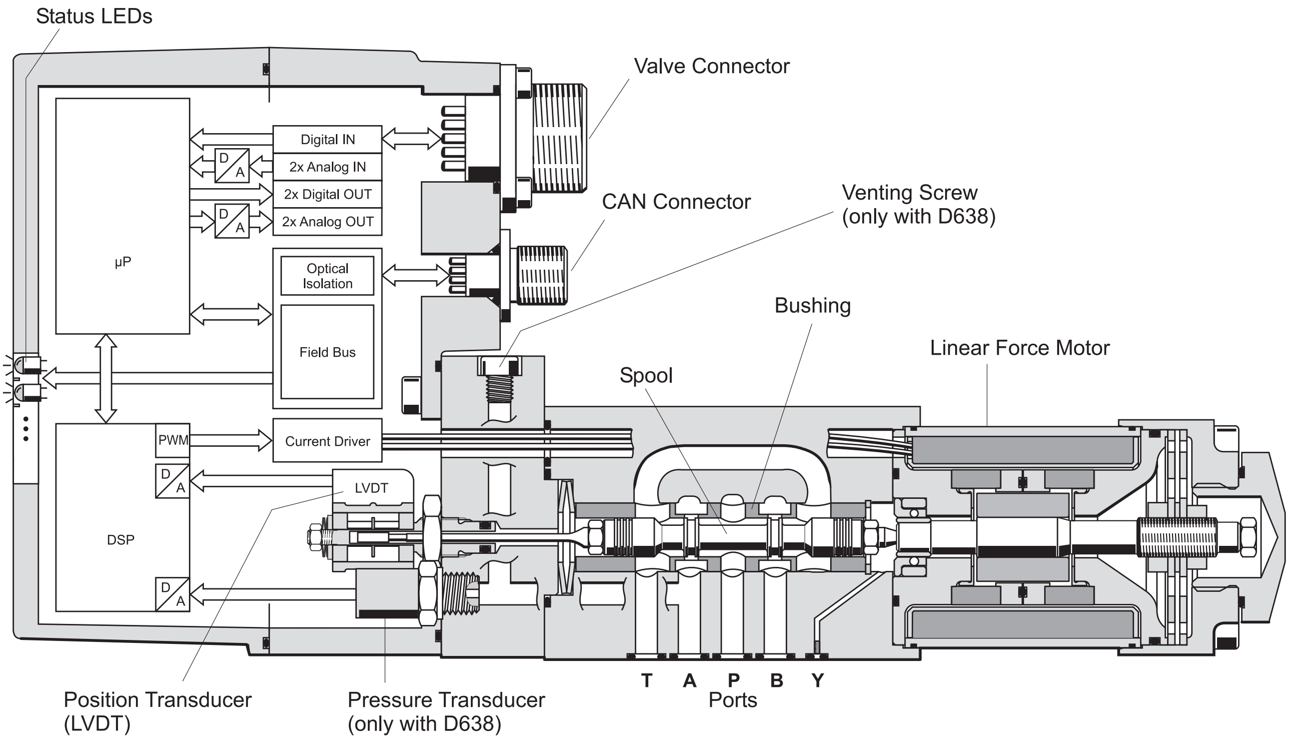


Figure 1: Representative depiction of the servo-proportional valve

3.1.2 Permanent Magnet Linear Force Motor

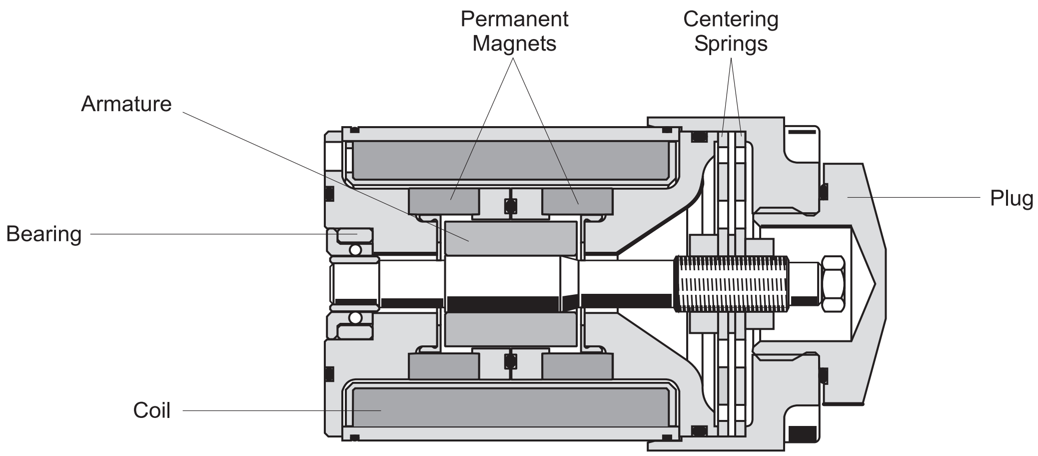


Figure 2: Representative depiction of the permanent magnet linear force motor

Permanent magnet linear force motor

The permanent magnet linear force motor is a permanently magnetically excited differential motor. A portion of the magnetic force is already integrated with the permanent magnet. This makes the linear force motor's power requirement considerably lower than that of comparable proportional magnets.

The linear force motor drives the spool of the servo-proportional valve. In the zero current condition, the centering springs determine the starting position of the spool. The linear force motor enables the spool to be guided in both directions from the starting position, the linear force motor's actuating power being proportional to the coil current. The strong forces from the linear force motor and the centering springs enable precise movement of the spool, even when working against flow and frictional forces.

3.2 Servo-proportional Valve Operational Modes

3.2.1 Flow Control (Q-Control)

Q-Control: Controlling the spool position

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

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 current to drive the linear force motor, which then brings the spool into the correct position.

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

3.2.2 Pressure Control (p-Control)

p-control: Controlling the pressure in port A

During this operating mode of the D638 valve the pressure in port A 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 current to drive the linear force motor, which then brings the spool into the correct position.

The pressure control function can be influenced with parameters in the valve software (for example: linearization, ramping, dead band, sectionally defined amplification, 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.

3.2.3 Flow Control and Pressure Control (pQ-Control) (optional for D638)

pQ-control

This is a combination of flow and pressure control for which both command signals (external flow and pressure limit 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

3.2.4 Notes on Controller Behavior

The resulting flow depends not only on the position of the spool, but also on the pressure drop Δp on the individual control edges.

Formula for calculating the flow Q

At 100 % flow command signal with a rated pressure drop Δp_N of 35 bar (500 psi) per control edge, the result is the rated flow Q_N. By altering the pressure drop, the flow Q also changes assuming a constant command signal, as shown by the following formula:

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

Q	[l/min]	=	actual flow
Q_N	[l/min]	=	rated flow
Δp	[bar]	=	actual pressure drop per control edge
Δp_N	[bar]	=	rated pressure drop per control edge

The following exert significant influence on the controlled system:

- Rated flow Q_N
- Actual pressure drop Δp per control edge
- Load stiffness
- Control volume being regulated by port A (D638 only)

Depending on differences in mechanical construction (such as volume, pipework, branching, reservoirs, etc.), different types of controller optimizations may be required in pressure control. These controller optimizations can be carried out with the configuration software via the CAN bus interface.

3.3 CAN Bus and CANopen

CAN bus interface

The servo-proportional valve is equipped with a CAN bus interface and can be operated within a CAN network.

The CAN bus is a differential 2-wire bus and was initially developed to facilitate rapid and interference-free networking of components in automobiles. But thanks to its many advantages and high level of reliability, the CAN bus is also suitable for applications within machines and has proven its usefulness as a widely accepted standard.

CANopen is a standardized communication profile for simple networking of CANopen-compatible devices from many different manufacturers.

CANopen communication profile (CiA standard DS 301, version 4.0)

The communication profile complies with the DS 301 standard, version 4.0, and is provided by CiA.

The CANopen standard defines various device profiles to enable connection of different types of devices, including for example: drives, controllers, angle transmitters, etc.

Device profile for proportional servo valves (CiA standard DSP 408)

The function of the D636 and D638 series valves corresponds to the device profile for proportional servo valves in accordance with the CiA standard DSP 408. This device profile is based on a profile established by a working group within the VDMA entitled "Device Profile Fluid Power Technology".

The machine controller or other CAN bus nodes can use the CAN bus to exchange data with the servo-proportional valve in real time. This data includes command signals and actual values as well as control and status reports. In addition to this real time transmission, configuration and parametric data can be exchanged between the controller and the valve at any time.

The controller or other CAN bus nodes transmit command signals, device control commands, and configuration data via the CAN bus to the servo-proportional valve.

The controller or other CAN bus nodes can read actual values, status information, and the current configuration from the servo-proportional valve.

Integrated valve electronics

The integrated valve electronics can take over device-specific and drive-specific functions like command signal ramping or dead band compensation. This can relieve the external controller and the CAN communication because external controllers previously had to perform these functions themselves and the interpolated intermediate values had to be transmitted via the CAN bus.

Monitoring, error recognition, and diagnostic functions

Monitoring, error recognition, and diagnostic functions enable recognition of device malfunctions via the CAN bus.

3.4 Analog Command Inputs

Analog command inputs

Depending on the valve model, various analog command inputs for flow control and/or pressure control are available. (Pin assignment of the valve connector: see Table 6, page 36)

Command input	Benefits
±10 V or 0–10 V	Simple measurement of the signal with an oscilloscope, for example
±10 mA or 0–10 mA	In contrast to the 4–20 mA command input, less power is required at low command signals; large transmission lengths are possible
4–20 mA	Line break monitoring and large transmission lengths possible

Table 1: Available analog command inputs

ℹ All current inputs are available as floating or single-ended versions. All voltage inputs are floating, but can be connected externally as single-ended inputs.

