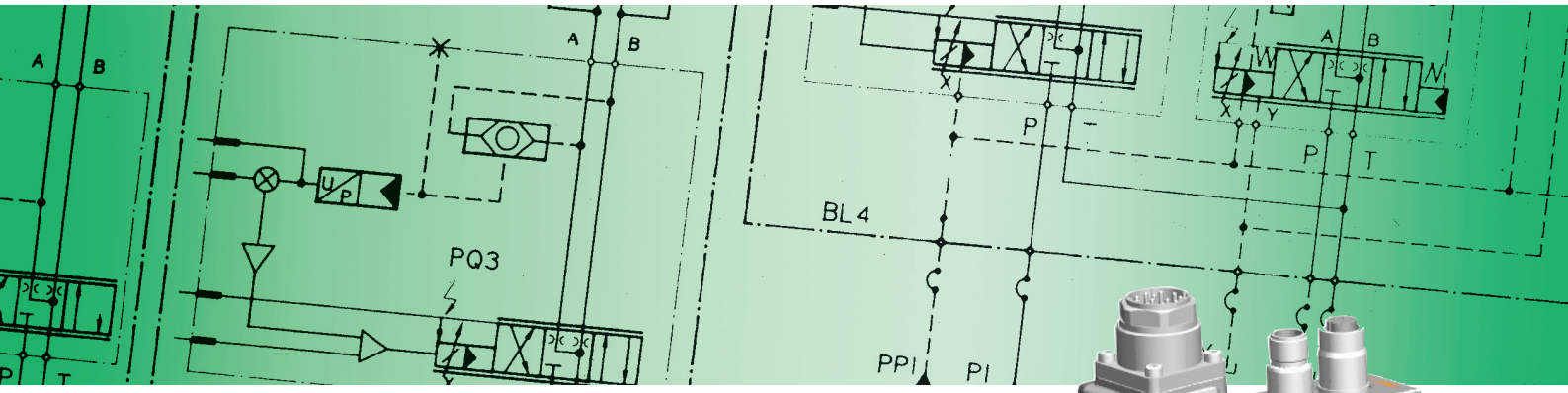
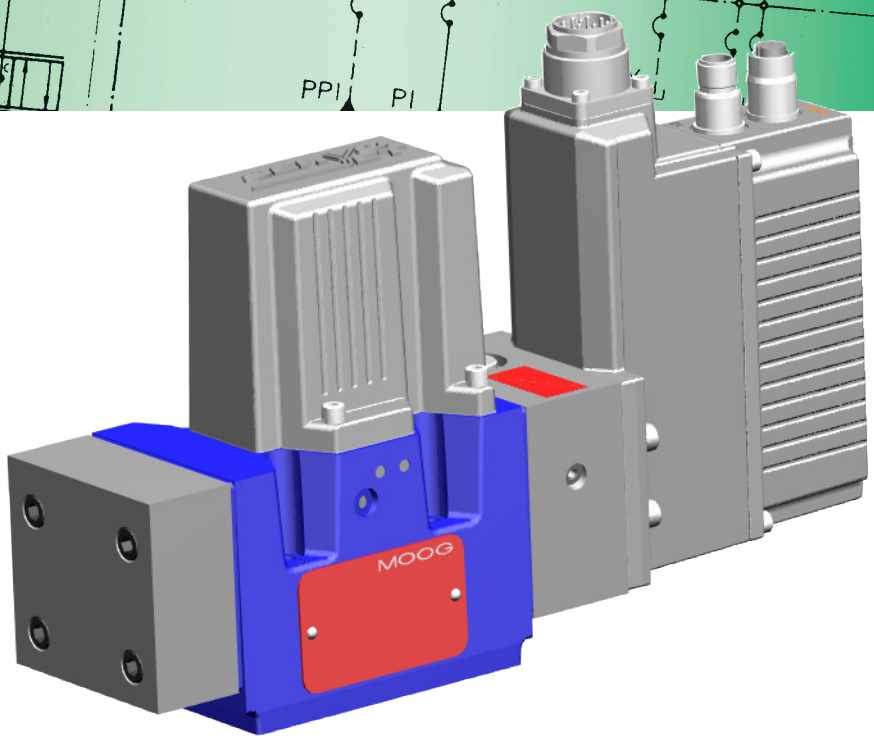
Operating Instructions

D941 Series

Two-Stage pQ-Proportional Valves
with Integrated Digital Electronics
and CAN Bus Interface





Copyright

Hanns-Klemm-Straße 28
71034 Böblingen
Germany
Telephone: +49 7031 622-0
Fax: +49 7031 622-191
E-mail: info@moog.de
Internet: http://www.moog.com/Industrial
http://www.moog.com/D941Series

Subject to change without notice.

Table of Contents

List of Figures

List of Tables

For your notes.

1 General Information

1.1 About the operating instructions

About the operating instructions

These operating instructions apply only to D941 series valves. The instructions contain the most important information for ensuring proper and correct operation of the valves.
⇨ "1.3 Intended operation", page 3
⇨ "2.1 Handling in accordance with safety requirements", page 7

Before starting work with and on the valves, all persons responsible for machine planning, assembly and operation must read, understand and follow the contents of the operating instructions in every particular. This requirement applies in particular to the safety instructions.
⇨ "1.2 Selection and qualification of personnel", page 2
⇨ "2.1 Handling in accordance with safety requirements", page 7

These operating instructions have been prepared with great care in compliance with the relevant regulations, state-of-the-art technology and our many years of knowledge and experience, and the contents have been generated to the best of the authors' knowledge.
However, the possibility of error remains and improvements are possible.
Please feel free to submit any comments about possible errors and incomplete information to us.

1.1.1 Subject to change without notice and validity

Subject to change without notice and validity of the operating instructions

The information contained in these operating instructions is valid and correct at the moment of release of this version of the operating instructions. Please see footer for version number and release date of the operating instructions.
We reserve the right to make changes to the operating instructions at any time and without specified reasons.

1.1.2 Completeness

Completeness of the operating instructions

These operating instructions are complete only when used in conjunction with the product-related hardware and software documentation required for the relevant application.

1.1.3 Storage location

Storage location for the operating instructions

The operating instructions and all the associated hardware and software documentation must always be kept ready to hand and accessible near the valve or the higher-level machine.

1.1.4 Typographical conventions

Typographical conventions

DANGER 	**Identifies safety instructions which are intended to warn of immediately imminent danger to life and limb or serious damage to property.** **Failure to comply with these safety instructions will inevitably result in fatalities, serious personal injuries (disablement) or serious damage to property!**
WARNING 	**Identifies safety instructions which are intended to warn of possible danger to life and limb or possible serious damage to property.** Failure to comply with these safety instructions may result in fatalities, serious personal injuries (disablement) or serious damage to property!
CAUTION 	Identifies safety instructions which are intended to warn of minor personal injuries or minor damage to property. Failure to comply with these safety instructions may result in minor personal injuries or minor damage to property.
	Identifies important notes/information
• or -	Identifies listings
⇨	Identifies references to another chapter, another page, table or illustration in the operating instructions
Blue text	Identifies hyperlinks in the PDF file
1., 2., …	Identifies steps in a procedure which must be performed in consecutive order
«MS»	Identifies LEDs on the valves (e.g., «MS»)
'Node-Id'	Identifies parameters of the valve software (e.g., 'Node-Id') or the valve status (e.g., 'ACTIVE').

1.2 Selection and qualification of personnel

Selection and qualification of personnel

WARNING 

Only properly qualified and authorized users may work with and on the valves.

Qualified users

Qualified users are specialized personnel with the required knowledge and experience who have been trained to performed such work. In particular, these specialized personnel must be authorized to operate, earth/ground and label devices, systems and power circuits in accordance with safety engineering standards. Project planners must be fully conversant with automation safety concepts.

1.3 Intended operation

WARNING

The valves may be used exclusively under the conditions and applications specified in the operating instructions.
Any other or more extensive use is not permitted.

Intended operation

The valves may only be operated as a component part of a higher-level overall system, for example in a machine.
They may 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. Use with other media requires our prior approval.
Correct, reliable and safe operation of the valves requires qualified project planning as well as proper utilization, transportation, storage, mounting, removal, electric and hydraulic connection, starting-up, configuration, operation, cleaning and maintenance.
The valves may only be started up after it has been verified that the higher-level machine complete with all its installed components complies with the respectively valid version of the relevant national and international regulations, standards and guidelines (such as, for example, the EU Machinery Directive, or the regulations specified by professional organizations).
The valves may only be operated in technically faultless and operationally safe condition.

Intended operation also includes the following:

- Observation of these operating instructions
- Handling of the valves in accordance with safety requirements
  ⇨ "2.1 Handling in accordance with safety requirements", page 7
- Adherence to the inspection and maintenance instructions of the manufacturer and the operator of machine
- Observation of all product-related hardware and software documentation relevant to the particular application
- Observation of all safety standards of the manufacturer and the operator of the machine relevant to the particular application
- Observation of the respectively valid version of the relevant national and international regulations, standards and guidelines (such as, for example, the EU Machinery Directive, or the regulations specified by professional organizations)

1.4 Structural modifications

WARNING

To avoid damage to the valves or accessories, structural modifications, on account of the complexity of the internal components of the valves or accessories, may only be performed by us or our authorized service centers.
Warranty and liability claims for personal injury and damage to property are excluded if they are caused by unauthorized or improperly performed structural modifications or other interventions.
⇨ "1.10 Warranty and liability", page 6

Structural modifications

1.5 Responsibilities

Responsibility of the manufacturer and the operator of the machine

The manufacturer and the operator of the machine are responsible for ensuring that work with and on the valves and handling of the valves is planned and performed in accordance with the directions given in these operating instructions and in the product-related hardware and software documentation relevant to the particular application.
The manufacturer and the operator of the machine are in particular responsible for ensuring the following:

- Observation of the respectively valid version of the relevant national and international regulations, standards and guidelines (such as, for example, the EU Machinery Directive, or the regulations specified by professional organizations) in configuration and construction of the machine with all its installed components
- Handling of the valves in accordance with safety requirements
  ⇨ "2.1 Handling in accordance with safety requirements", page 7
- Installation of a suitable safety device for limiting the pressure at the hydraulic ports
  ⇨ "2.1.1 Safety device for pressure limitation", page 7
- Intended operation of the valves
  ⇨ "1.3 Intended operation", page 3
- Selection and training of the personnel who perform work with and on the valves or who handle the valves
  ⇨ "1.2 Selection and qualification of personnel", page 2
- Prevention of unauthorized or improperly performed structural modifications, repairs or maintenance to the valves
  ⇨ "1.4 Structural modifications", page 3
  ⇨ "9 Service", page 75
- Compliance with the preconditions for satisfying the EMC protection requirements
  ⇨ "1.7 Electromagnetic compatibility (EMC)", page 5
- Proper bearing, transportation, mounting, removal, connection, starting-up, configuration, operation, cleaning, maintenance, trouble shooting or disposal of the valves
- Adherence to all the technical data relating to the bearing, transportation, mounting, removal, connection, starting-up, configuration, operation, cleaning, maintenance or trouble shooting of the valves, in particular the environmental conditions and the data pertaining to the hydraulic fluid
  ⇨ "4 Technical Data", page 33
- Definition and observation of the application-specific inspection and maintenance instructions
- Use of original spare parts
  ⇨ "12.2 Spare parts", page 87
- Storage of the operating instructions so that they are ready to hand and accessible
  ⇨ "1.1.3 Storage location", page 1

1.6 Manufacturer's declaration

Manufacturer's declaration

The valves comply with the standards specified in the associated manufacturer's declaration.
The valves comply with the requirements of the Machine Directive 98/37/EC.
Refer to the associated manufacturer's declaration for the standards applied.

1.7 Electromagnetic compatibility (EMC)

Electromagnetic compatibility (EMC)

The valves satisfy the EMC protection requirements for immunity to interference according to DIN EN 61000-6-2:2005 (evaluation criterion A) and for emitted interference according to DIN EN 61000-6-4:2005.

The following technical requirements must be in place so that the EMC protection requirements can be satisfied:

- Use of the mating connectors recommended for the valves
  ⇨ "12.3 Accessories", page 88
- Adequate shielding
- Design of equipotential bonding systems, protective earthing/grounding and shielding according to Technical Note TN 353

1.8 Environmental protection

1.8.1 Emissions

Environmental protection: emissions

When used according to their intended purpose, the valves do not issue harmful emissions.

1.8.2 Disposal

Environmental protection: disposal

It is essential to comply with the relevant national waste disposal regulations and environmental protection provisions when disposing of valves, spare parts or accessories, packaging that is no longer needed, hydraulic fluid or auxiliary materials and substances used for cleaning!

1.9 Trademarks

Trademarks

Moog, Moog Authentic Repair® and ServoJet® are registered trademarks of Moog Inc. and its subsidiaries.

Microsoft® and Windows® are either registered trademarks or trademarks of the Microsoft® Corporation in the USA and/or other countries.

ⓘ All the product and company names mentioned in these operating instructions are possibly proprietary names or trademarks of the respective manufacturers. The use of those names by third parties for their own purposes may infringe the rights of the manufacturers.
The absence of the symbols ® or ™ does not indicate that the name is free from trademark protection.

1.10 Warranty and liability

Our General Terms and Conditions of Sale and Payment always apply. These are made available to the buyer at the latest on conclusion of the contract.

Exclusion of warranty and liability

Among other things, warranty and liability claims for personal injury and damage to property are excluded if they are caused by one or more of the following:

- Non-intended operation of the valves
  ⇨ "1.3 Intended operation", page 3
- Failure to observe the respectively valid version of the relevant national and international regulations, standards and guidelines (such as, for example, the EU Machinery Directive, or the regulations specified by professional organizations) in configuration and construction of the machine with all its installed components
- Omission of a suitable safety device for limiting the pressure at the hydraulic ports
  ⇨ "2.1.1 Safety device for pressure limitation", page 7
- Use of the valves in a state that is not technically faultless or not operationally safe
- Work with and on the valves performed by or the valves handled by non-qualified users
  ⇨ "1.2 Selection and qualification of personnel", page 2
- Handling of the valves not in accordance with safety requirements
  ⇨ "2.1 Handling in accordance with safety requirements", page 7
- Failure to adhere to the inspection and maintenance instructions of the manufacturer and the operator of machine
- Failure to observe the operating instructions or the product-related hardware and software documentation relevant to the particular application
- Failure to observe the safety standards of the manufacturer and the operator of the machine relevant to the particular application
- Failure to adhere to the technical data relating to the bearing, transportation, mounting, removal, connection, starting-up, configuration, operation, cleaning, maintenance or trouble shooting of the valves, in particular the environmental conditions and the data pertaining to the hydraulic fluid
  ⇨ "4.1 General technical data", page 33
- Improper bearing, transportation, mounting, removal, connection, starting-up, configuration, operation, cleaning, maintenance, trouble shooting or disposal of the valves
- Storage or transportation of the valves, spare parts or accessories outside the original packaging
  ⇨ "11 Transportation and Storage", page 85
- Unauthorized or improperly performed structural modifications, repairs or maintenance to the valves
  ⇨ "1.4 Structural modifications", page 3
  ⇨ "9 Service", page 75
- Use of non-original spare parts
  ⇨ "12.2 Spare parts", page 87
- Catastrophes caused by foreign objects or force majeure

2 Safety

2.1 Handling in accordance with safety requirements

WARNING

It is the responsibility of the manufacturer and the operator of the machine to ensure that the valves are handled in accordance with safety requirements.

Handling in accordance with safety requirements

In order to ensure that the valves are handled in accordance with safety requirements and operated without faults, it is essential to observe the following:

- All the safety instructions in these operating instructions
- All the safety instructions in the product-related hardware and software documentation relevant to the particular application
- All the safety instructions in the safety standards of the manufacturer and the operator of the machine relevant to the particular application
- All the relevant national and international safety and accident prevention regulations, standards and guidelines, including the safety regulations specified by professional organizations, in particular the following standards pertaining to the safety of machinery:
  - DIN EN ISO 12100
  - DIN EN 982
  - DIN EN 60204

Observing the safety instructions and the safety and accident prevention regulations, standards and guidelines will help to prevent accidents, malfunctions and damage to property!

2.1.1 Safety device for pressure limitation

WARNING

Excessive pressure at the hydraulic ports damages the valve and can cause unsafe states in the machine.
A pressure-limiting valve or a comparable safety device must be installed to limit the pressure at all the hydraulic ports to the specified maximum operating pressure.
Maximum operating pressure:
⇨ "4 Technical Data", page 33

Safety device for pressure limitation

2.1.2 Safety-oriented systems

Safety-oriented systems

WARNING

As in any electronic control system, the failure of certain components in valves as well might lead to to an uncontrolled and/or unpredictable operational sequence.
All types of failure on a system level must be taken into consideration and appropriate protective measures must be taken.
The use of control technology in safety-oriented systems calls for special measures.
When planning to use control technology in a safety-oriented system, the user should seek detailed advice in addition to referring to all the potentially available standards or guidelines on safety-engineering installations.

2.2 Safety equipment

Safety equipment: safety shoes work gloves

CAUTION

The mass of the valve is 2.5 kg.
To protect yourself against personal injury by falling vales, always wear suitable safety equipment, such as work shoes, when handling the valve.

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

2.3 General safety instructions

General safety instructions

WARNING

Observe and adhere to the technical data and in particular the information given on the valve nameplate.
⇨ "4 Technical Data", page 33

CAUTION

When handling hydraulic fluids, observe the safety provisions applicable to the respective product.