3.4.1 Flow Command Input ±10 V Floating

Flow command input ±10 V floating

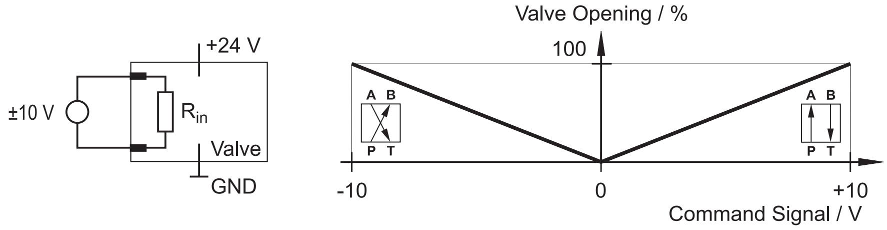


Figure 3: Flow command input ±10 V floating (circuit and characteristic curve)

The spool stroke is proportional to the input voltage U_{in}.

U_{in} = +10 V	100 % valve opening P ⇨ A and B ⇨ T
U_{in} = 0 V	Spool in hydraulic null position
U_{in} = -10 V	100 % valve opening P ⇨ B and A ⇨ T

! This command input is a floating, differential input. (The potential difference of each input to GND must be between -15 V and +32 V.) If differential voltage is not available, one input pin has to be connected to signal ground according to the required operating direction.

3.4.2 Flow Command Input ±10 mA Floating

Flow command input ±10 mA floating

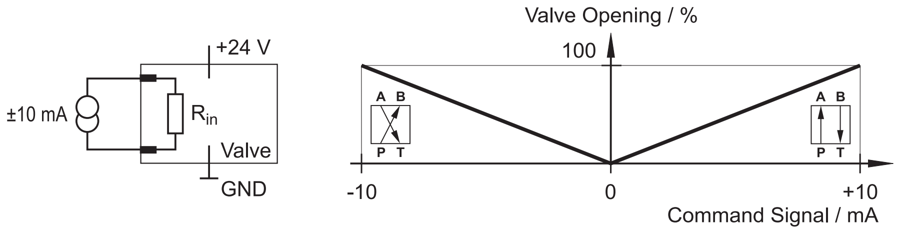


Figure 4: Flow command input ±10 mA floating (circuit and characteristic curve)

The spool stroke is proportional to the input current I_{in}.

I_{in} = +10 mA	100 % valve opening P ⇨ A and B ⇨ T
I_{in} = 0 mA	Spool in hydraulic null position
I_{in} = -10 mA	100 % valve opening P ⇨ B and A ⇨ T

! The input current I_{in} must be between -25 mA and +25 mA!

! This command input is a floating input. (The potential difference of each input to GND must be between -15 V and +32 V.) If a floating current source is not available, one input pin has to be connected to signal ground according to the required operating direction.

3.4.3 Flow Command Input ±10 mA Single-Ended

Flow command input ±10 mA single-ended

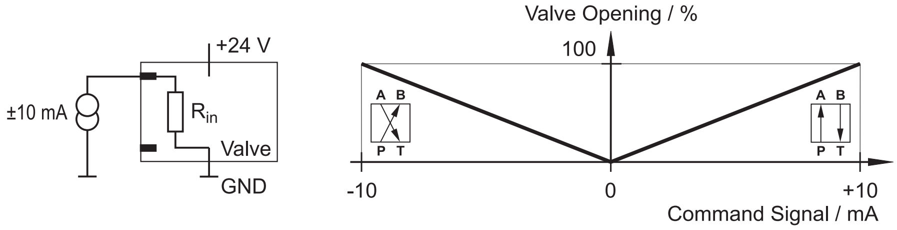


Figure 5: Flow command input ±10 mA single-ended (circuit and characteristic curve)

The spool stroke is proportional to the input current I_{in}.

I_{in} = +10 mA	100 % valve opening P ⇨ A and B ⇨ T
I_{in} = 0 mA	Spool in hydraulic null position
I_{in} = -10 mA	100 % valve opening P ⇨ B and A ⇨ T

The point of reference for this command input is GND.

! The input current I_{in} must be between -25 mA and +25 mA!

ℹ Depending on the required operating direction, one of the two input pins must not be connected.

3.4.4 Flow Command Input 4–20 mA Floating

Flow command input 4–20 mA floating

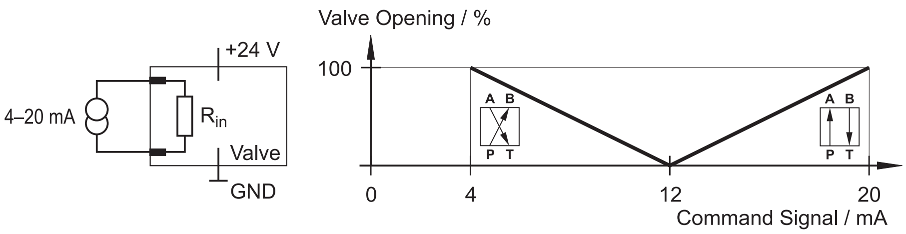


Figure 6: Flow command input 4–20 mA floating (circuit and characteristic curve)

The spool stroke is proportional to the input current I_{in}.

I_{in} = 20 mA	100 % valve opening P ⇨ A and B ⇨ T
I_{in} = 12 mA	Spool in hydraulic null position
I_{in} = 4 mA	100 % valve opening P ⇨ B and A ⇨ T

! The input current I_{in} must be between -25 mA and +25 mA!

! This command input is a floating input. (The potential difference of each input to GND must be between -15 V and +32 V.) If a floating current source is not available, one input pin has to be connected to signal ground according to the required operating direction.

ℹ Command signals I_{in} < 3 mA (due to line break, for example) indicate an error during flow control. The valve is switched off for safety reasons and goes into fail-safe position.

3.4.5 Flow Command Input 4–20 mA Single-Ended

Flow command input 4–20 mA single-ended

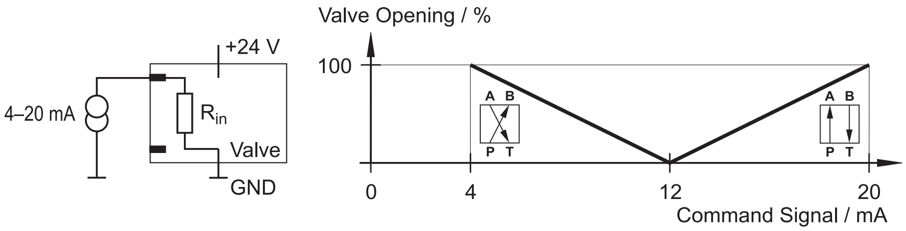


Figure 7: Flow command input 4–20 mA single-ended (circuit and characteristic curve)

The spool stroke is proportional to the input current I_{in}.

I_{in} = 20 mA 100 % valve opening P ⇨ A and B ⇨ T

I_{in} = 12 mA Spool in hydraulic null position

I_{in} = 4 mA 100 % valve opening P ⇨ B and A ⇨ T

The point of reference for this command input is GND.

! The input current I_{in} must be between -25 mA and +25 mA!

ℹ Depending on the required operating direction, one of the two input pins must not be connected.

ℹ Command signals I_{in} < 3 mA (due to line break, for example) indicate an error during flow control. The valve is switched off for safety reasons and goes into fail-safe position.

3.4.6 Pressure Command Input 0–10 V Floating (D638)

Pressure command input 0–10 V floating (D638)

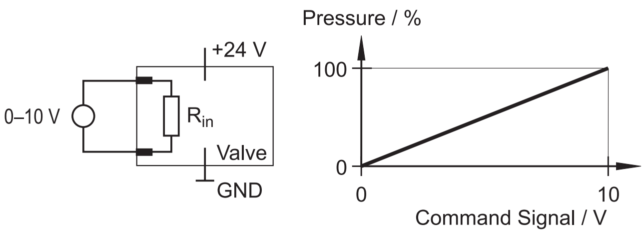


Figure 8: Pressure command input 0–10 V floating (circuit and characteristic curve)

The pressure in control port A is proportional to the input voltage U_{in}.

U_{in} = 10 V 100 % pressure in control port A

U_{in} = 0 V 0 % pressure in control port A

! This command input is a floating, differential input. (The potential difference of each input to GND must be between -15 V and +32 V.) If differential voltage is not available, one input pin has to be connected to signal ground.

3.4.7 Pressure Command Input 0–10 mA Floating (D638)

Pressure command input 0–10 mA floating (D638)

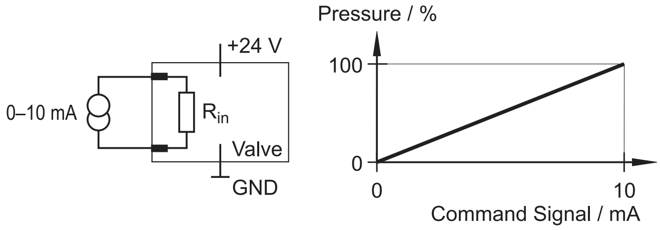


Figure 9: Pressure command input 0–10 mA floating (circuit and characteristic curve)

The pressure in control port A is proportional to the input current I_{in}.

I_{in} = 10 mA 100 % pressure in control port A

I_{in} = 0 mA 0 % pressure in control port A

! The input current I_{in} must be between -25 mA and +25 mA!

! This command input is a floating input. (The potential difference of each input to GND must be between -15 V and +32 V.) If a floating current source is not available, create a connection to 0 V of the command signal source.

3.4.8 Pressure Command Input 0–10 mA Single-Ended (D638)

Pressure command input 0–10 mA single-ended (D638)

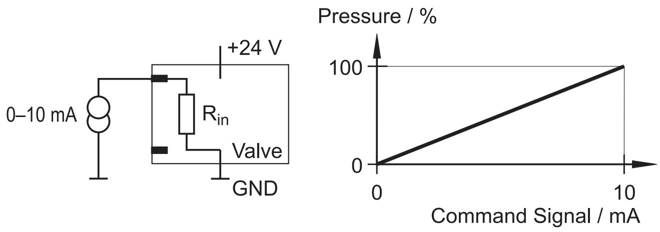


Figure 10: Pressure command input 0–10 mA single-ended (circuit and characteristic curve)

The pressure in control port A is proportional to the input current I_{in}.

I_{in} = 10 mA 100 % pressure in control port A

I_{in} = 0 mA 0 % pressure in control port A

The point of reference for this command input is GND.

! The input current I_{in} must be between -25 mA and +25 mA!

ℹ Only one of the two input pins must be connected.

3.4.9 Pressure Command Input 4–20 mA Floating (D638)

Pressure command input 4–20 mA floating (D638)

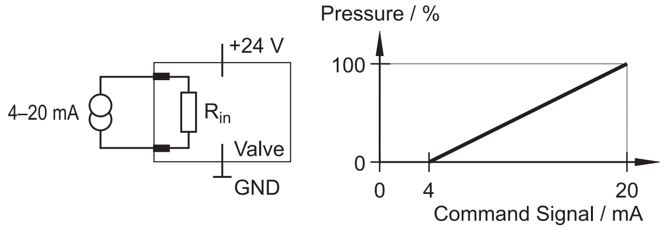


Figure 11: Pressure command input 4–20 mA floating (circuit and characteristic curve)

The pressure in control port A is proportional to the input current I_{in}.

I_{in} = 20 mA 100 % pressure in control port A

I_{in} = 4 mA 0 % pressure in control port A

! The input current I_{in} must be between -25 mA and +25 mA!

! This command input is a floating input. (The potential difference of each input to GND must be between -15 V and +32 V.) If a floating current source is not available, create a connection to 0 V of the command signal source.

ℹ Command signals I_{in} < 3 mA (due to line break, for example) indicate an error during pressure control. The valve is switched off for safety reasons and goes into fail-safe position.

3.4.10 Pressure Command Input 4–20 mA Single-Ended (D638)

Pressure command input 4–20 mA single-ended (D638)

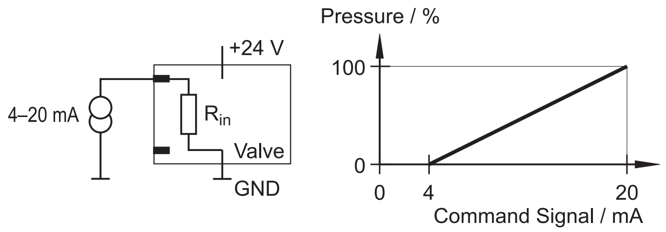


Figure 12: Pressure command input 4–20 mA single-ended (circuit and characteristic curve)

The pressure in control port A is proportional to the input current I_{in}.

I_{in} = 20 mA 100 % pressure in control port A

I_{in} = 4 mA 0 % pressure in control port A

The point of reference for this command input is GND.

! The input current I_{in} must be between -25 mA and +25 mA!

ℹ Only one of the two input pins must be connected.

ℹ Command signals I_{in} < 3 mA (due to line break, for example) indicate an error during pressure control. The valve is switched off for safety reasons and goes into fail-safe position.

3.5 Analog Actual Value Outputs

Analog actual value outputs

Depending on the valve model, various analog actual value outputs for flow control and/or pressure control (optional) are available. (Pin assignment of the valve connector: see Table 6, page 36)

3.5.1 Actual Flow Value Output 4–20 mA

The output current I_{out} is proportional to the spool stroke.

I_{out} = 20 mA	100 % valve opening P ⇨ A and B ⇨ T
I_{out} = 12 mA	Spool in hydraulic null position
I_{out} = 4 mA	100 % valve opening P ⇨ B and A ⇨ T

GND is the point of reference for the actual value output 4–20 mA.

ℹ Line breaks can be recognized externally with the 4–20 mA actual value output.

ℹ The 4–20 mA output is short-circuit protected.

3.5.2 Actual Pressure Output 4–20 mA (D638)

The output current I_{out} is proportional to the pressure in control port A.

I_{out} = 20 mA	100 % pressure in control port A
I_{out} = 4 mA	0 % pressure in control port A

GND is the point of reference for the actual value output 4–20 mA.

ℹ Line breaks can be recognized externally with the 4–20 mA actual value output.

ℹ The 4–20 mA output is short-circuit protected.

3.5.3 Evaluation of the 4–20 mA Actual Value Output

Evaluation of the actual value outputs

The 4–20 mA outputs can be evaluated in accordance with the following circuit.

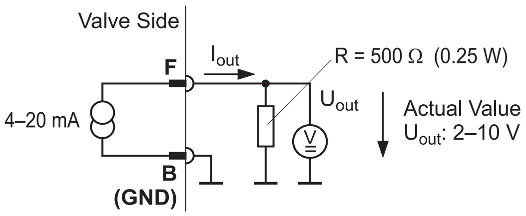


Figure 13:
Circuit for measuring the actual value I_{out}
for valves with 6+PE-pin valve connectors

3.6 Digital Inputs/Outputs

Digital inputs/outputs

Depending on the valve model, different digital inputs and outputs are available.

3.6.1 Enable Input (optional)

Digital inputs: enable input

Signals to the enable input from 8.5 VDC to 24 VDC (based on GND) enable the operation of the valve. Signals of less than 6.5 VDC force the valve into fail-safe mode. (Pin assignment of the 6+PE-pin valve connector, see page 36)

If the enable input is not activated, the valve will be in fail-safe mode.

The D636 and D638 servo-proportional valves are also available without the enable input.

3.6.2 Digital Outputs

Digital outputs

Depending on the model, up to two optional digital outputs are available.

3.7 Status Display

Status display LEDs

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

Figure 14: Status display LEDs

After the valve's power supply is switched on, the valve electronics perform a self-test, indicated by red and green blinking LEDs.

3.7.1 Module Status LED «MS»

The module status LED displays an available power supply and possible 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

Table 2: Conditions of the module status LED «MS»

3.7.2 Network Status LED «NS»

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

Network status LED

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 with other CAN bus nodes
blinking red	time overrun
red	major error
blinking red-green	self-test

Table 3: Conditions of the network status LED «NS»

For your notes.

4 Technical Data and Scope of Delivery

4.1 General Technical Data

General technical data

Maximum operating pressure

Ports P and B	350 bar (5,000 psi)
Port A	
for D636	350 bar (5,000 psi)
for D638	dependent on pressure transducer, max. 350 bar (5,000 psi)
Port T without Y	50 bar (724 psi) (see chapter 4.2.2, page 24)
Port T with Y	350 bar (5,000 psi)
Port Y	depressurized to the tank

Allowable ambient conditions

Ambient temperature	-20 °C to +60 °C
Vibration resistance	30 g, 3 axes, frequency: 5–2,000 Hz
Shock resistance	60 g, 6 directions, half-sine 11 ms

Gasket material HNBR, 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
Viscosity ν	
recommended	15-100 mm²/s
allowable	5-400 mm²/s
Cleanliness level, recommended	
for functional safety	ISO 4406 < 15 / 12
for life cycle (wear and tear)	ISO 4406 < 14 / 11

The cleanliness of the hydraulic fluid greatly influences the functional safety (safe positioning of the spool, high resolution) and the wearing protection (control edges, pressure gain, leakage losses) of the valve.

System filter

High pressure filter (without bypass, but with dirt indication) in the main flow path directly in front of the valve, as close as possible

Filter fineness, recommended

for functional safety	$\beta_{10} \geq 75$ (10 µm (0.0004 in) absolute)
for life cycle (wear and tear)	$\beta_6 \geq 75$ (6 µm (0.00024 in) absolute)

Shipping plate

Delivered with oilproof shipping plate

Mounting option

any position, fixed or movable.

When mounting the valve, follow the safety instructions from chapter 6, starting on page 31.

Mounting surface

Flatness: < 0.01 mm (0.0004 in) over 100 mm (3.9 in)

Average surface finish, R_a: < 0.8 µm (32 µin)

Mass 2.5 kg (5.5 lb)

4.2 Hydraulic Data

Hydraulic data

Valve construction type	Single stage, sliding spool with bushing
Mounting pattern	in accordance with ISO 4401-03-03-0-94 (with or without leakage port Y, see page 24)
∅ of the ports	7.9 mm (0.3 in)
Valve configuration	2-way, 3-way, 4-way, and 2x2-way operation
Actuation	directly with permanent magnet linear force motor
Pilot oil supply	none
Rated flow Q_N	5 (1.3) / 10 (2.6) / 20 (5.3) / 40 (10.6) l/min (gpm) (depending on the model) (at Δp_N = 35 bar (500 psi) per control edge, tolerance ±10 %)
Max. leakage flow Q_L [1)]	0.15 (0.040) / 0.3 (0.079) / 0.6 (0.16) / 1.2 (0.32) l/min (gpm) (depending on the model)
Max. flow	75 l/min (19.8 gpm)
Spool lap	Zero lap, < 3 % or 10 % positive lap (depending on the model)
Step response time for 0 to 100 % stroke	12 ms (typical)
Threshold [1)]	< 0.1 % (in Q-control)
Hysteresis [1)]	< 0.2 % (in Q-control)
Null shift	< 1.5 % (at ΔT = 55 K)
Linearity of pressure control (only with D638)	< 0.5 % F.S.

[1)] At operating pressure p_p = 140 bar (2,000 psi), oil viscosity ν = 32 mm²/s and an oil temperature of 40 °C (104 °F)

4.2.1 Servo-Proportional Valve Configurations

Valve configurations

The following valve configurations are possible with the D636/D638 (optional) valves:

- 4-way operation
- 3-way operation
- 2-way operation
- 2x2-way operation

4-way and 3-way operation

4-way and 3-way operation

In 4-way operation, the servo-proportional valves can be used to control the flow in ports A and B (use as throttle valves).

To obtain the 3-way operation, close either port A or port B.

If the pressure in the tank port T exceeds 50 bar (724 psi), the leakage port Y must be used (see chapter 4.2.2, page 24).

The valves are available with zero lap, less than 3 % or 10 % positive lap.