CAUTION

The information contained in these operating instructions, in particular the chapters mentioned below, must be inserted in the operating instructions for the machine.
⇨ "2 Safety", page 7
⇨ "9 Service", page 75

3 Function and Mode of Operation

3.1 Overview

Function of the valves: throttle valves

The valves of the D941 series are two-stage pQ-proportional valves with a ServoJet® pilot stage.
The valves are throttle valves for 2x2-, 3-, 4- or even 5-way applications. They control flow and regulate pressure (upper and lower limiting pressure). They can therefore be used for both pressure control and pressure-limiting control applications. The control electronics for spool position and pressure and a pressure transducer are integrated in the valve.

3.1.1 ServoJet® pilot stage

ServoJet® pilot stage

The main stage spool is driven by a ServoJet® pilot stage, which can move the spool in both working directions. This gives the valve strong actuating power for the spool (up to 80 % of the applied pilot pressure is converted via the end faces of the spool into actuating force) as well as very good static and dynamic characteristics.
⇨ "3.3 ServoJet® pilot stage", page 13

3.1.2 Operational modes

Depending on the model, one of the operational modes below is preset in the valve.
Changeover between the operational modes can be effected via the integrated CAN bus interface.

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

The following operational modes are possible:

- Flow control (Q-control)
  ⇨ "3.4.1 Flow control (Q-control)", page 14
- Pressure control (p-control)
  ⇨ "3.4.2 Pressure control (p-control)", page 15
- Flow and pressure control (pQ-control)
  ⇨ "3.4.3 Flow and pressure control (pQ-control)", page 15

3.1.3 Safety function/fail-safe

Fail-safe functions

The fail-safe functions of the valves bring about a defined safe spool position and thereby increase safety for the operator if, for example, the supply voltage to the valve fails or the pilot pressure p_X drops.
⇨ "3.5 Safety function/fail-safe", page 17

Valves with the following fail-safe functions are available:

- Valves with mechanical fail-safe function F, D and M
  ⇨ "3.5.2 Mechanical fail-safe functions", page 18
- Valves with fail-safe function W (fail-safe valves)
  ⇨ "3.5.3 Fail-safe valves", page 19

3.1.4 Analog and digital inputs/outputs

Analog command inputs

Depending on the model, different analog command inputs for flow and/or pressure control can be set in the valve.
⇨ "3.6 Analog command inputs", page 20

Analog actual value outputs

Depending on the model, the valve can have different analog actual value outputs for flow and/or pressure control.
⇨ "3.7 Analog actual value outputs 4–20 mA", page 26

Enable input

Depending on the model, the valve can have a digital enable input.
⇨ "3.8 Enable input", page 26

3.1.5 Status LEDs

Status LEDs

The operating state and the network state of the valve are indicated by multi-colored LEDs (status LEDs) on the valve electronics housing.
⇨ "3.9 Status display", page 27

3.1.6 Valve electronics and valve software

Integrated digital valve electronics and valve software

The digital driver and control electronics are integrated in the valve. The valve electronics contain a microprocessor system which executes all the 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 temperature.
⇨ "3.10 Valve software", page 28

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

3.1.7 CAN bus interface

CAN bus interface

The valves are configured, activated and monitored via the integrated CAN bus interface in accordance with the CiA standard CiA DSP 408.
⇨ "3.11 CAN bus interface and CANopen", page 30

3.1.8 Benefits of the valves

Benefits of the valves

The valves offer the following benefits:

- Superior control system output and outstanding static and dynamic performance due to the improved frequency response of the spool stroke, which facilitates high control loop amplification in flow control. The improved dynamic valve output is based on the extremely high natural frequency of the ServoJet® pilot stage (500 Hz) in combination with digitally realized control algorithms.
- Energy saving due to significantly improved utilization of the control flow of the ServoJet® pilot stage.
- Improved reproducibility of the spool position due to higher spool drive forces of the ServoJet® pilot stage (up to 80 % of the applied pilot pressure is converted via the end faces of the spool into actuating power).
- Increased safety for the user due to valves with a defined safe spool position.
  ⇨ "3.5 Safety function/fail-safe", page 17
- In case of a supply voltage failure or in case of an EMERGENCY OFF function, the spool is returned to the predefined, spring-loaded position without overshooting a working position (fail-safe).
  ⇨ "3.5.5 Shutdown/failure of the supply voltage", page 19
- Pressure control loop adjustable by means of software.
- Low hysteresis and high response characteristics.
- Standardized spool position signal.
- Electrical zero point adjustment is configurable.
- Flow and pressure control with only one valve.
- Galvanically isolated CAN bus interface.
  ⇨ "3.11 CAN bus interface and CANopen", page 30
- Fault-free signal transfer in the event of digital activation via the CAN bus.
- Simplified wiring of CAN networks due to CAN-IN/OUT connectors.
- Optionally with up to two analog command inputs and up to two analog actual value outputs with programmable function.
  ⇨ "3.6 Analog command inputs", page 20
  ⇨ "3.7 Analog actual value outputs 4–20 mA", page 26

3.2 Representative depiction of the valve

Representative depiction of a two-stage pQ-proportional valve

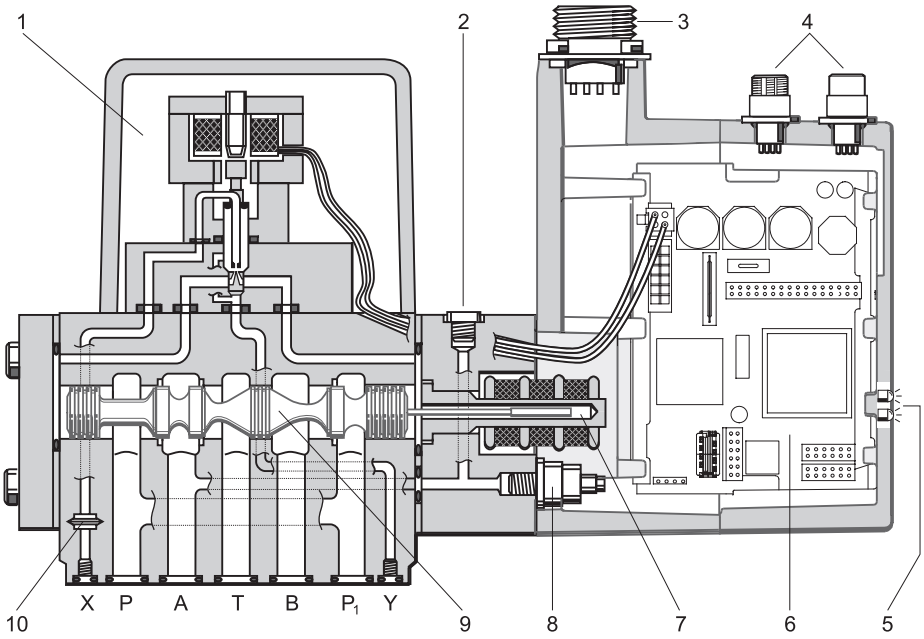


Figure 1: Representative depiction of a two-stage pQ-proportional valve

Item	Description	Further information
1	ServoJet® pilot stage	⇨ "3.3 ServoJet® pilot stage", page 13
2	Venting screw	⇨ "7.3.1 Venting", page 69
3	Valve connector	⇨ "6.1 Pin assignment", page 54
4	CAN-IN/OUT connectors	⇨ "6.1.3 CAN-IN/OUT connectors", page 59 ⇨ "6.2 Wiring CAN networks", page 60
5	Status LEDs	⇨ "3.9 Status display", page 27
6	Electronics	
7	Position transducer (LVDT)	⇨ "3.4.1 Flow control (Q-control)", page 14
8	Pressure transducer	⇨ "3.4.2 Pressure control (p-control)", page 15
9	Main stage spool	
10	Filter element	⇨ "9.1.2 Replacing the filter element", page 78
X…Y	Ports	⇨ "4.7.2 Mounting pattern of mounting surface", page 46

Table 1: Item numbers of the representative depiction of the two-stage pQ-proportional valve

3.3 ServoJet® pilot stage

3.3.1 Representative depiction and function

Representative depiction of the ServoJet® pilot stage

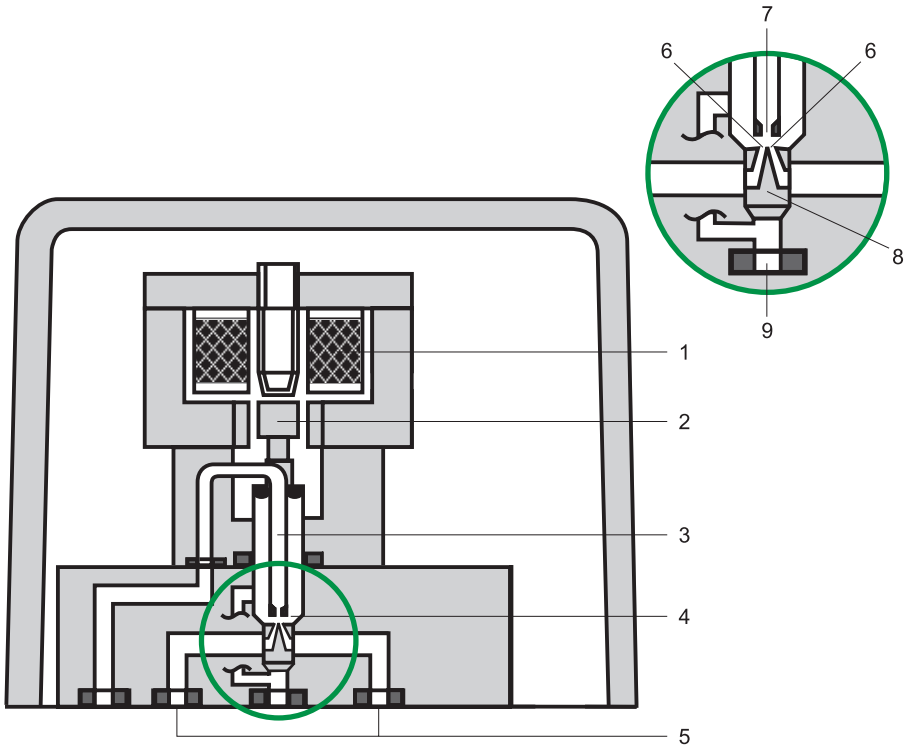


Figure 2: Representative depiction of the ServoJet® pilot stage

Item	Description
1	Coil
2	Armature
3	Jetpipe
4	Annular space under the nozzle
5	Control ports
6	Distributor bores
7	Nozzle
8	Distributor
9	Tank port

Table 2: Item numbers of the representative depiction of the ServoJet® pilot stage

Function of the ServoJet® pilot stage

The ServoJet® pilot stage is a further development of the jetpipe pilot stage according to the jetpipe principle. It consists primarily of the torque motor, jetpipe and distributor.
An electric current through the coil (item 1 in Figure 2) of the ServoJet® pilot stage causes the armature (item 2 in Figure 2) to be deflected with the jetpipe (item 3 in Figure 2). The deflected fluid jet concentrated by the special nozzle shape pressurizes one of the two distributor bores (item 8 in Figure 2) more than the other.
This creates a pressure difference in the control ports (item 5 in Figure 2) of the ServoJet® pilot stage. The resulting effective flow moves the main stage spool (item 9 in Figure 1) in the corresponding working direction. Return is via the annular space (item 4 in Figure 2) under the nozzle to the tank port (item 9 in Figure 2).

3.3.2 Pilot pressure

Pilot pressure

If large flows are required with a high valve pressure drop, a correspondingly high pilot pressure must be selected to overcome the flow forces. The following approximation formula applies to the pilot pressure p_X:

$$p_X \geq 8.5 \cdot 10^{-3} \cdot Q \cdot \sqrt{\Delta p}$$

p_X [bar] : pilot pressure
Q [l/min] : maximum flow
Δp [bar] : actual pressure drop per control edge

The pilot pressure p_X must be at least 25 bar above the return pressure of the ServoJet® pilot stage.

3.4 Operational modes

WARNING **To ensure faultless valve operation, it is necessary to configure the valve correctly with regard to flow and pressure.**

3.4.1 Flow control (Q-control)

Q-control: controlling the spool position

In this operational mode the position of the main stage spool is controlled. The predefined command signal corresponds to a particular spool position. The spool position is proportional to the activation signal.

The command signal (spool command position) is transmitted to the valve electronics. The actual spool position is measured with a position transducer (LVDT) and transmitted to the valve electronics. Deviations between the predefined command position and the measured actual position of the spool are corrected. The valve electronics activate the ServoJet® pilot stage, which positions the spool via the effective flow accordingly.

The command position can be influenced by means of parameters in the valve software (e.g., linearization, ramping, dead band, sectionally defined amplification, etc.). The parameters can be set for example with the aid of the Moog Valve Configuration Software in the valve software.

⇨ "3.10 Valve software", page 28

⇨ "4.5.3 Flow signal characteristic curve", page 43

3.4.2 Pressure control (p-control)

WARNING

Faultless valve functioning for pressure control is only guaranteed if the control loop is stable and the pressure in port T is lower than the pressure to be controlled.

p-control: controlling the pressure in port A

In this operational mode the pressure in port A is controlled. The predefined command signal corresponds to a particular pressure in port A.

The command signal (command pressure in port A) is transmitted to the valve electronics. The pressure in port A is measured with a pressure transducer and transmitted to the valve electronics. Deviations between the predefined command pressure and the pressure measured in port A are corrected. The valve electronics activate the ServoJet® pilot stage, which positions the spool via the effective flow accordingly. The controlled pressure follows the command signal proportionally.

The pressure control function can be influenced by means of parameters in the valve software (e.g., linearization, ramping, sectionally defined amplification, etc.). The pressure controller is designed as an extended PID controller. The parameters can be set for example with the aid of the Moog Valve Configuration Software in the valve software.

⇨ "3.10 Valve software", page 28

⇨ "3.12 Moog Valve Configuration Software", page 31

3.4.3 Flow and pressure control (pQ-control)

pQ-control

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

A command signal for the spool position is derived from the difference of the flow control command signal and the output signal of the pressure-limiting controller. The output signal of the pressure-limiting controller is zero as long as the pressure control actual value is smaller than the pressure control command signal (setpoint value). If the pressure control actual value exceeds the pressure control command signal, the pressure-limiting controller reduces the command signal for the spool position until the pressure control actual value is equal to the pressure control command signal.

If pressure control is to be realized instead of pressure-limiting control, a sufficiently high flow control command signal must be selected to enable the limitation case to occur. This is necessary because the pressure-limiting controller can only reduce the command signal for the spool position.

3.4.4 Electrical and hydraulic zero positions

WARNING **The hydraulic zero position of the spool is not necessarily identical to the electrical zero position.**

Electrical and hydraulic zero positions of the spool

The electrical zero position of the spool is set if the command signal input for the spool position is equal to zero.
The hydraulic zero position of the spool is set if the flow via the control edges is equal to zero.
The hydraulic zero position is model-dependent.

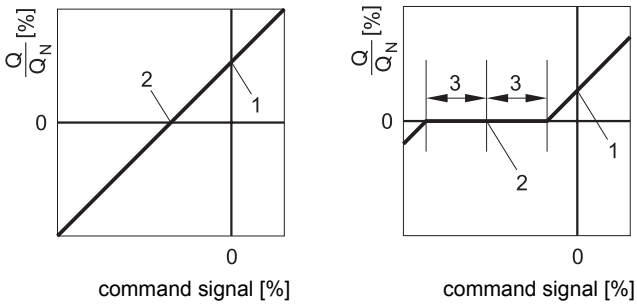


Figure 3: Examples of the electrical and hydraulic zero positions of the spool in the flow signal characteristic curve

Item	Explanation
1	Electrical zero position of the spool
2	Hydraulic zero position of the spool
3	Spool overlap

Table 3: Item numbers in the examples of the electrical and hydraulic zero positions of the spool in the flow signal characteristic curve

3.4.5 Notes on control response

Notes on control response

The controlled system is essentially influenced by:

- Rated flow Q_N
- Actual pressure drop Δp per control edge
- Load stiffness
- Fluid volume to be controlled after port A

Depending on differences in machine construction (such as volume, pipework, branching, accumulators, etc.), different types of controller optimizations may be required in pressure control. These controller optimizations can be performed for example with the Moog Valve Configuration Software via the CAN bus interface.
⇨ "3.12 Moog Valve Configuration Software", page 31

3.5 Safety function/fail-safe

WARNING

It is essential to observe the notes/information on handling in accordance with safety requirement particularly in the case of safety-critical applications.
⇨ "2.1 Handling in accordance with safety requirements", page 7

To avert damage, safety-critical applications are also governed by safety standards. It is vital among other things to ensure that both the individual components and the complete machine can be rendered in a safe state.

The following situations can occur for example:

- Failure of the valve supply voltage
  ⇨ "3.5.5 Shutdown/failure of the supply voltage", page 19
- Drop in the pilot pressure p_X
  ⇨ "3.5.6 Drop in the pilot pressure p_X", page 20

Fail-safe state of the valve

To avoid unsafe machine states that may result, various fail-safe functions have been developed for the valves whereby the fail-safe state of the value is achieved by moving the main stage spool into a defined safe position.
It is essential to ensure at the machine end that this spool position results in a safe state in the machine.

Valves with fail-safe function

Valves with the following fail-safe functions are available:

- Valves with mechanical fail-safe function F, D and M
  ⇨ "3.5.2 Mechanical fail-safe functions", page 18
- Valves with fail-safe function W (fail-safe valves)
  ⇨ "3.5.3 Fail-safe valves", page 19

Fail-safe function	Spool position	Pressure [bar]			Supply voltage	
		p_P	p_X external	p_X internal	Proportional valve	2/2-way seat valve
F	Defined safe end position: valve opening: P→B and A→T	independent[1]			off	-
D	Defined safe end position: valve opening: P→A and B→T	independent[1]			off	-
M	Defined overlapped safe center position: spool in electrical zero position	≥ 25	< 1	-	off	-
		< 1	-	< 1	off	-
W	Defined overlapped center position: spool in electrical zero position	≥ 25	≥ 25	-	on	off
		≥ 25	-	≥ 25	on	off
		≥ 25	≥ 25	-	off	off
		≥ 25	–	< 1	on	on
		≥ 25	< 1	-	on	on
	undefined	≥ 25	≥ 25	-	off	on
		≥ 25	-	≥ 25	off	on

Table 4: Position of the main stage spool as a function of the pressures and supply voltages at the valve

[1] Regardless of the applied system and pilot pressures, the spool is moved to the defined end position if the supply voltage to the proportional valve fails

When ordering the valves, it is necessary to specify which fail-safe function is to be integrated in the valve.