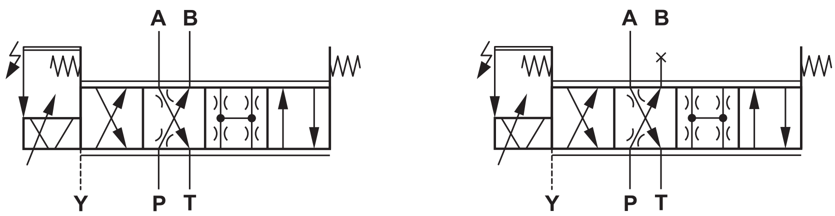


Figure 15: 4-way/3-way operation with fail-safe function (hydraulic symbols)

2-way and 2x2-way operation

2-way and 2x2-way operation

In 2-way and 2x2-way operation, the servo-proportional valves can be used to control the flow in one direction (use as throttle valves).

In 2x2-way operation, the valve can be used in 2-way applications for higher flows. To do this, the port P must be connected externally to B and A externally with T.

For 2x2-way operation, the leakage port Y must always be connected (see chapter 4.2.2, page 24).

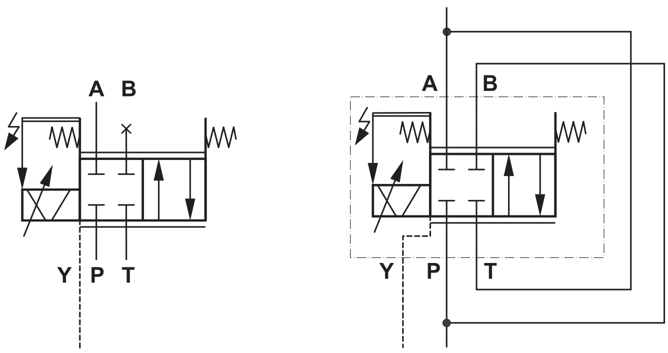


Figure 16: 2-way/2x2-way operation (hydraulic symbols)

4.2.2 Leakage Port Y

Leakage port Y

D636 and D638 servo-proportional valves can be delivered with or without the leakage port Y active.
Purchase orders for the valve must indicate whether port Y will be used.

The **leakage port Y** must be used in the following cases:

- if the pressure in the tank port T becomes greater than 50 bar (724 psi)
- with 2x2-way operation

4.3 Electrical Data

Electrical data

Supply power

nominal 24 VDC, 18 to 32 VDC

Duty cycle

100 %

Valve connector

6+PE pin connector with pin contacts in accordance with DIN EN 175201-804

Protection type in accordance with DIN EN 60529

IP65 without connectors

IP67 connectors plugged and locked

Power consumption

P_{min} (motor in neutral position)	9.6 W (0.4 A at 24 VDC)
P_{max} (at max. flow)	28.8 W (1.2 A at 24 VDC)

EMC protection requirements

in accordance with DIN EN 55011, DIN EN 50081-2 and DIN EN 61000-6-2

Inputs/outputs

Command input 0–10 V	R_{in} = 300 kΩ
Command input ±10 V	R_{in} = 300 kΩ
Command input 0–10 mA	R_{in} = 200 Ω
Command input ±10 mA	R_{in} = 200 Ω
Command input 4–20 mA	R_{in} = 200 Ω
Actual value output 4–20 mA	$R_{L\ max.}$ = 500 Ω with respect to GND
Enable input (function: see chapter 3.6.1, page 18)	Signals to the enable input from 8.5 VDC to 24 VDC (based on GND) enable the operation of the valve. Signals of less than 6.5 VDC force the valve into fail-safe mode.

CAN bus interface

CAN connector	5-pin connector with pin contacts (M12 x 1)
Physical	DIN ISO 11898 CAN-HIGH SPEED
Communication profile	CANopen DS 301, version 4.0
Device profile	CANopen DSP 408
Maximum voltage capacity	40 VDC

External fusing for each valve

1.6 A slow-blow

4.4 Characteristic Curves

4.4.1 Step Response, Frequency Response, and Flow Diagram

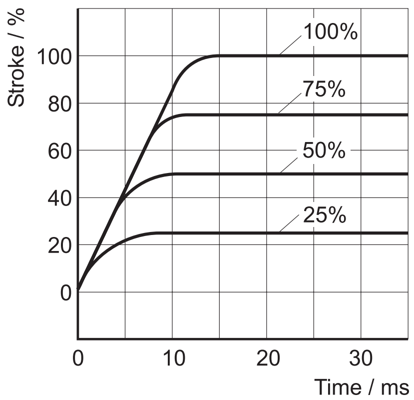


Figure 17: Step response

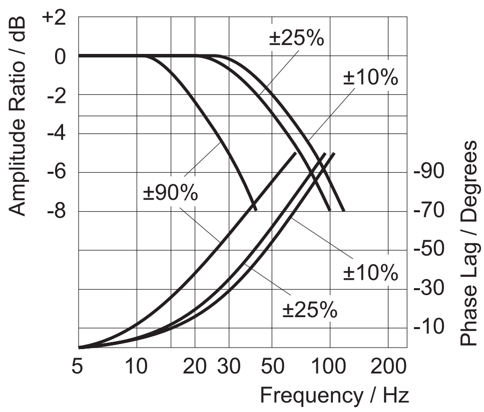


Figure 18: Frequency response

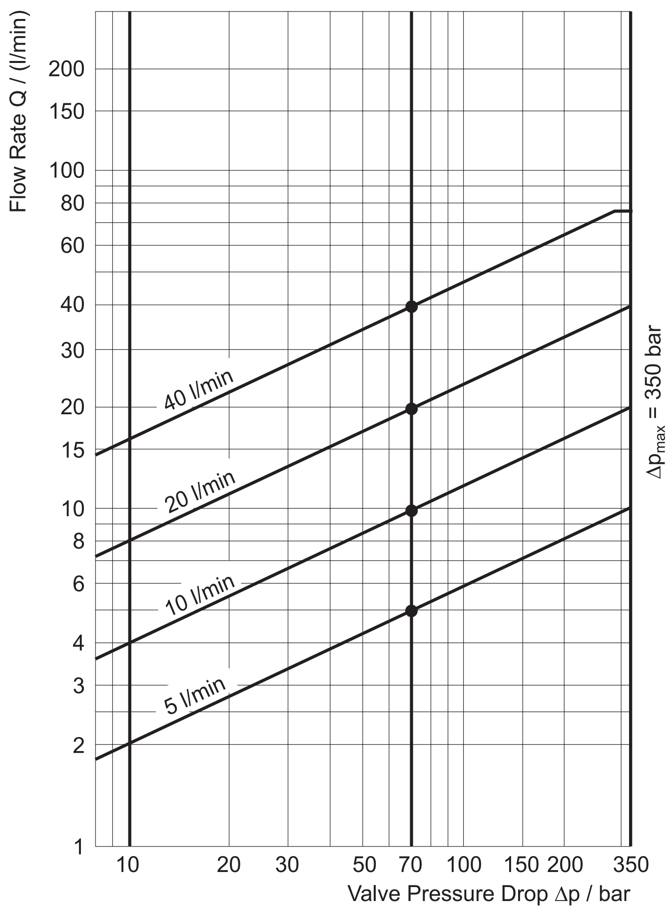


Figure 19: Flow diagram

4.4.2 Flow Characteristic Curve

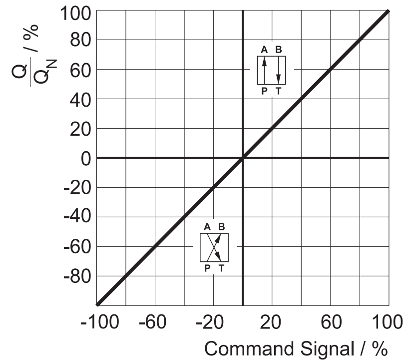


Figure 20:
Flow characteristic curve

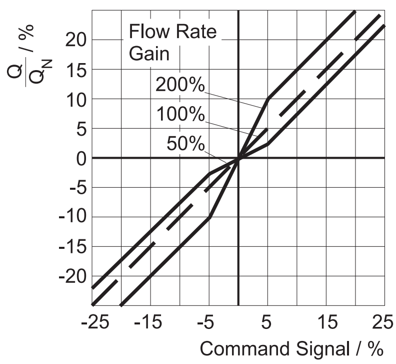


Figure 21:
Flow characteristic curve
(zero cut)

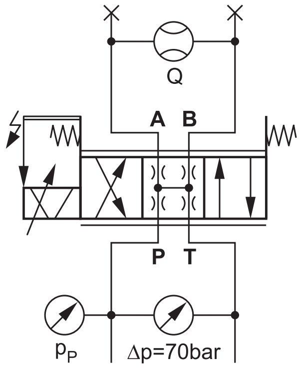


Figure 22:
Design for measuring the
flow characteristic curve

4.4.3 Pressure Characteristic Curves

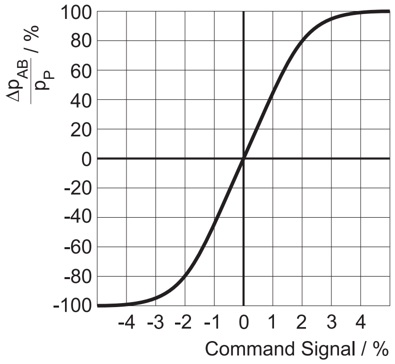


Figure 23:
Pressure characteristic curve of
flow control valves

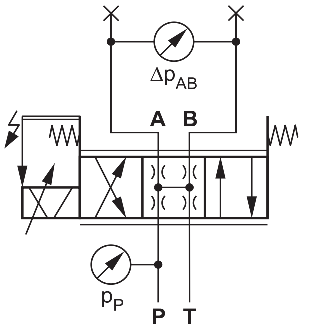


Figure 24:
Design for measuring the
pressure characteristic curve
of flow control valves