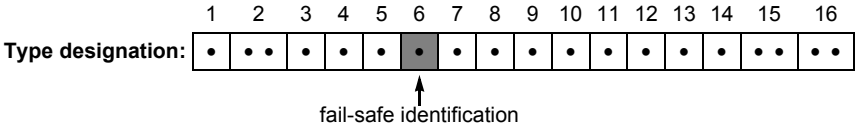
Depending on the model, moving of the spool into the valve's fail-safe state can be triggered by a corresponding signal at the enable input of the valve connector.
⇨ "3.5.4 Signals at the enable input", page 19

3.5.1 Fail-safe identification

Fail-safe identification

The fail-safe identification, i.e. the 6th position in the valve type designation, indicates which fail-safe function is integrated in the valve.

The 2nd, 15th and 16th positions of the type designation each consist of two characters.



Ident.	Fail-safe function	Further information
F	Valves with mechanical fail-safe function F	⇨ Table 4, page 17 ⇨ "3.5.2 Mechanical fail-safe functions", page 18
D	Valves with mechanical fail-safe function D	
M	Valves with mechanical fail-safe function M	
W	Valves with fail-safe function W (fail-safe valves)	⇨ Table 4, page 17 ⇨ "3.5.3 Fail-safe valves", page 19
X	Valves with special fail-safe function	

Table 5: Fail-safe identification in the type designation and explanation

3.5.2 Mechanical fail-safe functions

Mechanical fail-safe functions

Valves with the following mechanical fail-safe functions are available:

- Fail-safe function F
- Fail-safe function D
- Fail-safe function M

In the case of the mechanical fail-safe functions, the mechanical setting of the ServoJet® pilot stage or corresponding centering springs at the factory establishes which position the main stage spool assumes in the fail-safe state.
Position of the main stage spool: ⇨ Table 4, page 17

Installation drawings and hydraulic symbols:
⇨ "4.6.1 Valves with mechanical fail-safe function F, D and M", page 44

3.5.3 Fail-safe valves

Fail-safe valves

The valves with fail-safe function W with 2/2-way seat valves are called fail-safe valves.

When the supply voltage to the 2/2-way seat valve is shut down, the two control spaces of the main stage are hydraulically shorted, in the course of which pressure compensation takes place. The main stage spool is then pushed by the by spring restoring force into the safe center position identifying the fail-safe state of the fail-safe valve.

Installation drawing and hydraulic symbol:
⇨ "4.6.2 Valves with fail-safe function W (fail-safe valves)", page 45

Technical data of the 2/2-way seat valve:
⇨ "4.4 2/2-way seat valve of the fail-safe valve", page 40

3.5.4 Signals at the enable input

Signals at the enable input

Depending on the model, moving of the spool into the valve's fail-safe state can be triggered by a corresponding signal at the enable input of the valve connector. At signals less than 6.5 V, the valve is rendered in the fail-safe state.
⇨ "3.8 Enable input", page 26

Valve connector pin assignment:
⇨ "6.1 Pin assignment", page 54

3.5.5 Shutdown/failure of the supply voltage

Shutdown/failure of the supply voltage

WARNING

In the case of valves with fail-safe functions M and W, the position of the main stage spool is undefined if, with an applied pilot pressure of greater than 1 bar, the supply voltage is shut down, fails or drops below 18 V.

WARNING

After the supply voltage to the valve is shut down, fails or drops below 18 V, the ServoJet® pilot stage is no longer activated by the valve electronics.

With the pilot pressure applied, the mechanical setting of the ServoJet® pilot stage defines which end face of the main stage spool is pressurized with pilot pressure and thus which position the spool assumes in the fail-safe state.
Position of the main stage spool: ⇨ Table 4, page 17

The valve must be restarted after the supply voltage has been restored.
⇨ "3.5.5.1 Restarting the valve", page 19

3.5.5.1 Restarting the valve

Restarting the valve

The valve can be restarted after the supply voltage to the valve has been shut down, failed or dropped below 18 V as follows:

- Set the supply voltage for at least 1 second under defined conditions to zero and then restore the supply voltage in accordance with the technical data.
- Restore the supply voltage in accordance with the technical data, then cancel the fault via the digital interface and return the valve to the 'ACTIVE' status.

3.5.6 Drop in the pilot pressure p_X

Drop in the pilot pressure p_X

After the pilot pressure p_X has dropped below 1 bar, the main stage spool is pushed by the by spring restoring force into the defined safe center position identifying the fail-safe state of the safe valve.
Position of the main stage spool: ⇨ Table 4, page 17

3.6 Analog command inputs

Analog command inputs

Depending on the model, different analog command inputs for flow and/or pressure control can be set in the valve.

Settable analog command inputs

Command input	Benefits
±10 V or 0–10 V	Simple measurability of the signal, e.g., with an oscilloscope
±10 mA or 0–10 mA	In contrast to the 4–20 mA command input, less power is required with low command signals; large transmission lengths are possible
4–20 mA	Detection of fault in the electrical line and large transmission lengths are possible

Table 6: Settable analog command inputs

ⓘ When ordering the valves, it is necessary to specify which command inputs are to be set in the valve when it is delivered.

ⓘ All current and voltage inputs are floating but can be connected to ground (single-ended).

Basically, activation of the command inputs with differential signals is to be preferred. If the command signal cannot be transmitted differentially, the reference point of the command input at the valve must be connected to ground (GND).
⇨ "6.1.1.5 Single-ended command signals", page 58

Furthermore, activation with a current signal is to be preferred over activation with a voltage signal.

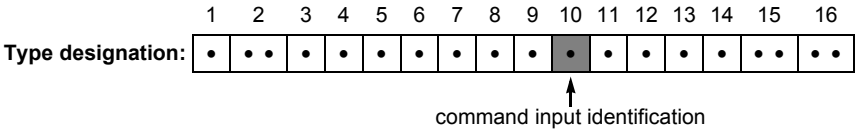
Valve connector pin assignment:
⇨ "6.1 Pin assignment", page 54

3.6.1 Command input identification

Command input identification

The command input identification, i.e. the 10th position in the valve type designation, indicates which command inputs are set in the valve when it is delivered.

ⓘ The 2nd, 15th and 16th positions of the type designation each consist of two characters.



Ident.	Explanation
M	Analog command signal via floating voltage inputs: Flow control command input ±10 V and pressure control command input 0–10 V Circuit and characteristic curve: ⇨ Figure 4, page 22 and ⇨ Figure 7, page 24 Pin assignment: ⇨ "6.1.1.2 Floating voltage inputs ±10 V and 0–10 V", page 55
X	Analog command signal via floating current inputs: Flow control command input ±10 mA and pressure control command input 0–10 mA Circuit and characteristic curve: ⇨ Figure 5, page 23 and ⇨ Figure 8, page 25 Pin assignment: ⇨ "6.1.1.3 Floating current inputs ±10 mA and 0–10 mA", page 56
E	Analog command signal via floating current inputs: Flow control command input 4–20 mA and pressure control command input 4–20 mA Circuit and characteristic curve: ⇨ Figure 6, page 24 and ⇨ Figure 9, page 25 Pin assignment: ⇨ "6.1.1.4 Floating current inputs 4–20 mA", page 57
9	Digital command signal via field bus interface ⇨ "3.11 CAN bus interface and CANopen", page 30

Table 7: Command input identification in the type designation and explanation

3.6.2 Flow control command inputs

3.6.2.1 Command input ±10 V

Floating flow control command input ±10 V

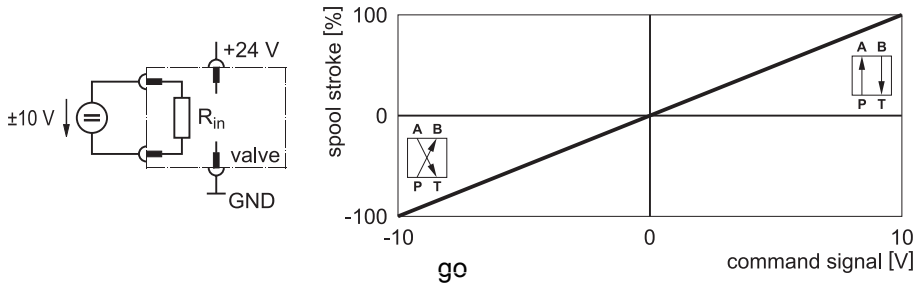


Figure 4: Floating flow control command input ±10 V (circuit and characteristic curve)

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

U_{in} = +10 V	100 % spool stroke, valve opening: P→A and B→T
U_{in} = 0 V	spool in electrical zero position
U_{in} = -10 V	100 % spool stroke, valve opening: P→B and A→T

CAUTION

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 there is no differential command input source available, the reference point of the command inputs must be connected to 0 V of the command input source (GND).
The operating direction of the command signal can be altered by modifying the parameters of the valve software.

3.6.2.2 Command input ±10 mA

Floating flow control command input ±10 mA

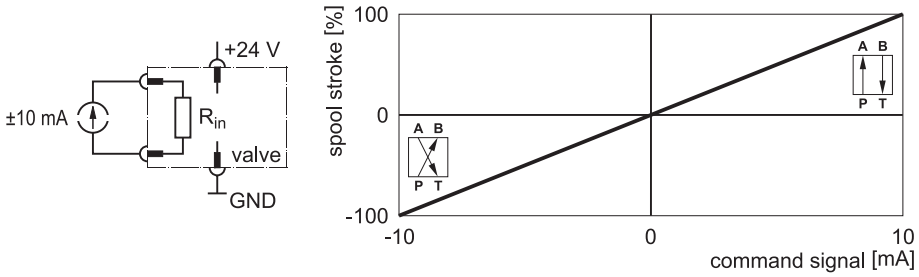


Figure 5: Floating flow control command input ±10 mA (circuit and characteristic curve)

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

I_{in} = +10 mA	100 % spool stroke, valve opening: P→A and B→T
I_{in} = 0 mA	spool in electrical zero position
I_{in} = - 10 mA	100 % spool stroke, valve opening: P→B and A→T

CAUTION

The input current I_{in} of the command inputs with current input signal must be between -25 mA and +25 mA!
Voltage levels in excess of 5 V may cause the destruction of the integrated valve electronics.

CAUTION

This command input is a floating input. The potential difference of each input to GND must be between -15 V and +32 V.

If there is no floating command input source available, the reference point of the command inputs must be connected to 0 V of the command input source (GND).
The operating direction of the command signal can be altered by modifying the parameters of the valve software.

3.6.2.3 Command input 4–20 mA

Floating flow control command input 4–20 mA

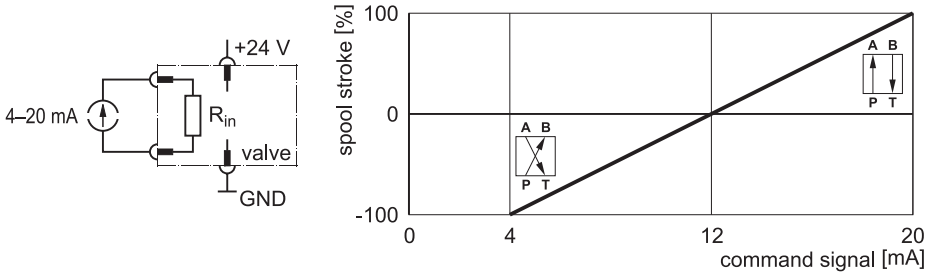


Figure 6: Floating flow control command input 4–20 mA (circuit and characteristic curve)

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

I_{in} = 20 mA 100 % spool stroke, valve opening: P→A and B→T

I_{in} = 12 mA spool in electrical zero position

I_{in} = 4 mA 100 % spool stroke, valve opening: P→B and A→T

CAUTION

The input current I_{in} of the command inputs with current input signal must be between -25 mA and +25 mA!
Voltage levels in excess of 5 V may cause the destruction of the integrated valve electronics.

3.6.3 Pressure control command inputs

3.6.3.1 Command input 0–10 V

Floating pressure control command input 0–10 V

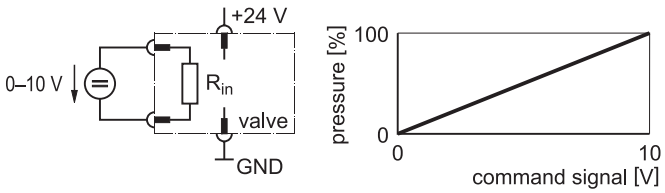


Figure 7: Floating pressure control command input 0–10 V (circuit and characteristic curve)

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

CAUTION

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 there is no differential command input source available, the reference point of the command inputs must be connected to 0 V of the command input source (GND).

3.6.3.2 Command input 0–10 mA

Floating pressure control command input 0–10 mA

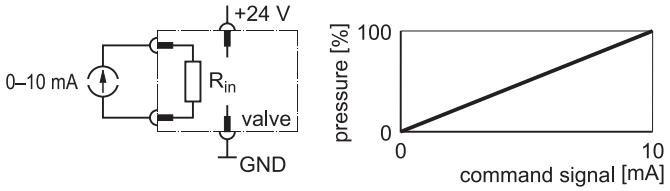


Figure 8: Floating pressure control command input 0–10 mA (circuit and characteristic curve)

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

CAUTION

The input current I_{in} of the command inputs with current input signal must be between -25 mA and +25 mA!
Voltage levels in excess of 5 V may cause the destruction of the integrated valve electronics.

CAUTION

This command input is a floating input. The potential difference of each input to GND must be between -15 V and +32 V.

If there is no floating command input source available, the reference point of the command inputs must be connected to 0 V of the command input source (GND).

3.6.3.3 Command input 4–20 mA

Floating pressure control command input 4–20 mA

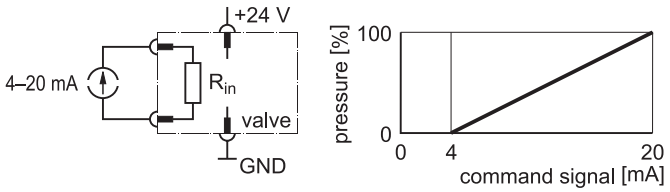


Figure 9: Floating pressure control command input 4–20 mA (circuit and characteristic curve)

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

CAUTION

The input current I_{in} of the command inputs with current input signal must be between -25 mA and +25 mA!
Voltage levels in excess of 5 V may cause the destruction of the integrated valve electronics.

CAUTION

This command input is a floating input. The potential difference of each input to GND must be between -15 V and +32 V.

If there is no floating command input source available, the reference point of the command inputs must be connected to 0 V of the command input source (GND).

3.7 Analog actual value outputs 4–20 mA

Analog actual value outputs

Depending on the model, the valve can have different analog actual value outputs for flow and/or pressure control.

Valve connector pin assignment:
⇨ "6.1 Pin assignment", page 54

Conversion of actual value output signals I_{out}:
⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58

The reference point for the 4–20 mA analog actual value outputs is GND.

ⓘ External detection of electrical line faults can be realized with the 4–20 mA analog actual value outputs.

ⓘ The 4–20 mA actual value outputs are short-circuit protected.

3.7.1 Flow control actual value output

Flow control actual value output 4–20 mA

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

I_{out} = 20 mA	100 % spool stroke, valve opening: P→A and B→T
I_{out} = 12 mA	spool in electrical zero position
I_{out} = 4 mA	100 % spool stroke, valve opening: P→B and A→T

3.7.2 Pressure control actual value output

Pressure control actual value output 4–20 mA

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

3.8 Enable input

Enable input

Depending on the model, the valve can have a digital enable input.
Depending on the model, moving to valve standby or fail-safe state can be triggered by corresponding signals at the enable input of the valve connector:

- Signals at the enable input between 8.5 V and 32 V referred to GND establish valve standby.
- At signals less than 6.5 V, the valve is rendered in the fail-safe state.

Valve connector pin assignment:
⇨ "6.1 Pin assignment", page 54

Fail-safe state of the valves:
⇨ "3.5 Safety function/fail-safe", page 17

3.9 Status display

Status LEDs

Multi-colored LEDs (status LEDs) on the electronics housing indicate the valve operating state and the network status.

3.9.1 Module status LED «MS»

The module status LED «MS» indicates an available supply voltage and possible operating and fault states.

Module status LED «MS»	Status
Off	No supply voltage
Green	Standard operation ('HOLD' or 'ACTIVE' valve status)
Flashing green	Standby ('INIT' or 'DISABLED' valve status)
Flashing red	Correctable fault
Red	Non-correctable fault
Flashing red-green	Self-test of valve electronics

Table 8: States of the module status LED «MS»

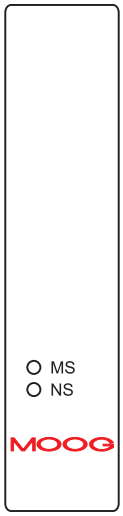


Figure 10: Valve label with status LEDs

3.9.2 Network status LED «NS»

Network status LED «NS»

The network status LED «NS» indicates the status of the CAN network.

Network status LED «NS»	Status
Off	No supply voltage or not online
Flashing green	Online, but not connected to other CAN bus nodes
Green	Online and connected to other CAN bus nodes
Flashing red	Time overrun
Red	Major fault
Flashing red-green	Self-test of valve electronics

Table 9: States of the network status LED «NS»

3.10 Valve software

Valve software

The valve software is an integral part of the valve and cannot be altered, copied or replaced by the user.

3.10.1 Configuration of the valves

Safety instructions: configuration of the valves

WARNING

The valves may only be configured by users who are qualified and authorized to do so.
⇨ "1.2 Selection and qualification of personnel", page 2

WARNING

Prior to starting-up, valves must be checked for correct configuration and possibly altered parameters. Altering the configuration or the parameters may change the function of the valve to such an extent that it will no longer function as specified in these operating instructions.

Incorrect configuration will result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

WARNING

The selected settings must be documented after the configuration of a valve has been altered.
The settings can be documented for example with the Moog Valve Configuration Software.
After a valve has been repaired or replaced, the user must transfer the settings again to the repaired or new valve because repaired or replacement valves are like new valves delivered with factory settings.
⇨ "3.10.1.1 Factory setting", page 29
⇨ "9.2 Repair", page 79

Configuration of the valves

Many of the functions made available by the valve software can be configured by the user by modifying parameters. For this purpose, the desired parameters must be sent via the CAN bus to the valve. Basically, parameters can be modified by each CAN bus node, for example also by the machine controller.
⇨ "7.2 Connecting the valve to the CAN bus", page 67

The Moog Valve Configuration Software is available as an accessory to simplify starting-up, diagnosis and configuration of the valves.
⇨ "3.12 Moog Valve Configuration Software", page 31
⇨ "12.3 Accessories", page 88

ⓘ If the valve is incorporated in a CAN bus system, the parameters can be transferred to the valve each time the system is powered up.
This ensures that the valve always receives the correct configuration.

3.10.1.1 Factory setting

Factory setting

The valve is delivered from the factory with preset parameters. This presetting corresponds to the factory setting.
Depending on the valve type and model, it may be necessary to adapt the parameters to the respective application.
Adaptations may be necessary particularly for the pressure controller and for the communication parameters provided the valve is to be operated in a CAN bus system.

ⓘ Detailed documentation of the factory setting parameters is available on request from us or our authorized service centers.

3.10.1.2 Storing of parameters

Volatile memory

Modified parameters are initially stored in the volatile memory of the microprocessor systems, i.e. they are lost if the power supply is interrupted. When the power supply is restored, the parameters which were stored last are again available.

Non-volatile memory

The microprocessor system also has a non-volatile memory. In order to store the modified parameters in this memory, it is necessary to send a memory command to the valve. If the power supply is interrupted, the modified configuration will again be available after the supply is restored.

3.11 CAN bus interface and CANopen

CAN bus interface

The valves are 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 motor vehicles. But due 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 communication profile (CiA DS 301)

CANopen is a standardized communication profile based on the CAN bus for simple networking of CANopen-compatible devices from many different manufacturers.
The communication profile complies with the CiA DS 301 standard, version 4.0, and is provided by CiA.
The CANopen standard defines various device profiles to enable connection of different device categories, including for example, drives, controllers, angle transmitters, etc.

Device profile for continuous valves (CiA DSP 408)

The function of the valves corresponds to the device profile for continuous valves in accordance with CiA DSP 408. This device profile is based on a profile specified 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 process data with the valves in real time. These data include in particular command signals and actual values as well as control and status messages. While process data are being transmitted, parameters can also be exchanged between the controller and the valves at the same time.

The controller or other CAN bus nodes transmit command signals, device control commands and parameters via the CAN bus to the valves.
The controller or other CAN bus nodes can read actual values, status information and the parameters of the current configuration from the valves.

Monitoring, fault recognition and diagnostic functions

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

3.12 Moog Valve Configuration Software

Moog Valve Configuration Software

The Moog Valve Configuration Software is a Microsoft® Windows® application enabling fast and convenient starting-up, diagnosis and configuration of the valves. The software communicates with the valves via the CAN bus.
⇨ "3.11 CAN bus interface and CANopen", page 30
⇨ "7.2 Connecting the valve to the CAN bus", page 67

The Moog Valve Configuration Software offers the following functions:

- Transfer of data between PC and valves
- Storage of the current valve settings on the PC
- Activation of the valves with graphic software control elements
- Graphic representation of status information, command signals and actual values as well as characteristic curves for the valves
- Recording and visualization of the system parameters with the integrated data logger and oscilloscope

The Moog Valve Configuration Software is available as an accessory.
⇨ "12.3 Accessories", page 88

Please refer to the associated software manual for detailed information on the Moog Valve Configuration Software.

For your notes.

4 Technical Data

WARNING **Observe and adhere to the technical data and in particular the information given on the valve nameplate.**

4.1 General technical data

WARNING **Use of the valves in potentially explosive environments is not permitted.**

CAUTION The valves must not be immersed in liquids!

General technical data

Permissible ambient conditions	Ambient temperature [1]	-20 to +60 °C
	Vibration resistance	30 g, 3 axes, frequency: 5 to 2000 Hz (as per DIN EN 60068-2-6)
	Shock resistance	60 g, 6 directions (as per DIN EN 60068-2-27)
Mounting option	In any position, fixed or movable; venting screw must point upwards ⇨ "4.7 Mounting surface", page 46 Observe the relevant safety instructions when mounting the valve. ⇨ "5 Mounting/Removal and Connection to the Hydraulic System", page 49	
Shipping plate	Delivered with oilproof shipping plate	
Weight	2.5 kg	

Table 10: General technical data

[1] In order to ensure that the electronic components integrated in the valve last as long as possible, we recommend that the hydraulic fluid be kept at as low a temperature as possible at as low an ambient temperature as possible.

4.2 Hydraulic data

CAUTION

Contrary to ISO/FDIS 4401-05-05-0-05 the length of the mounting surface must be at least 100 mm so that the required O-ring recesses on ports X and Y can be covered.

Valve construction type	Slide valve, two-stage, spool version		
Mounting pattern	as per ISO/FDIS 4401-05-05-0-05 ⇨ "4.7.2 Mounting pattern of mounting surface", page 46		
Diameter of ports	11.5 mm ⇨ "4.7.2 Mounting pattern of mounting surface", page 46		
Valve configurations	3-way, 4-way, 5-way and 2x2-way operation ⇨ "4.2.2 Valve configurations", page 35		
ServoJet® pilot stage	Natural frequency of the ServoJet® pilot stage: 500 Hz		
Control oil supply	Either external or internal		
Rated flow Q_N	8/30/60/80/2x80 l/min (at Δp_N = 5 bar per control edge: tolerance ±10 %)		
Max. flow	80 l/min (at Δp_N = 5 bar per control edge)		
Maximum operating pressure	Main stage	Ports P, A and B	350 bar
		Port T with Y internal	210 bar
		Port T with Y external	250 bar
	Pilot stage	Standard version	280 bar
		with integrated prethrottle (on request)	350 bar
Hydraulic fluid	Permissible fluids	Mineral-oil-based hydraulic oil as per DIN 51524-1 to DIN 51524-3 Other fluids on request	
	Permissible temperature [1]	-20 to +80 °C	
	Viscosity ν	recommended	15 to 45 mm^2/s
		permissible	5 to 400 mm^2/s
	Cleanliness level, recommended (ISO 4406)	for functional safety	< 19/16/13
		for life cycle (wear and tear)	< 17/14/11
	ⓘ The cleanness 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 as directly in front of the valve as possible		
	Filter fineness, recommended	for functional safety	$\beta_{15} \geq 75$ (15 µm absolute)
		for life cycle (wear and tear)	$\beta_{10} \geq 75$ (10 µm absolute)
Max. leakage flow Q_L [2]	Total maximum	3.5 l/min	
	Pilot stage alone	1.7 l/min	
Step response time for 0 to 100 % stroke [2]	33 ms		
Threshold [2]	in Q-control	< 0.05 %	
	in p-control	< 0.1 %, dependent on optimization	
Hysteresis [2]	in Q-control	< 0.3 %	
	in p-control	< 0.2 %, dependent on optimization	
Zero shift (typical)	< 1.0 % (at ΔT = 55 K)		
Linearity of pressure control	⇨ Table 12, page 35		
Gasket material	NBR, FPM, others on request		

Table 11: Hydraulic data

[1] In order to ensure that the electronic components integrated in the valve last as long as possible, we recommend that the hydraulic fluid be kept at as low a temperature as possible at as low an ambient temperature as possible.

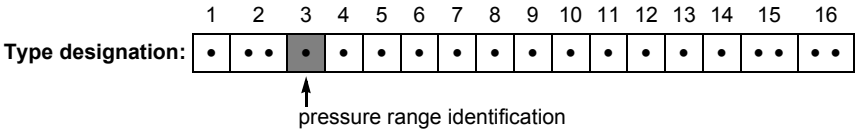
[2] Typical values (measured at pilot pressure p_X = 210 bar, viscosity of hydraulic fluid ν = 32 mm^2/s and temperature of hydraulic fluid T = 40 °C)

4.2.1 Pressure range identification and linearity of pressure control

Pressure range identification and linearity of pressure control

The pressure range identification, i.e. the 3rd position in the valve type designation, indicates which setting pressure is required for a pressure signal of 100 % and how great the deviation from the linearity of pressure control is.

The 2nd, 15th and 16th positions of the type designation each consist of two characters.



Ident.	Setting pressure for a pressure signal of 100 %	Typical deviation from linearity of pressure control
V	100 bar	< 0.35 % F.S. of pressure transducer
U	160 bar	< 0.25 % F.S. of pressure transducer
T	250 bar	< 0.21 % F.S. of pressure transducer
K	350 bar	< 0.17 % F.S. of pressure transducer
X	Special version	

Table 12: Pressure range identification in the type designation and typical deviation from the linearity of pressure control

4.2.2 Valve configurations

Valve configurations

Depending on the model, the following valve configurations are possible:

- 3-way operation
  ⇨ "4.2.2.1 Valves with 3-way and 5-way operation", page 36
- 4-way operation
  ⇨ "4.2.2.2 Valves with 4-way operation", page 37
- 5-way operation
  ⇨ "4.2.2.1 Valves with 3-way and 5-way operation", page 36
- 2x2-way operation
  ⇨ "4.2.2.3 Valves with 2x2-way operation", page 38

4.2.2.1 Valves with 3-way and 5-way operation

Valves with 3-way and 5-way operation in the main flow path

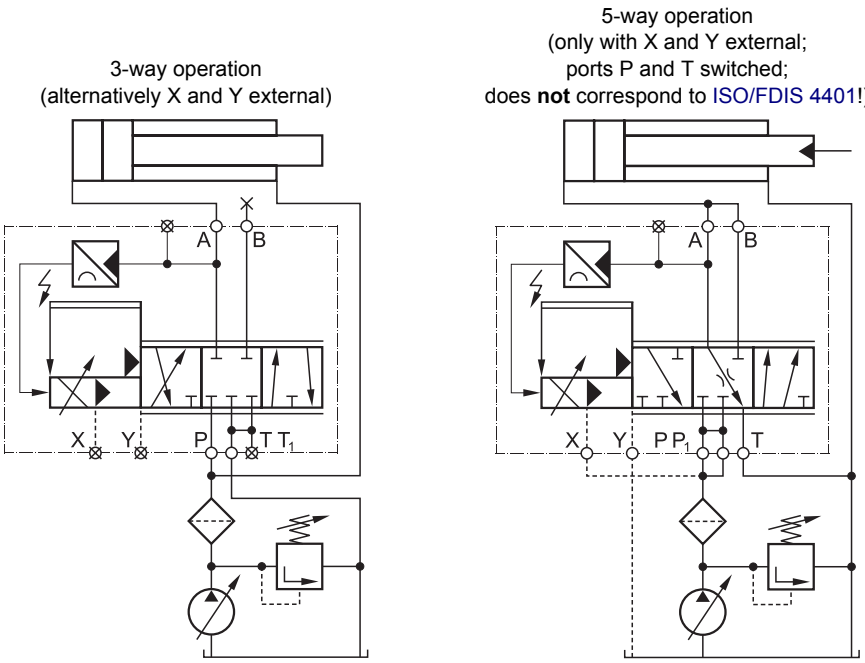


Figure 11: Valves with 3-way and 5-way operation in the main flow path

3-way operation

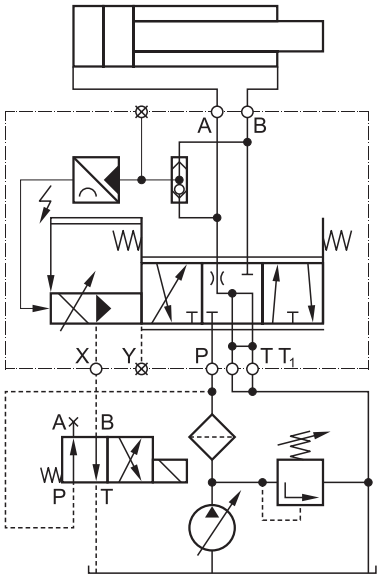
In 3-way operation, the valves operate as 3-way pressure-reducing valves with a flow of P→A or A→T. Only one control port is used.

5-way operation

In 5-way operation, the valves operates as in 3-way operation, but with double throughflow in the supply direction. The reversal of direction at the actuator requires an external force.

4.2.2.2 Valves with 4-way operation

4-way operation (alternatively Y external)



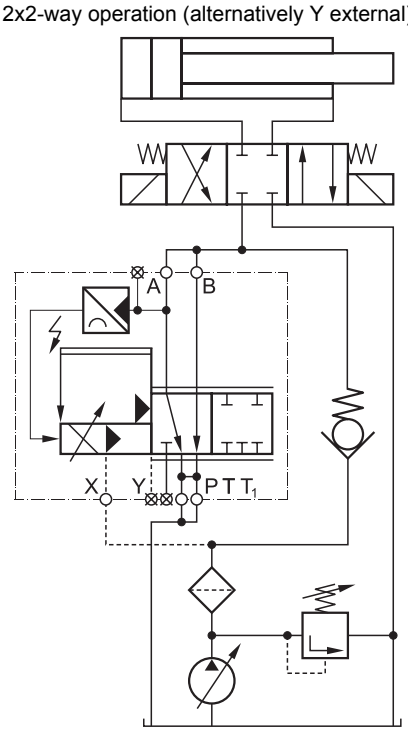
Valve with 4-way operation in the main flow path

Figure 12: Valve with 4-way operation in the main flow path

Without shuttle valve
The valve operates from P→A like a 3-way pQ-valve. From P→B there is only one flow control. This enables the direction of movement of the actuator to be reversed (speed-controlled return).

With shuttle valve
The valve operates as an electrically adjustable throttle over all four control edges, i.e. the actuator can be operated with pressure control in both directions of movement. Here the pressure is always controlled only in one of the two control ports. Depending on the polarity of the flow control command signal input, an electronic logic circuit ensures correct assignment between direction of movement and pressure control. The special spool geometry relieves the uncontrolled control port more or less to the tank.
X must be externally switchable when the spring-determined fail-safe state is used.

4.2.2.3 Valves with 2x2-way operation



Valve with 2x2-way operation in the secondary flow path

Figure 13: Valve with 2x2-way operation in the secondary flow path

In 2x2-way operation, the valve has double flow and operates as an electrically adjustable pressure-limiting valve from A→T or B→T_1. If a command signal of 0 % is input, the valve is fully open, i.e. the pressure at the control ports is zero, apart from pressure losses. It is necessary to ensure that a minimum pilot pressure (p_X > 25 bar) is maintained. This can be achieved for example by a non-return valve with spring bias, which effects a pilot pressure of 25 bar (as shown) or by a separate control oil pump.

4.2.3 Leakage port Y

Leakage port Y

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

- If the return pressure of the ServoJet® pilot stage is less than 25 bar below the pilot pressure p_X
- If high pressure peaks (> 210 bar) at tank port T which are caused by other switching valves in the hydraulic circuit can result in valve damage
- If the valve is used with 5-way operation

If the valve is used with 5-way operation, port X and leakage port Y must be externally connected.