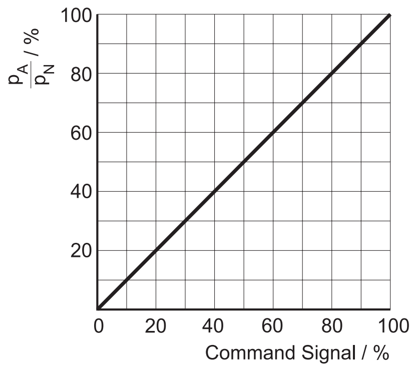


Figure 25:
Pressure characteristic curve of
pressure control valve (D638)

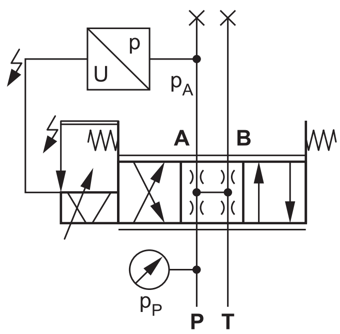


Figure 26:
Design for measuring the
pressure characteristic curve of
pressure control valves (D638)

4.5 Dimensions (Installation Drawing)

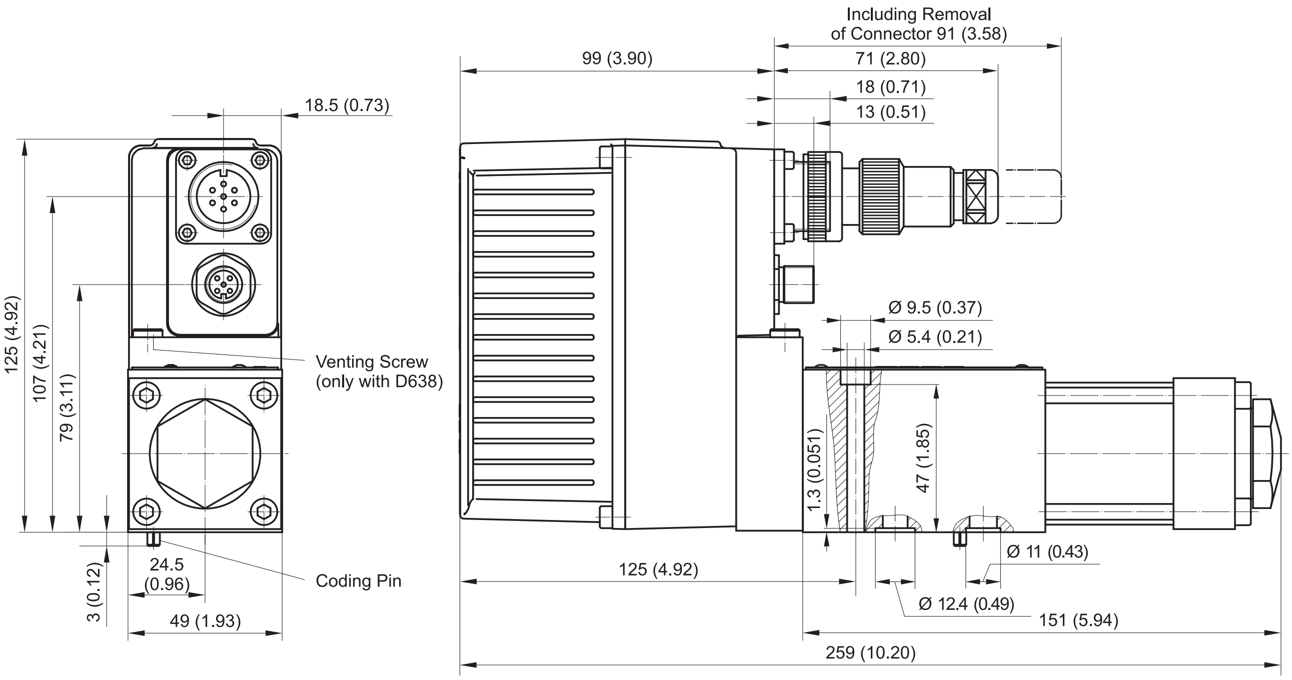


Figure 27: Installation drawing (dimensions in mm, values in parenthesis in inches)

4.6 Mounting Pattern and Mounting Surface

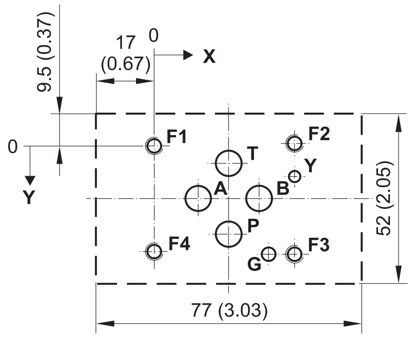


Figure 28:
Mounting Pattern, ISO 4401-03-03-0-94, without port X
(dimensions in mm, values in parenthesis in inches)

	P	A	B	T	X[1]	Y	F_1	F_2	F_3	F_4	G[2]
	∅ 7.5 (0.30)	∅ 7.5 (0.30)	∅ 7.5 (0.30)	∅ 7.5 (0.30)	-	∅ 3.3 (0.13)	M5	M5	M5	M5	∅ 4.0 (0.16)
x	21.5 (0.85)	12.7 (0.50)	30.2 (1.19)	21.5 (0.85)	-	40.5 (1.59)	0	40.5 (1.59)	40.5 (1.59)	0	33 (1.30)
y	25.9 (1.02)	15.5 (0.61)	15.5 (0.61)	5.1 (0.20)	-	9.0 (0.35)	0	-0.75 (-0.03)	31.75 (1.25)	31 (1.22)	31.75 (1.25)

Table 4: Dimensions for mounting pattern (dimensions in mm, values in parenthesis in inches)
([1] do not drill port X; [2] coding pin hole G has to be at least 4 mm (0.16 in) deep)

4.7 Scope of Delivery

The following items are included in delivery of the valve:

Scope of delivery

- Servo-proportional valve with attached oilproof shipping plate on the hydraulic ports
- 4 O-rings ID 9.25 (0.36) x ∅ 1.8 (0.07) for the P, T, A, B ports (dimensions in mm, values in parenthesis in inches)
- 1 O-ring ID 7.65 (0.30) x ∅ 1.8 (0.07) for the Y port (dimensions in mm, values in parenthesis in inches)

5 Transport and Storage

Safety instructions for transport and storage

! The allowable environmental conditions (see chapter 4, page 21) must be maintained at all times.

! Do not transport or store the servo-proportional valves without first properly installing the shipping plate.

5.1 Packaging/Transport

Packaging/transport

Please read the following carefully:

- Do not damage valves during packaging or transportation.
- Transport valves only in the properly closed original packaging.
- Store the valve's original packaging for later use.
- Immediately inform the freight company and Moog in writing about any damages incurred during transportation.
- Remove the shipping plate only directly before mounting the valve.
- Store the shipping plate and the accompanying attachment screws.
- Always install the shipping plate before transporting the valves.

5.2 Storage

Storage

Please read the following carefully:

- Store valves only in the properly closed original packaging.
- Protect valves from dust and moisture.
- Always install the shipping plate before transporting the valves in order to protect the valve from the entry of dirt or moisture.

For your notes.

6 Mounting/Removing and Connection to the Hydraulic System

Safety instructions for mounting/removing and connection to the hydraulic system

The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

Hydraulic oil can cause serious injuries, burns, and fires if it squirts out under high pressure.
Before mounting or removing servo-proportional valves, all pressure lines and reservoirs in the hydraulic circuit must therefore be depressurized.

Servo-proportional valves and hydraulic connection lines may become very hot while in operation.

When mounting, removing, or servicing servo-proportional valves, always wear suitable protective equipment such as work gloves.

When handling hydraulic fluids, always follow the safety guidelines applicable to the product.

Technical data and especially the information on the servo-proportional valve's nameplate must be read carefully and complied with.

Remove the shipping plate from the hydraulic ports only shortly before placing the servo-proportional valve on the mounting surface.

Always check the mounting surface for dirt (and clean if necessary) immediately before mounting the valve.

To avoid overheating the servo-proportional valve, mount it in a way that ensures good ventilation.
Do not mount valves directly onto mechanical parts that are subject to strong vibrations or sudden movement.
When mounted on units subject to sudden movement, the spool direction should not be the same as the unit's direction of movement.

If a servo-proportional valve contains a venting screw (D638), always mount the valve in such a way that it can be vented.
In order to allow air that may be contained in the valve to escape after the venting screw is opened, make sure the venting screw points upward.

6.1 Mounting the Servo-Proportional Valve

Mounting the servo-proportional valve

⚠ Never use the shipping plate's attachment screws to attach the servo-proportional valve.

! The mounting surface must be free of residue and dirt during mounting of the servo-proportional valve. Use a clean, soft, and lint free cloth to clean the mounting surface. Do not use cleaning wool or waste cotton.
Do not use cleaning methods that could attack the mounting surface mechanically or chemically.

! If a servo-proportional valve contains a venting screw (D638), always mount the valve in such a way that it can be vented.
In order to allow air that may be contained in the valve to escape after the venting screw is opened, make sure the venting screw points upward.

ℹ A 4 mm Allen wrench is needed to mount the servo-proportional valve.

ℹ The servo-proportional valve may be mounted in any position, fixed or movable. For characteristics of the mounting surface, see chapter 4.1, page 22.

Procedure for mounting the servo-proportional valve:

1. Clean the mounting surface.
2. Remove the shipping plate from the valve's hydraulic ports and retain it for later use, for example maintenance.
3. Check that O-rings are available for the ports and that they are in the correct position.
4. Place the valve on the mounting surface and adjust it so it aligns with the mounting holes.
5. Fasten the valve by alternately tightening each of the installation screws (Allen screws) without distortion (see table below for proper tightening torque).