4.3 Electrical data

Electrical data

Supply voltage	nominal 24 V DC (18–32 V DC) At supply voltages less than 18 V, the valve is rendered in the fail-safe state. ⇨ "3.5.5 Shutdown/failure of the supply voltage", page 19	
External fuse protection for each valve	0.5 A slow-blowing fuse	
Duty cycle	100 %	
Valve connector	11+PE-pin connector with pin contacts (as per DIN EN 175201-804) ⇨ "6.1.1 11+PE-pin valve connector", page 54	
Protection type	IP65 with mounted mating connector or mounted dust protection cap (with sealing function) (as per DIN EN 60529)	
EMC protection requirements	Immunity to interference as per DIN EN 61000-6-2:2005 (evaluation criterion A) Emitted interference as per DIN EN 61000-6-4:2005	
Power consumption	Valve electronics	8.4 W (0.35 A at 24 V DC)
Inputs/outputs	Command input 0–10 V	R_{in} = 20 kΩ
	Command input ±10 V	R_{in} = 20 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: 0–500 Ω to GND
	Enable input	Signals at the enable input between 8.5 V and 32 V referred to GND establish valve standby. At signals less than 6.5 V, the valve is rendered in the fail-safe state. ⇨ "3.8 Enable input", page 26
CAN bus interface	CAN-IN/OUT connectors	In each case one 5-pin connector with pin contacts and one with socket connectors (both M12x1) ⇨ "6.1.3 CAN-IN/OUT connectors", page 59
	Physical	ISO/DIS 11898 CAN-HIGH SPEED
	Communication profile	CiA DS 301, version 4.0
	Device profile	CiA DSP 408
	Maximum voltage capacity	±40 V continuous ±2.5 kV ESD (classification A: Human Body Model, C = 100 pF, R = 1.5 kΩ)
	Maximum permissible number of CAN bus nodes	32 or 110 ⇨ "6.2.2 Permissible number of CAN bus nodes", page 62

Table 13: Electrical data

4.4 2/2-way seat valve of the fail-safe valve

2/2-way seat valve of the fail-safe valve

Valve construction type	2/2-way seat valve
Function	solenoid-actuated
Connector	3-pin connector (as per DIN EN 175301-803) ⇨ "4.4.1 Plug connection of the 2/2-way seat valve", page 40
Supply voltage	nominal 24 V DC (21.6–26.4 V DC, max. 1.2 A)
Nominal power	26 W

Table 14: Technical data of the 2/2-way seat valve of the fail-safe valve

⇨ "3.5.3 Fail-safe valves", page 19

4.4.1 Plug connection of the 2/2-way seat valve

Schematic circuit of the plug connection of the 2/2-way seat valve of the fail-safe valve

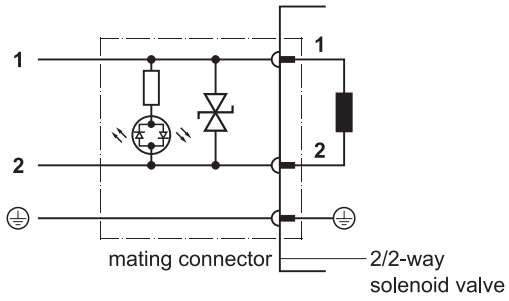


Figure 14: Schematic circuit of the plug connection of the 2/2-way seat valve of the fail-safe valve (with free-wheeling and light emitting diodes)

4.5 Characteristic curves

4.5.1 Step response and frequency response[1]

Step response of the spool stroke

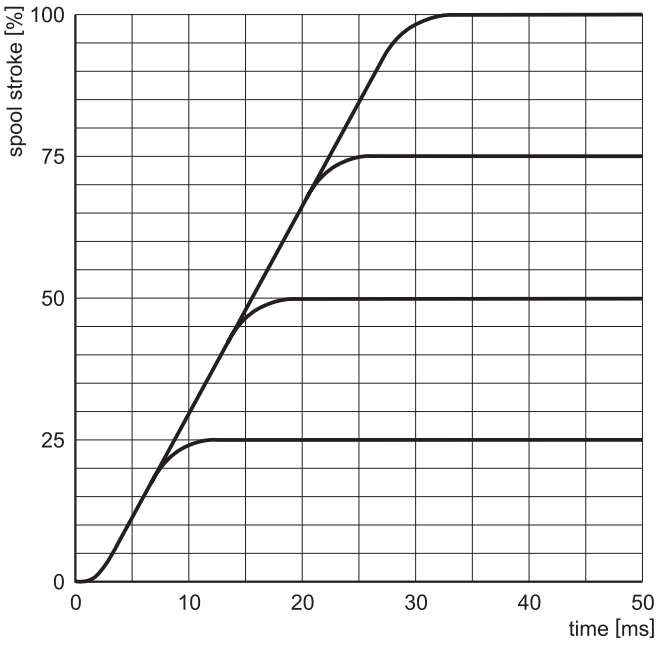


Figure 15: Step response of the spool stroke

Frequency response of the spool stroke

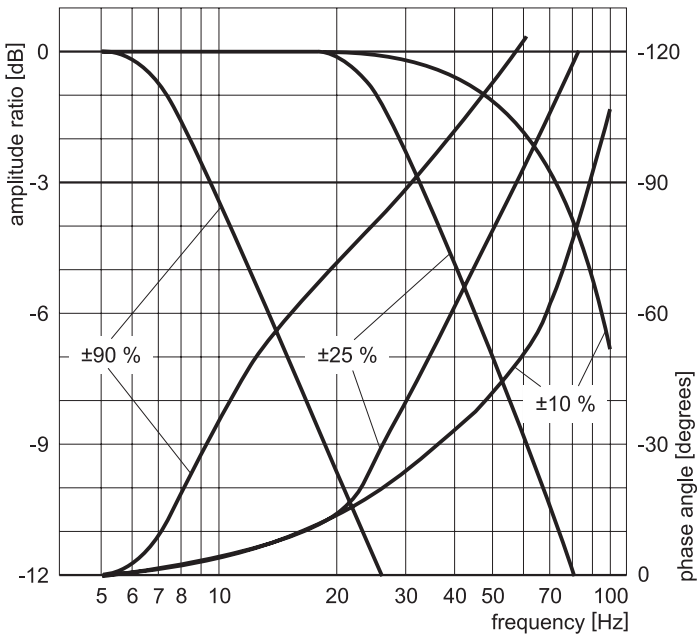


Figure 16: Frequency response of the spool stroke

[1] Typical characteristic curves
(measured at pilot pressure p_X = 210 bar, viscosity of hydraulic fluid ν = 32 mm^2/s and temperature of hydraulic fluid T = 40 °C)

4.5.2 Flow diagram (4-way operation)

Flow diagram (4-way operation)

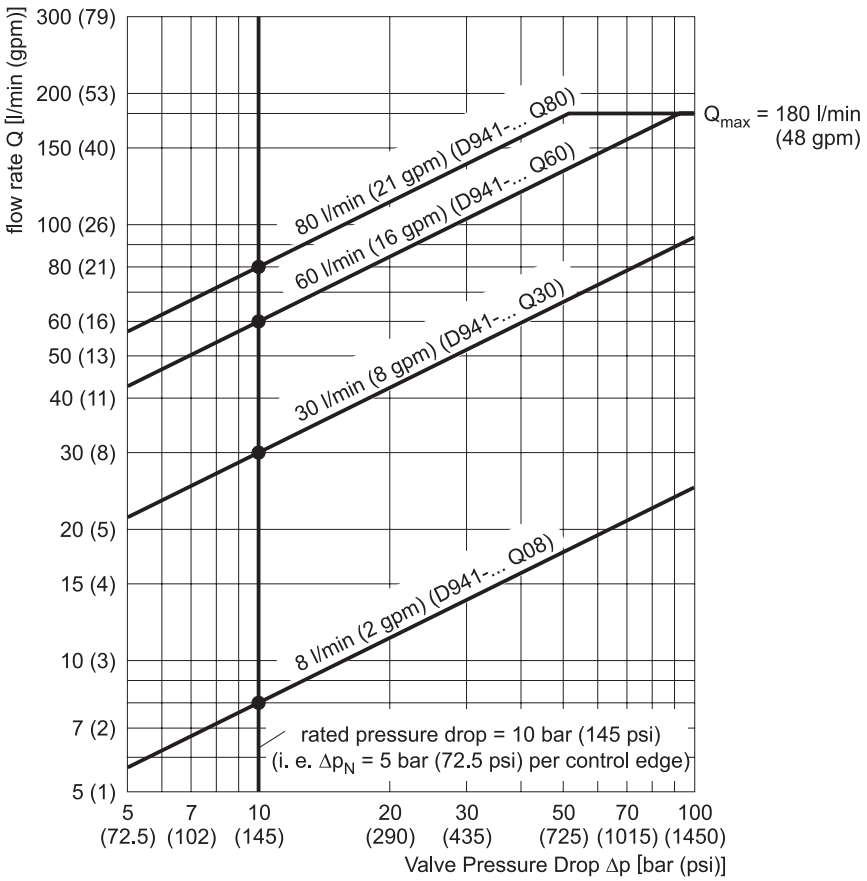


Figure 17: Flow diagram (4-way operation)

The flow that is set is dependent not only on the spool position but also on the pressure drop Δp at the individual control edges.

Formula for calculating the flow Q

A flow control command signal of 100 % produces with a rated pressure drop of Δp_N = 5 bar per control edge the rated flow Q_N. If the pressure drop is altered, so the flow Q also changes with a constant command signal in accordance with 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 Δp_N = 5 bar per control edge

To avoid cavitation, the flow speed of the actual flow Q calculated in this way at ports P, A, B and T must not be too great.
In typical applications the maximum permissible flow speed is 30 m/s.

⇨ "3.4.1 Flow control (Q-control)", page 14

4.5.3 Flow signal characteristic curve[1]

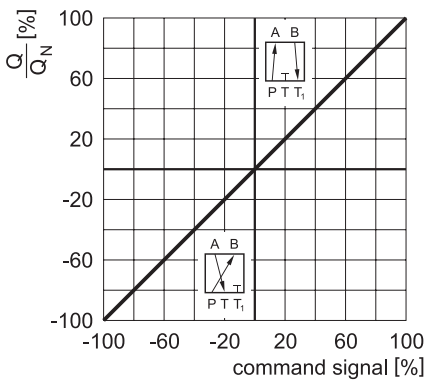


Figure 18: Example of a flow signal characteristic curve with equal electrical and hydraulic zero positions

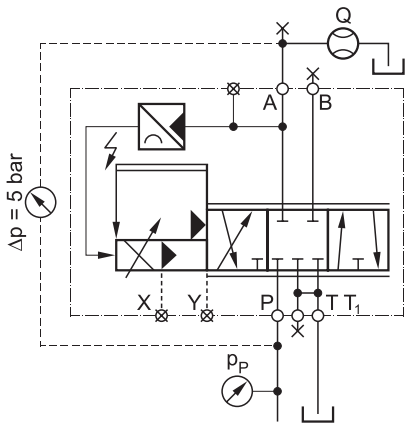


Figure 19: Design for measuring the flow signal characteristic curve for a valve with 3-way operation, e.g., P→A

Flow signal characteristic curve

4.5.4 Pressure signal characteristic curve[1]

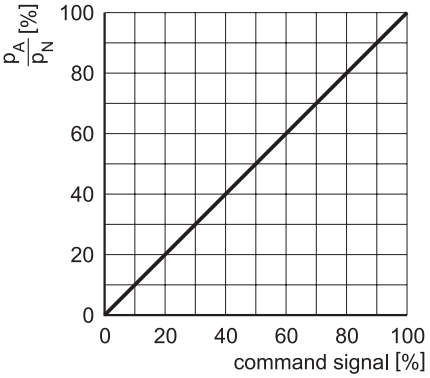


Figure 20: Pressure signal characteristic curve

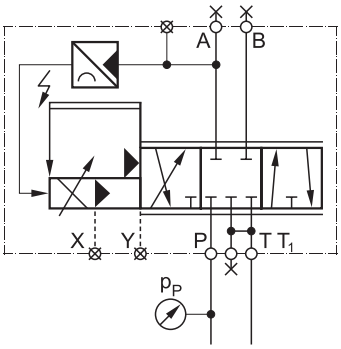


Figure 21: Design for measuring the pressure signal characteristic curve

Pressure signal characteristic curve

[1] Typical characteristic curves
(measured at pilot pressure p_X = 210 bar, viscosity of hydraulic fluid ν = 32 mm^2/s and temperature of hydraulic fluid T = 40 °C)

4.6 Dimensions (installation drawing)

4.6.1 Valves with mechanical fail-safe function F, D and M

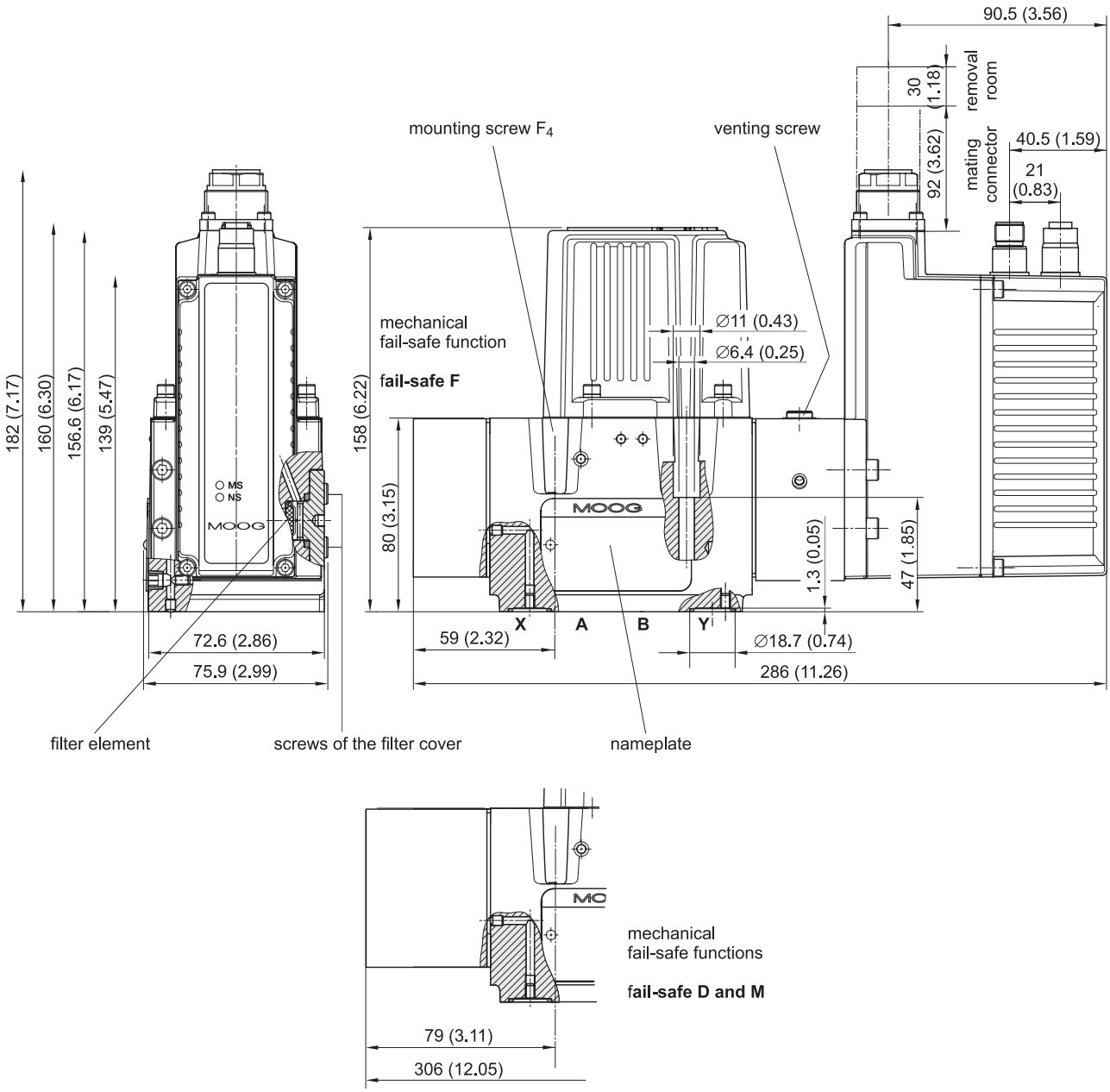


Figure 22: Installation drawing - Valves with mechanical fail-safe function F, D and M (dimensions in mm, values in parenthesis in inches)

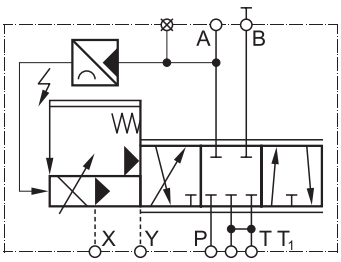


Figure 23: Hydraulic symbol of a valve with 3-way operation (fail-safe function F)

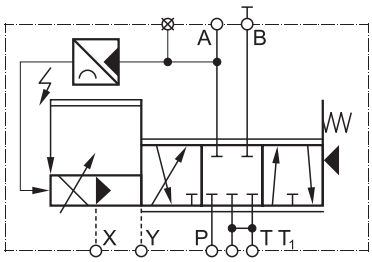


Figure 24: Hydraulic symbol of a valve with 3-way operation (fail-safe function D)

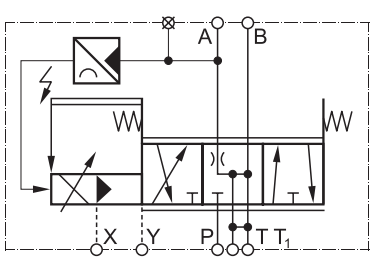


Figure 25: Hydraulic symbol of a valve with 4-way operation with spring centering (fail-safe function M)

4.6.2 Valves with fail-safe function W (fail-safe valves)

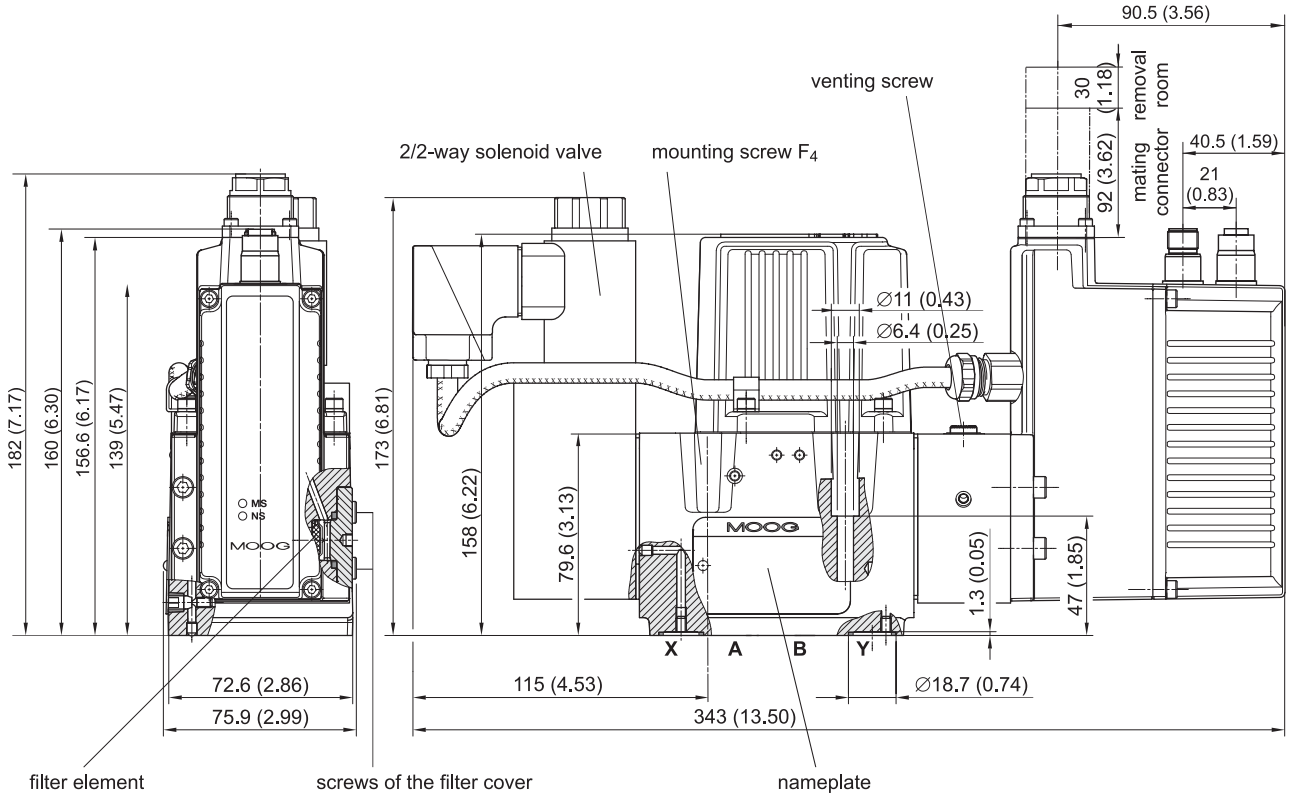


Figure 26: Installation drawing - Valves with fail-safe function W (fail-safe valves) (dimensions in mm, values in parenthesis in inches)

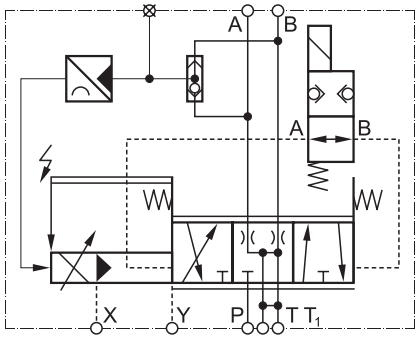


Figure 27: Hydraulic symbol of a valve with 4-way operation with shuttle valve, 2/2-way seat valve and spring centering (fail-safe function W)

4.7 Mounting surface

If the valve is mounted on the mounting surface, it projects over the mounting surface.
Valve dimensions:
⇨ Figure 22, page 44 and ⇨ Figure 26, page 45

4.7.1 Surface quality

Evenness and roughness of the mounting surface

Evenness as per DIN EN ISO 1302: < 0.01 mm over 100 mm
Average surface finish R_a as per DIN EN ISO 1302: < 0.8 µm

4.7.2 Mounting pattern of mounting surface

CAUTION

Contrary to ISO/FDIS 4401-05-05-0-05 the length of the mounting surface must be at least 100 mm so that the required O-ring recesses on ports X and Y can be covered.

Mounting pattern and mounting surface

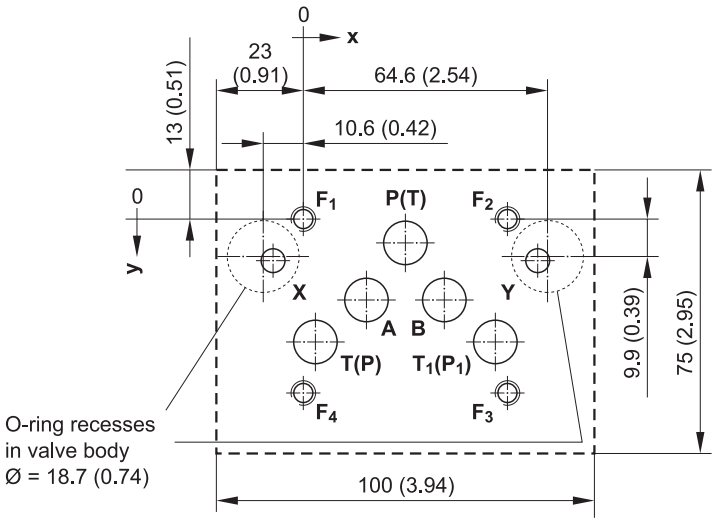


Figure 28: Mounting pattern of mounting surface as per ISO/FDIS 4401-05-05-0-05
(dimensions in mm, values in parenthesis in inches)

	P	A	T	T_1 optional	B	F_1	F_2	F_3	F_4	X	Y
	Ø 11.5	Ø 11.5	Ø 11.5	Ø 11.5	Ø 11.5	M6	M6	M6	M6	Ø 6.3	Ø 6.3
X	27	16,7	3.2	50.8	37.3	0	54	54	0	-8	62
Y	6.3	21.4	32.5	32.5	21.4	0	0	46	46	11	11

Table 15: Dimensions for mounting pattern of mounting surface in Figure 28 (dimensions in mm)

For valves with 4-way operation with Q_N > 60 l/min and for valves with 2x2-way operation the second tank port T_1 is required.

For valves with 5-way operation which have double flow to the actuator, ports P and T are switched, i.e. T becomes P, T_1 becomes P_1 and P becomes T. X and Y must be externally connected.

For maximum flow, the ports for P, T, T_1, A and B must contrary to the standard be designed with a diameter of 11.5 mm.

4.8 Nameplate

Nameplate

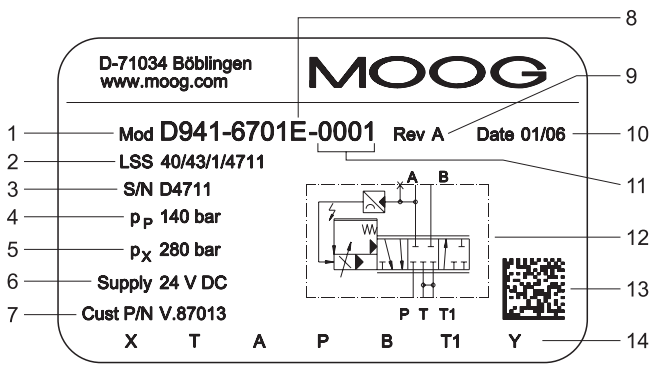


Figure 29: Nameplate (example)

Item	Description	Further information
1	Model number	
2	LSS address (decimal)	⇨ "4.8.2 LSS address", page 48
3	Serial number	
4	Rated pressure (max. operating pressure)	
5	Pilot pressure	⇨ "3.3.2 Pilot pressure", page 14
6	Supply voltage	⇨ "4.3 Electrical data", page 39
7	Optional customer-specific designation	
8	Optional factory identification	
9	Optional version identification	
10	Date of manufacture in MM/YY format	
11	Revision number	
12	Hydraulic symbol	
13	Data matrix code	⇨ "4.8.1 Data matrix code", page 47
14	Designation of ports	⇨ "4.7 Mounting surface", page 46

Table 16: Item numbers of the nameplate in Figure 29

4.8.1 Data matrix code

Data matrix code

The data matrix code is a two-dimensional code. The code on the nameplate contains a text string which is set out as follows:

model number	#	optional version identification	#	serial number with country identification
⇨ Figure 29, page 47, item 1		⇨ Figure 29, page 47, item 9		⇨ Figure 29, page 47, item 3

If there is no optional version identification, a blank space appears here.

Example of a data matrix code: D941-6701E-001#A#D4711

4.8.2 LSS address

LSS address

The LSS address in accordance with CiA DSP 305 contains a string which is set out as follows:

manufacturer ID	/	product code	/	revision number without leading zeros	/	serial number without country identification
40		model-dependent		⇨ Figure 29, page 47, item 11		⇨ Figure 29, page 47, item 3

Example of an LSS address: 40/43/1/4711

5 Mounting/Removal and Connection to the Hydraulic System

Safety instructions: mounting/removal and connection to the hydraulic system

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.
Depressurize all pressure lines and accumulators in the hydraulic circuit before mounting or removing, electrically or hydraulically connecting, starting-up, trouble shooting or servicing the valves.

WARNING

Only properly qualified and authorized users may work with and on the valves.
⇨ "1.2 Selection and qualification of personnel", page 2

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

5.1 Tools and materials required

Tools and materials required for mounting/removal

The following are required for mounting/removing the valve:

- Torque wrench for 5 WAF hexagon socket screws
- Installation screws
  ⇨ "5.1.1 Specification for installation screws", page 50

The installation screws are not included in the valve's scope of delivery. They are available as an accessory.
⇨ "12.3 Accessories", page 88

5.1.1 Specification for installation screws

Specification for installation screws

Installation screws as per DIN EN ISO 4762	Quality class	Number required	Tightening torque
M6x60	10.9	4	11 Nm ± 10 %

Table 17: Specification for installation screws

5.2 Mounting the valve

Safety instructions: mounting the valve

WARNING

Use the installation screws specified here for mounting. The shipping plate attachment screws must not be used to mount the valve. Secure valve mounting cannot be guaranteed in such a case.
Specification for installation screws: ⇨ Table 17, page 50

CAUTION

The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be reinstalled directly after the valve has been removed.
Fitting the shipping plate is the only way of adequately protecting the valves against entry of dirt and moisture.
Store the shipping plate and the associated attachment screws.

CAUTION

To prevent the valve from overheating, mount the valve so as to ensure adequate ventilation.
Do not mount the valve directly on machine parts which are exposed 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.

CAUTION

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 upwards.
⇨ "7.3.1 Venting", page 69
Position of the venting screw: ⇨ Figure 1, page 12

CAUTION

The valve connecting surface and the mounting surface must be free of residues and dirt when the valve is about to be mounted.
Use a clean, soft and fluff-free cloth to clean the connecting and mounting surfaces. Do not use cleaning wool! Do not use any cleaning agents or methods which could attack the surfaces or the O-rings mechanically or chemically.

Procedure for mounting the valve:

Procedure for mounting the 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 or transportation.
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 that it aligns with the mounting holes.
5. Secure the valve by tightening the installation screws (hexagon socket screws) diagonally and evenly without distortion to 11 Nm ± 10 %.
   ⇨ "5.1.1 Specification for installation screws", page 50

The installation screws are not included in the valve’s scope of delivery. They are available as an accessory.
⇨ "12.3 Accessories", page 88

5.3 Removal of the valves

Safety instructions: removal of the valves

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.
Depressurize all pressure lines and accumulators in the hydraulic circuit before mounting or removing, electrically or hydraulically connecting, starting-up, trouble shooting or servicing the valves.

CAUTION

The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be reinstalled directly after the valve has been removed.
Fitting the shipping plate is the only way of adequately protecting the valves against entry of dirt and moisture.
Store the shipping plate and the associated attachment screws.

Procedure for removing the valve

Procedure for removing the valve:

1. Release 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 valve's hydraulic ports.
5. Store the valve in its original packaging.
⇨ "11 Transportation and Storage", page 85
6. Seal the ports of the hydraulic system to prevent the hydraulic fluid from being contaminated.

6 Electrical Connection

Safety instructions: electrical connection

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.
Depressurize all pressure lines and accumulators in the hydraulic circuit before mounting or removing, electrically or hydraulically connecting, starting-up, trouble shooting or servicing the valves.

WARNING

Only properly qualified and authorized users may work with and on the valves.
⇨ "1.2 Selection and qualification of personnel", page 2

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

CAUTION

Do not lay valve connection cables in the immediate vicinity of high-voltage cables or together with cables that switch inductive or capacitive loads.

CAUTION

An EMC-compliant power unit must be used for the power supply. Electrical connection must be conducted in compliance with EMC requirements.

Procedure for electrically connecting the valve:

Procedure for electrically connecting the valve

1. Conduct electrical connection in accordance with the pin assignment.
   ⇨ "6.1 Pin assignment", page 54
2. Design the equipotential bonding system, protective earthing/grounding and shielding according to Technical Note TN 353.
3. Carry out the CAN bus wiring.
   ⇨ "6.1.3 CAN-IN/OUT connectors", page 59

6.1 Pin assignment

6.1.1 11+PE-pin valve connector

11+PE-pin valve connector

CAUTION

For the floating command inputs (pins 4, 5 and 7) the potential difference (measured to pin 10) must be between -15 V and +32 V.

CAUTION

The input current I_{in} of the command inputs with current input signal must be between -25 mA and +25 mA!
Voltage levels in excess of 5 V may cause the destruction of the integrated valve electronics.

Detailed information on the individual command inputs:
⇨ "3.6 Analog command inputs", page 20

All current and voltage inputs are floating but can be connected to ground (single-ended).

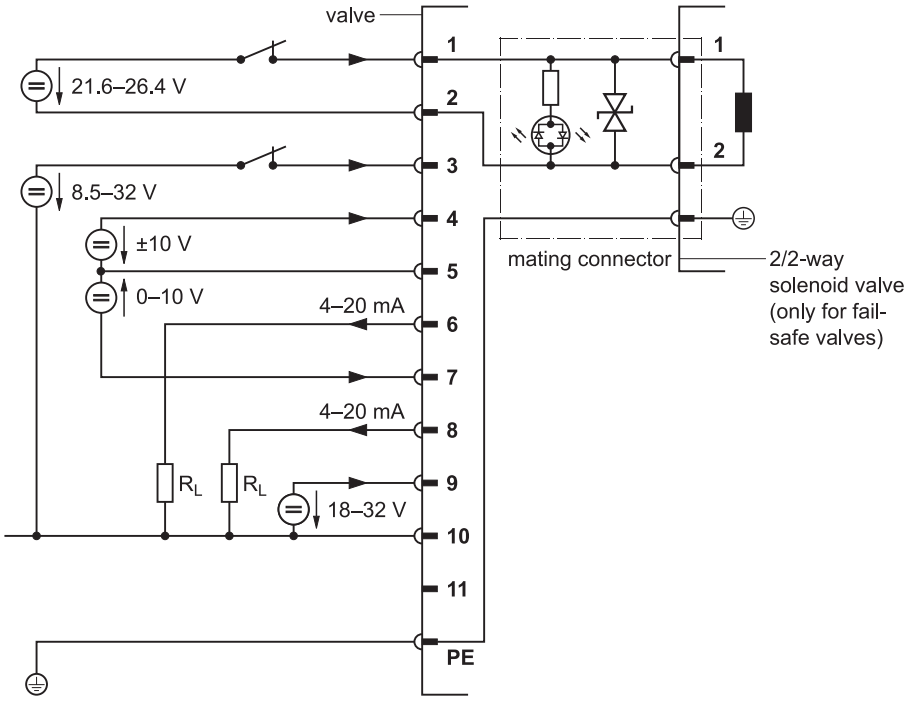
Basically, activation of the command inputs with differential signals is to be preferred. If the command signal cannot be transmitted differentially, the reference point of the command input at the valve must be connected to ground (GND).
⇨ "6.1.1.5 Single-ended command signals", page 58

6.1.1.1 Mating connector for the 11+PE-pin valve connector

Mating connector for the 11+PE-pin valve connector

The mating connector for the 11+PE-pin valve connector is available as an accessory.
⇨ "12.3 Accessories", page 88

6.1.1.2 Floating voltage inputs ±10 V and 0–10 V



11+PE-pin valve connector for valves with floating voltage inputs ±10 V and 0–10 V

Figure 30: 11+PE-pin valve connector for valves with floating voltage inputs ±10 V and 0–10 V (circuit)

Pin	Assignment	Description
1	Optional	Supply to the 2/2-way seat valve (for fail-safe valves only): nominal 24 V DC (21.6–26.4 V DC, max. 1.2 A)
2	Optional	Supply to the 2/2-way seat valve (for fail-safe valves only): 0 V
3	Enable input	8.5–32 V referred to GND: valve ready for operation <6.5 V referred to GND: valve fail-safe state ⇨ "3.8 Enable input", page 26
4	Flow control command input	$U_{in} = U_{4-5}$ = ±10 V (pin 5 is reference point for pins 4 and 7) R_{in} = 20 kΩ
5	Reference point of command inputs	Reference point for pins 4 and 7
6	Spool position actual value output	I_{out}: 4–20 mA referred to GND (I_{out} is proportional to the spool position; the output is short-circuit protected); R_L: 0–500 Ω to GND ⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58
7	Pressure control command input	$U_{in} = U_{7-5}$ = 0–10 V (pin 5 is reference point for pins 4 and 7) R_{in} = 20 kΩ
8	Pressure control actual value output	I_{out}: 4–20 mA referred to GND (I_{out} is proportional to controlled pressure; the output is short-circuit protected); R_L: 0–500 Ω to GND ⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58
9	Supply voltage	nominal 24 V DC (18–32 V DC)
10	Supply zero	Ground/GND
11	Digital output	No function! Do not connect!
PE	Protective conductor contact	Connect protective earthing/grounding as per TN 353

Table 18: Pin assignment of the 11+PE-pin valve connector for valves with floating voltage inputs ±10 V and 0–10 V

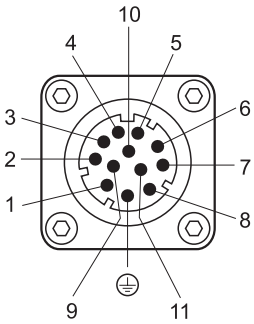


Figure 31: 11+PE-pin valve connector with pin contacts (looking towards the connector on the valve)

6.1.1.3 Floating current inputs ±10 mA and 0–10 mA

11+PE-pin valve connector for valves with floating current inputs ±10 mA and 0–10 mA