Installation screws (in accordance with DIN EN ISO 4762)	Quantity	Tightening torque ±10 % (in accordance with DIN EN ISO 4762)	
		Quality class 10.9	Quality class 12.9
M 5 x 55 mm (2.2 in)	4	6.8 Nm (60.2 lb-in)	10 Nm (89 lb-in)

Table 5: Installation material and tightening torque values

6.2 Removing the Servo-Proportional Valve

Removing the servo-proportional valve

⚠ The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

⚠ Hydraulic oil can cause serious injuries, burns, and fires if it squirts out under high pressure.
Before mounting or removing servo-proportional valves, all pressure lines and reservoirs in the hydraulic circuit must therefore be depressurized.

! Attach the shipping plate to the hydraulic ports immediately after removing the valve.

ℹ A 4 mm Allen wrench is needed to remove the valve.

The valve is removed in the reverse order to the mounting.

Procedure for removing the servo-proportional valve:

1. Loosen the valve's installation screws.
2. Remove the valve from the mounting surface.
3. Check that O-rings are available for the ports and that they are in the correct position.
4. Attach the shipping plate to the hydraulic ports.
5. Store the servo valve in the original packaging.
6. Cover the ports of the hydraulic system to prevent contamination.

For your notes.

7 Electrical Connection

Safety instructions for electrical connection

The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

Servo-proportional valves and hydraulic connection lines may become very hot while in operation.

When mounting, removing, or servicing servo-proportional valves, always wear suitable protective equipment such as work gloves.

When handling hydraulic fluids, always follow the safety guidelines applicable to the product.

Technical data and especially the information on the servo-proportional valve's nameplate must be read carefully and complied with.

Do not place the servo-proportional valve's connection cables in the immediate vicinity of high voltage lines or together with cables that switch inductive or capacitive loads.

An EMC-compliant power unit must be used for the supply voltage. The electrical connection must be completed in an EMC-compliant manner.

Electrical connection of the servo-proportional valve

Procedure for establishing the servo-proportional valve's electrical connection:

1. Wire the servo-proportional valve in accordance with the pin assignment described in chapter 7.1 (page 36).
2. Construct the equipotential system, the protective ground, and shielding in accordance with the enclosed TN 353 technical note.
3. Construct CAN bus wiring as described in chapter 7.2 (page 37).

7.1 Pin Assignment

7.1.1 Valve Connector

Pin	Signal type / Signal	Voltage floating ±10 V, 0–10 V	Current floating ±10 mA, 0–10 mA, 4–20 mA	Current single-ended ±10 mA, 0–10 mA, 4–20 mA
A	Supply voltage	24 VDC (18 to 32 VDC)		
B	Power ground / signal ground	0 V (GND)		
C	Enable input	8.5–24 VDC based on pin B: operation of the valve enabled < 6.5 VDC based on pin B: valve fail-safe condition (see also chapter 3.6.1, page 18)		
D **E**	Command input	! The potential difference (measured against pin B) must be between -15 V and +32 V. $U_{in} = U_{DE}$ R_{in} = 300 kΩ differential	$I_{in} = I_D = -I_E$ R_{in} = 200 Ω ! The input current I_{in} must be between -25 mA and +25 mA! Command signals I_{in} < 3 mA (due to line break, for example) indicate an error during flow control for inputs of 4-20 mA. The valve is switched off for safety reasons and goes into fail-safe position.	$I_{in} = I_D$ R_{in} = 200 Ω Do **not** connect Pin E!
F	Actual value output	I_{out}: 4–20 mA based on GND (I_{out} is proportional to the position of the spool or to the regulated pressure (on D638); the output is short-circuit protected; for interpretation of the actual value output, see chapter 3.5.3, page 17); R_L: 0-500 Ω		
⏚	Protective conductor contact			

Table 6: Pin assignment of the 6+PE-pin valve connector

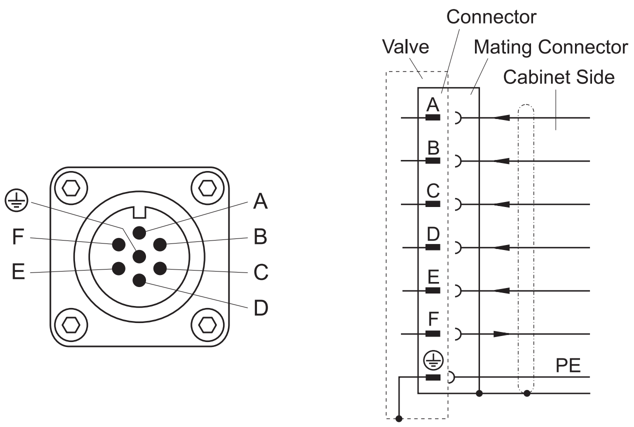


Figure 29: Pin assignment of the 6+PE-pin valve connector
(looking towards the connector on the valve)

The mating connector for the 6+PE-pin valve connector is available as an accessory (see chapter 11.2, page 49).

7.1.2 CAN Connector

CAN connector

Pin	Signal	
1	CAN_SHLD	shield
2	CAN_V+	is not attached in the valve
3	CAN_GND	
4	CAN_H	Transceiver H
5	CAN_L	Transceiver L

Table 7: Pin assignment of the CAN connector

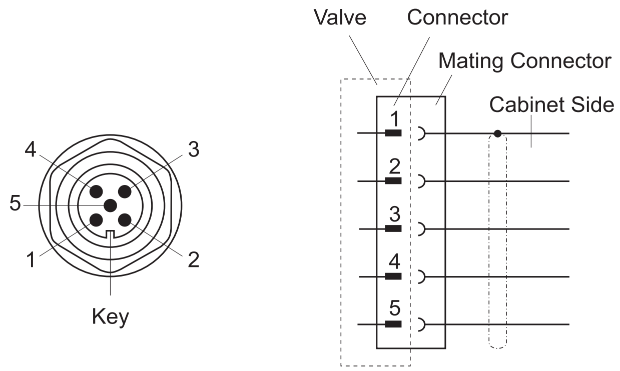


Figure 30: Pin assignment of the CAN connector
(looking towards the CAN connector on the valve)

Alignment of the CAN connector may vary. Please align the pins in accordance with the key.

We recommend the use of molded cord sets with a straight mating connector (see Table 11, page 40).

7.2 Wiring CAN Networks

The servo-proportional valve is equipped with a galvanically isolated CAN bus interface. The CAN bus interface is supplied internally; it is therefore not absolutely necessary to connect CAN_V+ 24 VDC (pin 2 of the CAN connector).

Wiring CAN networks

Note the following points when wiring CAN networks:

- All cables, plug connectors, and terminal resistors used in CAN networks must comply with DIN ISO 11898.
- In general, it is important to comply with all information in the enclosed TN 353 technical note.
- Use shielded four-lead cables (twisted pair) and surge impedance of 120 Ω (CAN_H, CAN_L, CAN_GND and CAN_SHLD (cable shield) grounded, optionally CAN_V+ 24 VDC).
- A CAN bus cable must not branch but short stub cables with T-connectors are allowed.
- Stub cables must be as short as possible (for the maximum stub cable length, see Table 10, page 40).
- The cable between CAN_L and CAN_H on both CAN bus cable ends must be ended by a terminal connector with terminal resistance of 120 Ω ± 10 %.
- Connect reference potential CAN_GND and CAN_SHLD to the protective ground (PE) at **only one point** (on a terminal connector, for example).
- The transmission rate must be adapted to the CAN bus cable length (see Table 8, page 39).
- Do not lay CAN bus cables in the immediate vicinity of EMI sources. If EMI sources cannot be avoided, use double shielded cables.

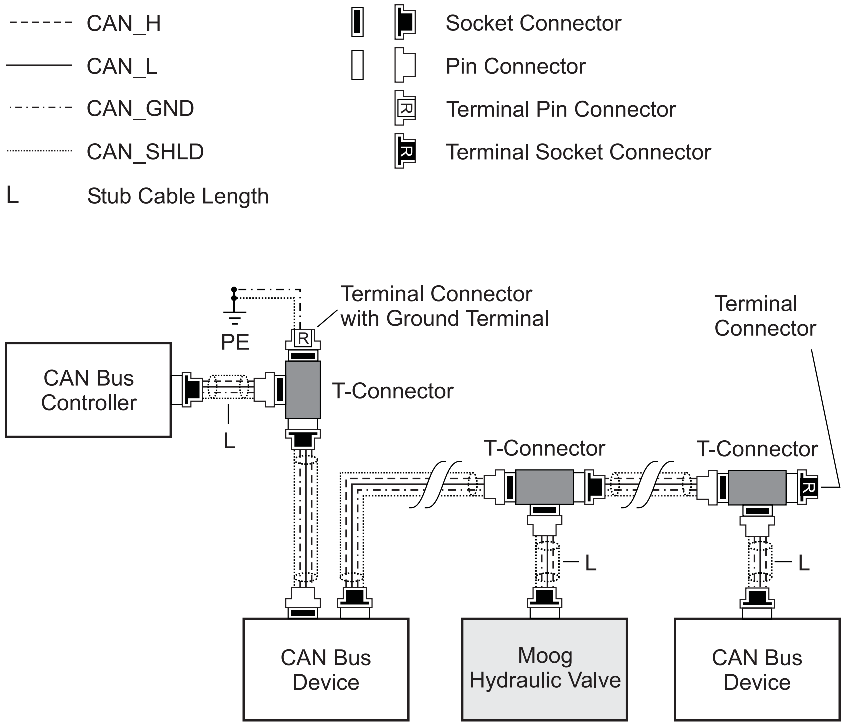


Figure 31: Example of CAN network wiring

For CAN bus nodes without a galvanically isolated CAN bus interface, CAN_GND is generally connected to the 0V supply voltage inside the device. In these cases, the supply voltage connection cable must be grounded at the same place as the CAN_GND connection cable.

To avoid noise in extensive CAN networks, avoid CAN bus nodes that do not have galvanically isolated CAN bus interfaces.

If it is not possible to refrain from CAN bus nodes that do not have galvanically isolated CAN bus interfaces, arrange these nodes in the immediate vicinity of the central ground point. The cable length to this central ground point should be kept as short as possible!