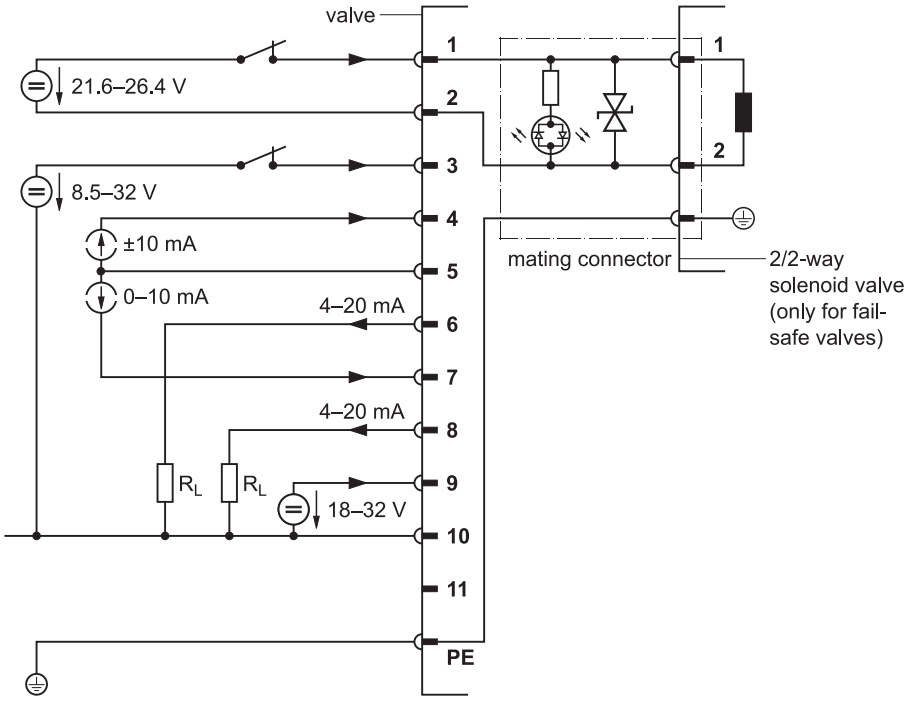


Figure 32: 11+PE-pin valve connector for valves with floating current inputs ±10 mA and 0–10 mA (circuit)

Pin	Assignment	Description
1	Optional	Supply to the 2/2-way seat valve (for fail-safe valves only): nominal 24 V DC (21.6–26.4 V DC, max. 1.2 A)
2	Optional	Supply to the 2/2-way seat valve (for fail-safe valves only): 0 V
3	Enable input	8.5–32 V referred to GND: valve ready for operation <6.5 V referred to GND: valve fail-safe state ⇨ "3.8 Enable input", page 26
4	Flow control command input	$I_{in} = I_4$ = ±10 mA (pin 5 is common feedback for pins 4 and 7) R_{in} = 200 Ω
5	Reference point of command inputs	Common feedback for pins 4 and 7
6	Spool position actual value output	I_{out}: 4–20 mA referred to GND (I_{out} is proportional to the spool position; the output is short-circuit protected); R_L: 0–500 Ω to GND ⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58
7	Pressure control command input	$I_{in} = I_7$ = 0–10 mA (pin 5 is common feedback for pins 4 and 7) R_{in} = 200 Ω
8	Pressure control actual value output	I_{out}: 4–20 mA referred to GND (I_{out} is proportional to controlled pressure; the output is short-circuit protected); R_L: 0–500 Ω to GND ⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58
9	Supply voltage	nominal 24 V DC (18–32 V DC)
10	Supply zero	Ground/GND
11	Digital output	No function! Do not connect!
PE	Protective conductor contact	Connect protective earthing/grounding as per TN 353

Table 19: Pin assignment of the 11+PE-pin valve connector for valves with floating current inputs ±10 mA and 0–10 mA

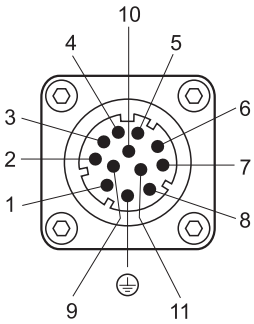
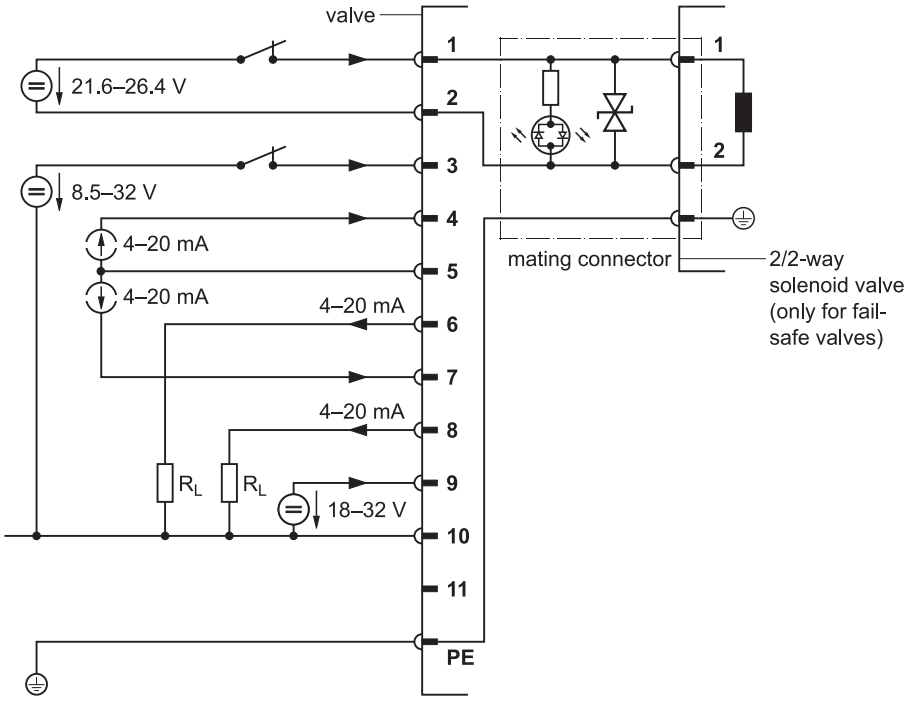


Figure 33: 11+PE-pin valve connector with pin contacts (looking towards the connector on the valve)

6.1.1.4 Floating current inputs 4–20 mA



11+PE-pin valve connector for valves with floating current inputs 4–20 mA

Figure 34: 11+PE-pin valve connector for valves with floating current inputs 4–20 mA (circuit)

Pin	Assignment	Description
1	Optional	Supply to the 2/2-way seat valve (for fail-safe valves only): nominal 24 V DC (21.6–26.4 V DC, max. 1.2 A)
2	Optional	Supply to the 2/2-way seat valve (for fail-safe valves only): 0 V
3	Enable input	8.5–32 V referred to GND: valve ready for operation <6.5 V referred to GND: valve fail-safe state ⇨ "3.8 Enable input", page 26
4	Flow control command input	$I_{in} = I_4$ = 4–20 mA (pin 5 is common feedback for pins 4 and 7) R_{in} = 200 Ω
5	Reference point of command inputs	Common feedback for pins 4 and 7
6	Spool position actual value output	I_{out}: 4–20 mA referred to GND (I_{out} is proportional to the spool position; the output is short-circuit protected); R_L: 0–500 Ω to GND ⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58
7	Pressure control command input	$I_{in} = I_7$ = 4–20 mA (pin 5 is common feedback for pins 4 and 7) R_{in} = 200 Ω
8	Pressure control actual value output	I_{out}: 4–20 mA referred to GND (I_{out} is proportional to controlled pressure; the output is short-circuit protected); R_L: 0–500 Ω to GND ⇨ "6.1.2 Conversion of actual value output signals I_{out}", page 58
9	Supply voltage	nominal 24 V DC (18–32 V DC)
10	Supply zero	Ground/GND
11	Digital output	No function! Do not connect!
PE	Protective conductor contact	Connect protective earthing/grounding as per TN 353

Table 20: Pin assignment of the 11+PE-pin valve connector for valves with floating current inputs 4–20 mA

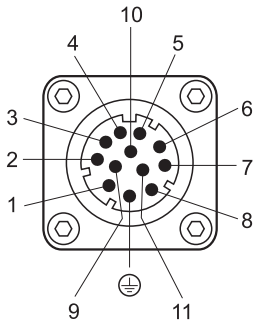


Figure 35: 11+PE-pin valve connector with pin contacts (looking towards the connector on the valve)

6.1.1.5 Single-ended command signals

Basically, activation of the command inputs with differential signals is to be preferred. If the command signal cannot be transmitted differentially, the reference point of the command input at the valve must be connected to ground (GND).

Circuit for single-ended command signals

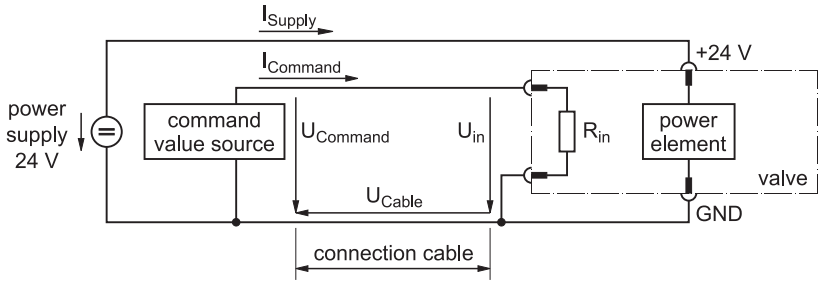


Figure 36: Circuit for single-ended command signals

Single-ended connection of the command inputs

If the command inputs are connected to ground (single-ended), the connection cable must be as short as possible and have an appropriately large cross-section in order to keep the voltage drop as low as possible.
The voltage drop on the forward and return lines is generated by the supply current I_{Supply} of the valve electronics power circuit. It is proportional to the length of the connection cable and varies according to the valve status.

Input voltage $U_{in} = U_{Command} - U_{Cable}$

The voltage drop U_{Cable} on the return line and the resulting potential shift of ground (GND) results in not the command signal $U_{Command}$ but rather the input voltage U_{in} be applied at the command input in accordance with the following equation:

$$U_{in} = U_{Command} - U_{Cable}$$

Command signal sources with impressed current I_{comm}

In the case of command signal sources with impressed current $I_{Command}$, the potential shift of ground (GND) has not effect on the signal. However, changes in the voltage drop resulting from the valve's varying current consumption must be corrected by the command signal source. If current control does not follow the voltage change in terms of time, the command signal at the valve input may also be affected here.

The function of single-ended command inputs is identical to the function of floating command inputs.
⇨ "3.6.2 Flow control command inputs", page 22
⇨ "3.6.3 Pressure control command inputs", page 24

6.1.2 Conversion of actual value output signals I_{out}

Conversion of actual value output signals I_{out} (4–20 mA) into 2–10 V

The actual value output signals I_{out} (4–20 mA) can be converted into 2–10 V in accordance with the following circuit.

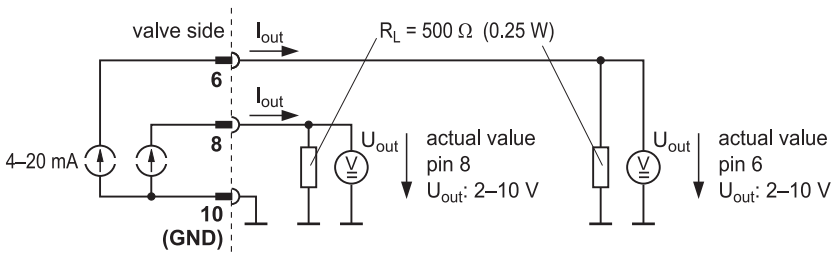


Figure 37: Circuit for converting actual value output signals I_{out}

6.1.3 CAN-IN/OUT connectors

CAUTION

Dirt or moisture can get into the valve through open connectors, i.e. if no mating connector is attached, which may result in damage to the valve.
Open connectors must be covered and sealed.
The plastic caps attached to the connectors on delivery are not suitable as sealing covers.
Suitable metallic dust protection caps for CAN-IN/OUT connectors are available as accessories.
⇨ "12.3 Accessories", page 88

CAUTION

To prevent the connector from being damaged, pay attention to the alignment of the key.

5-pin CAN-IN/OUT connectors

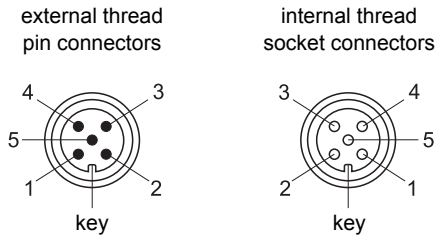


Figure 38: 5-pin CAN-IN/OUT connectors
(looking towards the connector on the valve)

Pin assignment of 5-pin CAN-IN/OUT connectors

Pin	Signal	
1	CAN_SHLD	Shield (fitted on control cabinet side)
2	CAN_V+	Not connected in the valve
3	CAN_GND	Ground
4	CAN_H	Transceiver H
5	CAN_L	Transceiver L

Table 21: Pin assignment of 5-pin CAN-IN/OUT connectors

To connect the valves to a CAN network, we recommend molded cord sets with a straight mating connector.
⇨ "6.2.3 Suitable cable types for CAN networks", page 62

Notes on wiring CAN networks:
⇨ "6.2 Wiring CAN networks", page 60

6.2 Wiring CAN networks

CAN bus interface

The valve is equipped with a galvanically isolated CAN bus interface. The CAN bus interface is supplied internally.

Wiring CAN networks

Observe the following points when wiring CAN networks:

- All cables, plug connectors and terminal resistors used in CAN networks should comply with ISO/DIS 11898.
- It is important to comply always with all the information contained in the Technical Note TN 353.
- Use shielded cables with four cores (twisted pair) and surge impedance of 120 Ω (CAN_H, CAN_L, CAN_GND and CAN_SHLD grounded).
- A CAN bus cable must not branch but short stub cables with T-connectors are permitted.
- Stub cables must be as short as possible.
  Maximum stub cable length: ⇨ Table 24, page 61
- The cable between CAN_L and CAN_H at both CAN bus cable ends must be ended by a connector with terminal resistor of 120 Ω ± 10 %.
- Reference potential CAN_GND and CAN_SHLD may be connected to protective earth/ground (PE) **at one point only** (on a connector with terminal resistor, for example).
- The transmission rate must be adapted to the CAN bus cable length.
  ⇨ Table 24, page 61
- The maximum permissible number of CAN bus nodes in the CAN network must not be exceeded.
  ⇨ "6.2.2 Permissible number of CAN bus nodes", page 62
- Do not lay CAN Bus cables in the immediate vicinity of disturbance sources. If interference sources cannot be avoided, use double-shielded cables.

Wiring example, CAN network

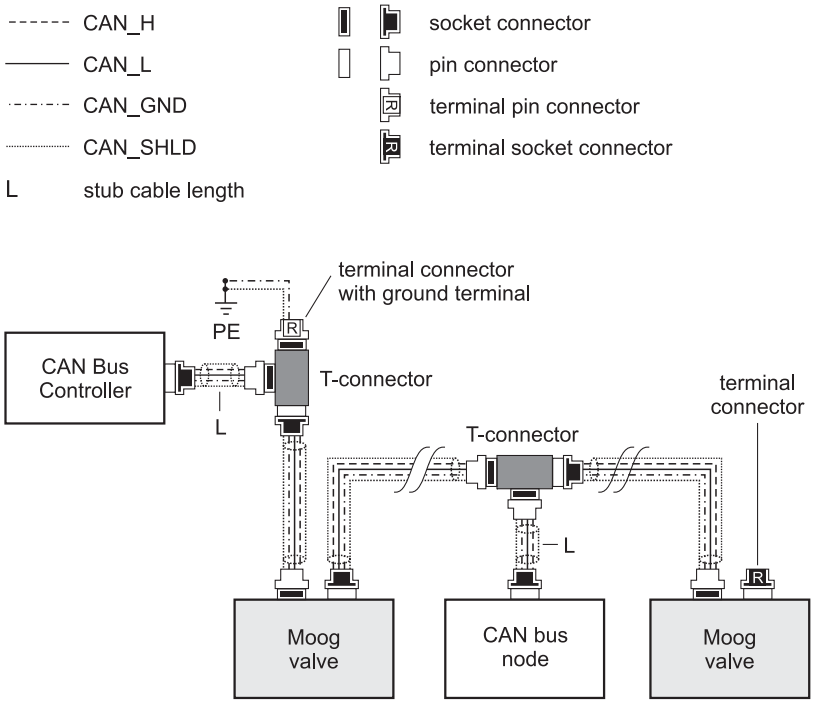


Figure 39: Wiring example, CAN network

For CAN bus nodes without a galvanically isolated CAN bus interface, CAN_GND is generally connected to supply voltage GND inside the device.
In these cases, the supply voltage connection cable must be grounded at the same point inside the machine as the CAN_GND connection cable.
Maximum interference immunity is achieved in extensive CAN networks by using solely CAN bus nodes with galvanically isolated CAN bus interface.
If it is not possible to dispense with CAN bus nodes without galvanically isolated CAN bus interface, arrange these nodes in the immediate vicinity of the central ground point. The cable length to this central ground point is to be kept as short as possible. It is particularly important in this respect to ensure that the equipotential bonding line is properly dimensioned!