7.2.1 Cable Lengths and Cable Cross Sections in CAN Networks

Recommendation for maximum cable lengths in CAN networks

Transmission rate	Maximum cable length
1,000 kbit/s	25 m (984 in)
800 kbit/s	50 m (1,969 in)
500 kbit/s	100 m (3,937 in)
250 kbit/s	250 m (9,843 in)
125 kbit/s	500 m (19,685 in)
100 kbit/s	650 m (25,591 in)
50 kbit/s	1,000 m (39,370 in)
20 kbit/s	2,500 m (98,425 in)
10 kbit/s	5,000 m (196,850 in)

Table 8: Recommendation for maximum cable lengths in CAN networks, depending on the transmission rate

Cable cross section	Maximum cable length for n CAN bus nodes		
	n = 32	n = 64	n = 100
0.25 mm² (22 AWG)	200 m (7,874 in)	170 m (6,693 in)	150 m (5,906 in)
0.5 mm² (20 AWG)	360 m (14,173 in)	310 m (12,305 in)	270 m (10,623 in)
0.75 mm² (18 AWG)	550 m (21,654 in)	470 m (18,504 in)	410 m (16,142 in)

Table 9: Recommendation for maximum cable lengths in CAN networks, depending on the cable cross section and the number of CAN bus nodes

Maximum allowable stub cable length in CAN networks

Transmission rate	Maximum stub cable length	
	Maximum	Cumulative
1,000 kbit/s	2 m (78.7 in)	20 m (787 in)
500 kbit/s	6 m (236 in)	39 m (1,535 in)
250 kbit/s	6 m (236 in)	78 m (3,071 in)
125 kbit/s	6 m (236 in)	156 m (6,142 in)

Table 10: Maximum allowable stub cable lengths in CAN networks

7.2.2 Suitable Cable Types

Suitable cable types for CAN networks

Manufacturer	Cable type
Hans Turck GmbH & Co. KG Witzlebenstraße 7 45472 Mülheim an der Ruhr Germany Tel.: +49-208-4952-0, Fax: +49-208-4952-264 E-mail: turckmh@mail.turck-globe.de http://www.turck.com	577 Flexlife thin cable, 5710 Flexlife mid cable, 575 Flexlife thick cable

Table 11: Suitable cable types for CAN networks

8 Starting-Up the Servo-Proportional Valve

Safety instructions for starting-up the servo-proportional valve

The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

Operating machines with leaking servo-proportional valves or a leaking hydraulic system is dangerous and not allowed.

When starting-up a servo-proportional valve on a field bus for the first time, we recommend operating the valve in a depressurized state.

Hydraulic oil can cause serious injuries, burns, and fires if it squirts out under high pressure.
Before mounting or removing servo-proportional valves, all pressure lines and reservoirs in the hydraulic circuit must therefore be depressurized.

Servo-proportional valves and hydraulic connection lines may become very hot while in operation.

When mounting, removing, or servicing servo-proportional valves, always wear suitable protective equipment such as work gloves.

When handling hydraulic fluids, always follow the safety guidelines applicable to the product.

! Technical data and especially the information on the servo-proportional valve's nameplate must be read carefully and complied with.

! Remove the shipping plate from the hydraulic ports only shortly before placing the servo-proportional valve on the mounting surface.

! Attach the shipping plate to the hydraulic ports immediately after removing the valve.

! Fresh oil is contaminated. When filling the hydraulic system, always use a filling filter with a fineness of at least $\beta_{10} \geq 75$ (10 µm absolute).

! Before the initial start-up of a new facility or after completion of modifications, the hydraulic system must be carefully flushed in accordance with the facility manufacturer's instructions.

Starting-up the servo-proportional valve

The following steps are necessary when starting-up the servo-proportional valve:

1. Prepare the hydraulic system in accordance with chapter 8.1 (page 42).
2. Mount the valve in accordance with chapter 6.1 (page 32).
3. Wire the valve's electrical connection in accordance with chapter 7 (starting on page 35).
4. Connect the valve to the field bus in accordance with chapter 8.3 (starting on page 43).

   A Windows-based configuration program is available that simplifies start-up on the CAN bus.
   The configuration software is a graphical user interface that simplifies parameterization and diagnosis of the servo-proportional valve and enables the execution of a valve test.
   See the configuration software's handbook or the configuration software's online help for descriptions of the configuration software.

5. Start-up the hydraulic system in accordance with chapter 8.2 (starting on page 43).

8.1 Filling and Flushing the Hydraulic System

Filling and flushing the hydraulic system

Procedure for filling and flushing the hydraulic system:

1. Depressurize the hydraulic system.
2. Fill the hydraulic system in accordance with the instructions provided by the system manufacturer.
3. Before starting the flushing process, insert into the pressure filter suitable flushing elements in place of the high pressure filter elements.
4. Remove the servo-proportional valve (see chapter 6.2, page 33).
5. Instead of the servo-proportional valve, you must install a flushing plate or, if allowed by the system, a switching valve.

   ⚠ This switching valve must not introduce any potentially dangerous conditions into the system.

   Use the flushing plate to flush the lines P and T.
   The switching valve can also be used to flush the actuator with lines A and B.

6. Carefully flush the hydraulic system in accordance with the manufacturer's instructions.
   While doing this, please observe the following:
   - The hydraulic oil's operating temperature should be reached during the flushing process.
   - Observe the minimum flushing time: t = (V/Q) x 5 [h]
     (V = tank contents in l, Q = pump flow rate in (l/min))
   - End the flushing process when the system cleanliness level of 15/12 as specified by ISO 4406 or class 6 as specified by NAS 1638 or better has been achieved.
7. Depressurize the hydraulic system.

8. Replace flushing elements in the pressure filter with suitable high pressure elements.
9. Remove the flushing plate or switching valve
10. Mount the servo-proportional valve (see chapter 6.1, page 32).

8.2 Venting (D638) and Starting-Up the Hydraulic System

A 5 mm Allen wrench is needed to open and close the servo-proportional valve's venting screw (D638 only).

Venting (D638) and starting-up the hydraulic system

Procedure for venting the hydraulic system:

1. Bring the hydraulic system into operation in accordance with the manufacturer's instructions.
2. After switching on the supply voltage, check the status display LEDs «MS» and «NS» in accordance with chapter 3.7 (starting on page 18) .
3. Vent the hydraulic system in accordance with the manufacturer's instructions.
4. Vent the servo-proportional valve (D638 only):
   - Pressure command must be set.
   - Supply pressure must be set to a low value.
   - Carefully open the venting screw approximately one rotation.
   - Wait until no more air escapes or until the escaping hydraulic oil contains no more air bubbles.
   - Close the venting screw (tightening torque of 10 Nm (89 lb-in)).
   - Clean the hydraulic oil that has escaped.

   It may be necessary to repeat this procedure.
5. Check the hydraulic system for external leaks.

8.3 Connection to the CAN Bus

Safety instructions for creating connections to the CAN bus

The servo-proportional valve must only be operated via the configuration software if doing so does not endanger the machine and its immediate surroundings.

The configuration software must not be operated on a CAN bus if CAN communication is still running.

If the valve cannot be operated safely via the configuration software even when the CAN communication is switched off, it must only communicate via a direct (i.e. point-to-point) connection with the configuration software. The valve must be depressurized for this purpose.
(To create a direct connection between the configuration software and the valve, unplug the CAN bus cable from the valve and connect the valve directly to the PC's CAN bus interface card.)

⚠ When starting-up a servo-proportional valve on a field bus for the first time, we recommend operating the valve in a depressurized state.

⚠ The servo-proportional valve's hydraulic and electrical connections must have been made properly in accordance with these operating instructions.

! Each module address (node-ID) must be used only once within a CAN network.

! All CAN bus nodes within a CAN network must be set to the same transmission rate value.

ℹ The configuration software communicates with the valve via the standard CANopen services. The valve and the configuration software must not be operated within a CAN network. Instead, the valve and the configuration software must communicate via a direct connection (point-to-point).

If the configuration software is to be operated within a CAN network, the following points must be observed:

! Data exchange with the valve may be disturbed if another device (such as a controller) connects to the valve simultaneously.

! Node guarding must be activated only if no other CAN bus nodes are monitoring the valve via this service.

! CAN telegrams can also be received by other CAN bus nodes. This can have unforeseeable results.

A condition necessary for connecting the valve to the CAN bus is correct wiring in accordance with chapter 7.2 (starting on page 37).

The factory setting for the valve's module address (node-ID) is 127; the factory setting for the transmission rate is 500 kbit/s.
If the valve is to receive a different module address (node-ID) or if the transmission rate is to be changed, make these adjustments via the LSS (Layer Setting Services) through the CAN bus.

ℹ The valve's module address (node-ID) and transmission rate can be changed with the configuration software.

9 Maintenance and Repair

Maintenance and Repair

⚠ The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

D636 and D638 servo-proportional valves are generally maintenance-free.

It is necessary only to check the servo-proportional valve and the hydraulic connections at regular intervals (once per day, for example) for externally visible damages and deficiencies such as leaks.

If damages or deficiencies are found on the servo-proportional valve or the machine, report this immediately to the responsible persons. If necessary, stop and secure the machine immediately.

⚠ Operating machines with leaking servo-proportional valves or a leaking hydraulic system is dangerous and not allowed.

If leaks are found, repair these immediately in accordance with all safety instructions and the operating instructions.

D636 and D638 servo-proportional valves must be repaired only by Moog or Moog authorized service centers.

For your notes.

10 Trouble Shooting

⚠ The servo-proportional valves must only be mounted and removed, and electrical and hydraulic connections made by suitably trained technical personnel with the necessary authorization. They must perform such tasks in accordance with the applicable regulations and the valve must be in an **idle and depressurized** state and the **machine switched off.**

While this work is in progress, the machine must be secured against restarting, for example by:

- Locking the main command device and removing the key and/or
- attaching a warning sign to the main switch

Problem	**Trouble Shooting**
Leak at the valve's connection surface	Check for the presence of o-rings on ports A, B, P, T and Y and make sure the o-rings are properly seated and are not damaged. Check to make sure that installation screws are tight (see Table 5, page 32 for screw tightening torque).
Leak at the linear force motor's plug	Check ports P and T for proper connection. Check the max. pressure in ports T or Y. When the Y port is not in use, the return pressure in T must not exceed 50 bar (724 psi). ⚠ If a leak is discovered on the linear force motor's plug, send the valve to Moog or a Moog authorized service center for inspection.
Valve exhibits no hydraulic reaction	Inspect the hydraulic installation. Check for the presence of hydraulic pressure. Check for the presence of supply voltage. Do this by checking the status display LEDs (see chapter 3.7, page 18 for more information about the status display LEDs). Check signals at the connector, especially the enable input. Check valve status via the CAN bus interface. If an enable is not ready, it will not be possible to overcome the "DISABLE" status. Specify command signal as an analog value or via the CAN bus interface (depending on the model). Check the configuration and parameters. Check to make sure the connectors are not corroded. Command signal not ready or line break?
System unstable; control circuit oscillating	Check the external control circuit, may be necessary to reduce amplification. You can optimize the parameters (P, I, D, etc.) of pressure control valves.

Problem	Trouble Shooting
Communication problems in CAN networks	Check the status display LEDs (see chapter 3.7, page 18 for more information about the status display LEDs). Check for correct cable terminations. Check the wiring of the CAN network (see chapter 7.2 for more information, starting on page 37) Check the module address (node-ID) of the CAN bus nodes. (Each module address (node-ID) must be used only once within a CAN network.) Check to make sure that the valve's transmission rate matches that of the other devices on the CAN bus network. CAN bus diagnosis tools allow you to observe data traffic on the CAN bus, making it easier to identify the causes of problems.

11 Tools, Replacement Parts, and Accessories

11.1 Tools for 6+PE Pin Connectors

Designation	Part number
Crimping tool for mating connector	C21162-001
Positioner, tool kit for crimping tool with contact sizes 16 and 20	C21163-001
Installation tool for contact sizes 16 and 20	C21164-001
Removal tool for contact sizes 16 and 20	C21165-001

Table 12: Tools for 6+PE pin connectors

11.2 Replacement Parts and Accessories D636/D638

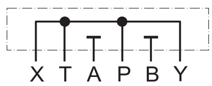
Part designation	Quantity	Comments	Part number
O-rings for ports P, T, A, B **O-ring for port Y**	4 1	ID 9.25 (0.36) x ∅ 1.8 (0.07): HNBR 90 Shore FPM 90 Shore ID 7.65 (0.30) x ∅ 1.8 (0.07): HNBR 90 Shore FPM 90 Shore (dimensions in mm, values in parenthesis in inches) (included in delivery)	B97009-013 -42082-013 B97009-012 -42082-012
Shipping plate	1	(included in delivery)	B46035-001
Mating connector for 6+PE pin valve connector, waterproof, IP67	1	DIN EN 175201-804 suitable cable with min. ∅ 10 mm (0.39 in), max. ∅ 12 mm (0.47 in) (not included in delivery)	B97007-061
Dust protection cap for CAN connector	1	(not included in delivery)	C55823-001
Start-up cable for CAN bus	1	(not included in delivery)	TD3999-132
Flushing plate for ports P, A, B, T, X, Y	1	 (not included in delivery)	B46634-002
Installation screws for the valve	4 required	M 5 x 55 mm (2.2 in) (DIN EN ISO 4762, quality class 10.9, tightening torque: 6.8 Nm (60.2 lb-in)) (not included in delivery)	A03665-050-055
Configuration software	1	(not included in delivery)	B99104
Operating instructions for D636/D638 series	1	(not included in delivery)	B95872-001

Table 13: Replacement parts and accessories for the D636/D638 series

For your notes.

12 Appendix

12.1 Additional Literature

Additional literature

Blackburn, John F., Reethof, Gerhard and Sherer, J. Lowen:
Fluid Power Control; The MIT Press, Cambridge, MA.

Lenz, Walter:
Developments in High Performance Proportional Valves with CANopen Fieldbus Interface, Proceedings of the Sixth Scandinavian International Conference on Fluid Power, May 26-28 1999

Merritt, Herbert E.:
Hydraulic Control Systems; John Wiley & Sons. Inc.

12.2 Quoted Standards

Quoted standards

DIN 51524-1, Edition 1985-06:
Pressure fluids - Hydraulic oils - HL hydraulic oils - Minimum requirements

DIN 51524-2, Edition 1985-06:
Pressure fluids - Hydraulic oils - HLP hydraulic oils - Minimum requirements

DIN 51524-3, Edition 1990-08:
Pressure fluids - Hydraulic oils - HVLP hydraulic oils - Minimum requirements

DIN EN 982:
Safety of machinery - Safety requirements for fluid power systems and their components - Hydraulics

DIN EN 50081-1, Edition 1993-03:
Electromagnetic compatibility (EMC) - Generic emission standard - Part 1: Residential, commercial and light industry

DIN EN 50081-2, Edition 1994-03:
Electromagnetic compatibility (EMC) - Generic emission standard - Part 2: Industrial environment

DIN EN 50082-1, Edition 1997-11:
Electromagnetic compatibility (EMC) - Generic immunity standard - Part 1: Residential, commercial and light industry

DIN EN 55011, Edition 2000-05:
Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurements

DIN EN 60204:
Safety of machinery - Electrical equipment of machines

DIN EN 60529, Edition 2000-09:
Degrees of protection provided by enclosures (IP Code)

DIN EN 61000-6-2, Edition 2000-03:
Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments

DIN EN 175201-804, Edition 2000-09:
Detail specification: Circular connectors - Round contacts, size diameter 1.6 mm, threaded coupling

DIN EN ISO 4762, Edition 1998-02:
Hexagon socket head cap screws

DIN EN ISO 12100:
Safety of machinery - Basic concepts, general principles for design

DIN ISO 11898, Edition 1995-08:
Road vehicles - Interchange of digital information - Controller area network (CAN) for high-speed communication

ISO 4401, Edition 1994-12:
Hydraulic fluid power - Four-port directional control valves - Mounting surfaces

ISO 4406, Edition 1999-12:
Hydraulic fluid power - Fluids - Method for coding level of contamination by solid particles

NAS 1638, Edition 1992:
Cleanliness requirements of parts used in hydraulic systems

12.3 Addresses

CAN in Automation (CiA) e. V.

Address: CiA

Am Weichselgarten 26

91058 Erlangen (Germany)

Tel.: +49 9131 601091

Fax: +49 9131 601092

http://www.can-cia.de

VDMA

Address: VDMA

German Machinery and Plant Manufacturers' Association

Lyoner Straße 18

60528 Frankfurt/Main (Germany)

Tel.: +49 69 6603 1332

Fax: +49 69 6603 1459

http://www.vdma.org

Institute for Fluid Drives and Controllers (IFAS) of RWTH Aachen

Address: IFAS RWTH

Steinbachstraße 53

52074 Aachen (Germany)

Tel.: +49 241 807511

Fax: +49 241 8888194

http://www.rwth-aachen.de/ifas/

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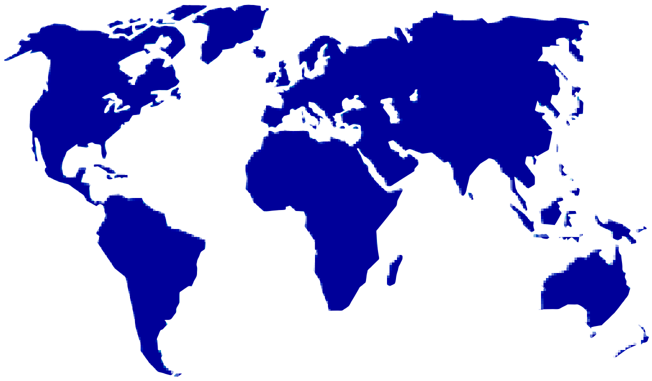

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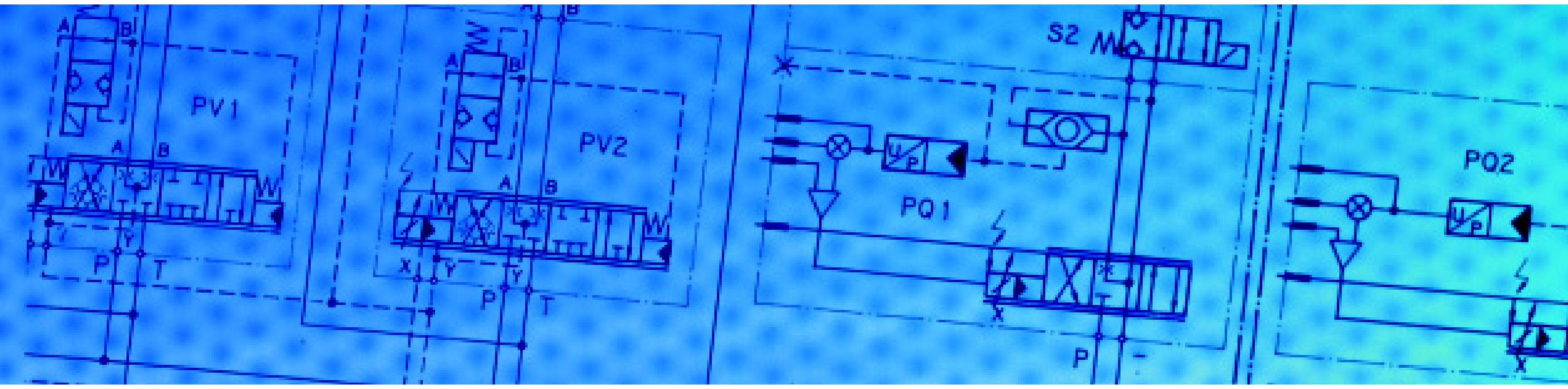

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