6.2.1 Cable lengths and cable cross sections

Recommendation for maximum cable lengths in CAN networks

Transmission rate	Maximum cable length
1000 kbit/s	25 m
800 kbit/s	50 m
500 kbit/s	100 m
250 kbit/s	250 m
125 kbit/s	500 m
100 kbit/s	650 m
50 kbit/s	1,000 m
20 kbit/s	2,500 m

Table 22: Recommendation for maximum cable lengths in CAN networks, depending on the transmission rate

	Maximum cable length for n CAN bus nodes		
Cable cross section	n = 32	n = 64	n = 100
0.25 mm^2	200 m	170 m	150 m
0.50 mm^2	360 m	310 m	270 m
0.75 mm^2	550 m	470 m	410 m

Table 23: Recommendation for maximum cable lengths in CAN networks, depending on the cable cross section and the number n of CAN bus nodes

Maximum permissible stub cable lengths in CAN networks

	Maximum stub cable length	
Transmission rate	Maximum	Cumulative
1,000 kbit/s	2 m	20 m
500 kbit/s	6 m	39 m
250 kbit/s	6 m	78 m
125 kbit/s	6 m	156 m

Table 24: Maximum permissible stub cable lengths in CAN networks

6.2.2 Permissible number of CAN bus nodes

Permissible number of CAN bus nodes

The CAN bus interface for the valve supports integration in CAN networks with up to 110 CAN bus nodes.
However, the maximum permissible number of CAN bus nodes can be restricted by other nodes with an older CAN bus driver to 32.

6.2.3 Suitable cable types for CAN networks

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 http://www.turck.com	577 Flexlife thin cable 5710 Flexlife mid cable 575 Flexlife thick cable

Table 25: Suitable cable types for CAN networks

7 Starting-up

Safety instructions: starting-up

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Operating machines with damaged or defective components or with a leaking hydraulic system is dangerous and not permitted.

Before starting-up or operating the valve, check the higher-level machine including all its installed components for damage and defects.
Pay particular attention to higher-level and hydraulic safety devices such as, for example, EMERGENCY OFF switches and pressure-limiting valves.

In addition, to avoid damage or leaks, perform the following tasks at regular intervals in accordance with the instructions of the manufacturer and the operator of the machine:

- Checking the valve and the hydraulic system for externally identifiable damage and defects.
- Checking for loose plugs/connectors.
- Checking the cleanliness level of the hydraulic fluid.
- Replacing the filter element.
  ⇨ "9.1.2 Replacing the filter element", page 78
- Checking the elasticity of the port O-rings.
  Replace hardened O-rings.
  ⇨ "9.1.1 Checking and replacing the port O-rings", page 77

Report damage or defects to the relevant department immediately. If necessary, shut down and secure the machine immediately.
Repair any leaks immediately in accordance with these operating instructions, paying particular attention to the notes/instructions on handling in accordance with safety requirements.
⇨ "2.1 Handling in accordance with safety requirements", page 7
⇨ "10 Trouble shooting", page 81

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.
Depressurize all pressure lines and accumulators in the hydraulic circuit before mounting or removing, electrically or hydraulically connecting, starting-up, trouble shooting or servicing the valves.

WARNING

Only properly qualified and authorized users may work with and on the valves.
⇨ "1.2 Selection and qualification of personnel", page 2

WARNING

Excessive pressure at the hydraulic ports damages the valve and can cause unsafe states in the machine.
A pressure-limiting valve or a comparable safety device must be installed to limit the pressure at all the hydraulic ports to the specified maximum operating pressure.
Maximum operating pressure:
⇨ "4 Technical Data", page 33

WARNING

Prior to starting-up, valves must be checked for correct configuration and possibly altered parameters. Altering the configuration or the parameters may change the function of the valve to such an extent that it will no longer function as specified in these operating instructions.

Incorrect configuration will result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

CAUTION

The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be reinstalled directly after the valve has been removed.
Fitting the shipping plate is the only way of adequately protecting the valves against entry of dirt and moisture.
Store the shipping plate and the associated attachment screws.

CAUTION

Dirt or moisture can get into the valve through open connectors, i.e. if no mating connector is attached, which may result in damage to the valve.
Open connectors must be covered and sealed.
The plastic caps attached to the connectors on delivery are not suitable as sealing covers.
Suitable metallic dust protection caps for CAN-IN/OUT connectors are available as accessories.
⇨ "12.3 Accessories", page 88

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

CAUTION

Fresh hydraulic fluid is contaminated.
Fill the hydraulic system using a filling filter with a filter fineness of at least $\beta_{15} \geq 75$ (15 µm absolute).

CAUTION

Before starting up a new machine for the first time or after completion of modifications to an existing facility, flush the hydraulic system thoroughly in accordance with the instructions of the manufacturer and the operator of the machine.

The valves may only be started up after it has been verified that the higher-level machine complete with all its installed components complies with the respectively valid version of the relevant national and international regulations, standards and guidelines (such as, for example, the EU Machinery Directive, or the regulations specified by professional organizations).
The valves may only be operated in technically faultless and operationally safe condition.
⇨ "1.3 Intended operation", page 3

Procedure for starting-up:

Procedure for starting-up

1. Prepare the hydraulic system.
   ⇨ "7.1 Filling and flushing the hydraulic system", page 66
2. Establish the valve hydraulic connection.
   ⇨ "5.2 Mounting the valve", page 50
3. Establish the valve electrical connection.
   ⇨ "6 Electrical Connection", page 53
4. Connect the valve to the field bus.
   ⇨ "7.2 Connecting the valve to the CAN bus", page 67
5. Starting-up the hydraulic system.
   ⇨ "7.3 Starting-up the hydraulic system", page 69

7.1 Filling and flushing the hydraulic system

WARNING

The switching valve which is fitted to flush the hydraulic system must not cause any potentially dangerous states in the machine.

Procedure for 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 of the manufacturer and the operator of the machine.
3. Before starting the flushing process, insert suitable flushing elements in place of the high-pressure filter elements into the pressure filters.
4. Remove the proportional valve.
   ⇨ "5.3 Removal of the valves", page 52
5. Instead of the proportional valve, you must install a flushing plate or, if allowed by the hydraulic system, a switching valve.

   ⓘ Use the flushing plate to flush 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 instructions of the manufacturer and the operator of the machine. Observe the following when doing so:
   - The operating temperature of the hydraulic fluid should be reached during the flushing process.
   - Observe the minimum flushing time t: t = (V/Q) x 5 [h]
     where: V = tank content [l], Q = pump flow rate [l/min]
   - End the flushing process when cleanliness level 19/16/13 as specified in ISO 4406 or better is achieved.
7. Depressurize the hydraulic system.
8. Replace the flushing elements in the pressure filters with suitable high-pressure elements.
9. Remove the flushing plate or switching valve.
10. Mount the proportional valve.
    ⇨ "5.2 Mounting the valve", page 50

7.2 Connecting the valve to the CAN bus

Safety instructions: connecting the valve to the CAN bus

WARNING

When starting up a valve on the field bus for the first time, we recommend that the valve be operated in a depressurized state.

WARNING

Before connecting the valve to the CAN bus, ensure that the valve has been hydraulically and electrically connected properly in accordance with the operating instructions.

⇨ "5 Mounting/Removal and Connection to the Hydraulic System", page 49
⇨ "6 Electrical Connection", page 53
⇨ "6.2 Wiring CAN networks", page 60

WARNING

It is only permitted to activate the valve via the Moog Valve Configuration Software if this does not cause any dangerous states in the machine and in its surroundings.

It is not permitted to operate the Moog Valve Configuration Software on a CAN bus while machine CAN communication is running.

The Moog Valve Configuration Software communicates with the valve via the standard CANopen services.

The following faults may occur if the Moog Valve Configuration Software is operated within a CAN network while machine CAN communication is running:

- Data exchange with the valve may be disrupted if another device (such as a controller) accesses the valve simultaneously.
- Node guarding may be activated only if no other CAN bus node is monitoring the valve via this service.
- CAN telegrams can also be received by other CAN bus nodes. This may trigger off unforeseeable events!

If the valve cannot be operated safely via the Moog Valve Configuration Software even when machine CAN communication is switched off, it may only communicate in a depressurized state via a direct connection (point-to-point) with the software.

To establish a direct connection between the Moog Valve Configuration Software and the valve, disconnect the CAN bus cable from the valve and connect the valve directly to the PC's CAN bus interface card. A 120 Ω ± 10 % terminal resistor is required here.

⇨ "6.2 Wiring CAN networks", page 60

Procedure for connecting the valve to the CAN bus:

Procedure for connecting the valve to the CAN bus

1. Establish the electrical connection to the CAN bus.
   ⇨ "6.1.3 CAN-IN/OUT connectors", page 59
2. Set the module address (node ID).
   ⇨ "7.2.1 Module address (node ID) of the valve", page 68
3. Set the transmission rate.
   ⇨ "7.2.2 Transmission rate of the valve", page 68
4. Check the valve software configuration.
   ⇨ "3.10 Valve software", page 28
5. If necessary, optimize the pressure controller.
   ⇨ "3.4.5 Notes on control response", page 16

7.2.1 Module address (node ID) of the valve

Module address (node ID) of the valve

WARNING

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

The factory setting for the valve's module address (node ID) is 127.

The module address (node ID) can be changed with the LSS services (Layer Setting Services) via the CAN bus.
If there are no further nodes present on the CAN bus, it is possible to set the node ID via the Service Switch Mode Global.
To change the valve's node ID within a CAN network, it is essential to address the valve unambiguously via the LSS address. The node ID is then set via the Service Switch Mode Selective.
⇨ "4.8.2 LSS address", page 48

ⓘ The valve's module address (node ID) can also be changed with the Moog Valve Configuration Software.

7.2.2 Transmission rate of the valve

Transmission rate of the valve

CAUTION

The transmission rate must be set to the same value for all the CAN bus nodes within a CAN network.

The factory setting for the transmission rate is 500 kbit/s.

The transmission rate can be changed with the LSS services (Layer Setting Services) via the CAN bus.

ⓘ The valve's transmission rate can also be changed with the Moog Valve Configuration Software.

7.3 Starting-up the hydraulic system

Procedure for starting-up the hydraulic system:

Procedure for starting-up the hydraulic system

1. Start-up the hydraulic system in accordance with the instructions of the manufacturer and the operator of the machine.
2. After switching on the operating voltage, check the «MS» and «NS» status LEDs.
   ⇨ "3.9 Status display", page 27
3. Vent the hydraulic system in accordance with the instructions of the manufacturer and the operator of the machine.
4. Vent the valve.
   ⇨ "7.3.1 Venting", page 69
   It may be necessary to repeat the procedure.
5. Check the hydraulic system for external leaks.

7.3.1 Venting

7.3.1.1 Tool required

The following tool is required for venting the valve:

Tool required for venting the valve

- Torque wrench for 5 WAF hexagon socket screws

7.3.1.2 Venting the valve and the actuator

WARNING

The valve and actuator may only be vented at a low system pressure of max. 10 bar.
Risk of injury!

Procedure for venting the valve and the actuator:

Procedure for venting the valve and the actuator

1. A low system pressure of max. 10 bar must be applied.
2. Input valve command signals so that the pressure-controlled port is pressurized with system pressure.
3. Carefully open the venting screw by approx. one revolution.
   Position of the venting screw: ⇨ Figure 1, page 12
4. Wait until no further air escapes or until the escaping hydraulic fluid contains no further air bubbles.
5. Close the venting screw (tightening torque: 15 Nm).
6. Remove the escaped hydraulic fluid.
7. If the actuator is higher than the valve, the actuator must likewise be vented at the highest point.

For your notes.

8 Operation

Safety instructions: operation

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Operating machines with damaged or defective components or with a leaking hydraulic system is dangerous and not permitted.

Before starting-up or operating the valve, check the higher-level machine including all its installed components for damage and defects.
Pay particular attention to higher-level and hydraulic safety devices such as, for example, EMERGENCY OFF switches and pressure-limiting valves.

In addition, to avoid damage or leaks, perform the following tasks at regular intervals in accordance with the instructions of the manufacturer and the operator of the machine:

- Checking the valve and the hydraulic system for externally identifiable damage and defects.
- Checking for loose plugs/connectors.
- Checking the cleanliness level of the hydraulic fluid.
- Replacing the filter element.
  ⇨ "9.1.2 Replacing the filter element", page 78
- Checking the elasticity of the port O-rings.
  Replace hardened O-rings.
  ⇨ "9.1.1 Checking and replacing the port O-rings", page 77

Report damage or defects to the relevant department immediately. If necessary, shut down and secure the machine immediately.
Repair any leaks immediately in accordance with these operating instructions, paying particular attention to the notes/instructions on handling in accordance with safety requirements.
⇨ "2.1 Handling in accordance with safety requirements", page 7
⇨ "10 Trouble shooting", page 81

WARNING

Only properly qualified and authorized users may work with and on the valves.
⇨ "1.2 Selection and qualification of personnel", page 2

WARNING

Observe and adhere to the technical data and in particular the information given on the valve nameplate.
⇨ "4 Technical Data", page 33

WARNING

It is only permitted to activate the valve via the Moog Valve Configuration Software if this does not cause any dangerous states in the machine and in its surroundings.
It is not permitted to operate the Moog Valve Configuration Software on a CAN bus while machine CAN communication is running.

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

CAUTION

Dirt or moisture can get into the valve through open connectors, i.e. if no mating connector is attached, which may result in damage to the valve.
Open connectors must be covered and sealed.
The plastic caps attached to the connectors on delivery are not suitable as sealing covers.
Suitable metallic dust protection caps for CAN-IN/OUT connectors are available as accessories.
⇨ "12.3 Accessories", page 88

8.1 Preparations for valve operation

Preparations for valve operation

The valves may only be operated as a component part of a higher-level overall system, for example in a machine.
⇨ "1.3 Intended operation", page 3

The following must be completed before the valve is operated:

- Qualified project planning
- Correct starting-up and configuration
  ⇨ "7 Starting-up", page 63

8.2 Operation of the valves

Operation of the valves: activation via signals from the machine

The valve is activated via the signals which it receives from the machine controller.
Direct interventions by the user on the valve during normal operation are not necessary.
The valve has no control elements which have to be actuated.

Depending on the model, switching to valve standby or fail-safe state can be triggered by corresponding signals at the enable input of the valve connector:

- Signals at the enable input between 8.5 V and 32 V referred to GND establish valve standby.
- At signals less than 6.5 V, the valve is rendered in the fail-safe state.

⇨ "3.8 Enable input", page 26

The valve operating state and the network status are indicated by way of the status LEDs on the electronics housing.
⇨ "3.9 Status display", page 27

Information on maintenance:
⇨ "9.1 Maintenance", page 76

Information on correcting possible faults:
⇨ "10 Trouble shooting", page 81

For your notes.

9 Service

Safety instructions: service

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.
Depressurize all pressure lines and accumulators in the hydraulic circuit before mounting or removing, electrically or hydraulically connecting, starting-up, trouble shooting or servicing the valves.

WARNING

In the interest of avoiding damage to the valves or accessories, repair and other maintenance work not explained in these operating instructions, on account of the complexity of the internal components of the valves or accessories, may only be performed by us or our authorized service centers.
Warranty and liability claims for personal injury and damage to property are excluded among other things if they are caused by unauthorized repairs or other unauthorized interventions.
⇨ "1.10 Warranty and liability", page 6

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

CAUTION

Incorrect or faulty spare parts can cause valve or machine damage, malfunction or failure.
For this reason, original spare parts must be used.
Warranty and liability claims for personal injury and damage to property are excluded among other things if they are caused by the use of non-original spare parts.
⇨ "1.10 Warranty and liability", page 6
⇨ "12.2 Spare parts", page 87

9.1 Maintenance

Safety instructions: maintenance

DANGER

Operating machines with damaged or defective components or with a leaking hydraulic system is dangerous and not permitted.

Before starting-up or operating the valve, check the higher-level machine including all its installed components for damage and defects.
Pay particular attention to higher-level and hydraulic safety devices such as, for example, EMERGENCY OFF switches and pressure-limiting valves.

In addition, to avoid damage or leaks, perform the following tasks at regular intervals in accordance with the instructions of the manufacturer and the operator of the machine:

- Checking the valve and the hydraulic system for externally identifiable damage and defects.
- Checking for loose plugs/connectors.
- Checking the cleanliness level of the hydraulic fluid.
- Replacing the filter element.
  ⇨ "9.1.2 Replacing the filter element", page 78
- Checking the elasticity of the port O-rings.
  Replace hardened O-rings.
  ⇨ "9.1.1 Checking and replacing the port O-rings", page 77

Report damage or defects to the relevant department immediately. If necessary, shut down and secure the machine immediately.
Repair any leaks immediately in accordance with these operating instructions, paying particular attention to the notes/instructions on handling in accordance with safety requirements.
⇨ "2.1 Handling in accordance with safety requirements", page 7
⇨ "10 Trouble shooting", page 81

WARNING

Only properly qualified and authorized users may work with and on the valves.
⇨ "1.2 Selection and qualification of personnel", page 2

9.1.1 Checking and replacing the port O-rings

9.1.1.1 Tools and materials required

Tools and materials required for checking and replacing the O-rings

The following are required for checking and replacing the port O-rings:

- Torque wrench for 5 WAF hexagon socket screws (for removing and mounting the valve)
- Replacements for O-rings to be replaced if necessary
  ⇨ "12.2 Spare parts", page 87

9.1.1.2 Procedure

Procedure for checking and replacing the O-rings

Procedure for checking and replacing the port O-rings:

1. Remove the valve.
   ⇨ "5.3 Removal of the valves", page 52
2. Check the elasticity of the port O-rings.
3. Replace hardened O-rings with new O-rings.
4. Remount the valve.
   ⇨ "5.2 Mounting the valve", page 50

9.1.2 Replacing the filter element

Replaceable filter element

The valve is equipped with a replaceable filter element to protect the ServoJet® pilot stage against contamination and thus against malfunctioning.
A contaminated filter element causes the valve's response time to increase.

9.1.2.1 Tools and materials required

Tools and materials required for replacing the filter element

The following are required for replacing the filter element:

- Torque wrench for 5 WAF hexagon socket screws (for removing and mounting the valve)
- Torque wrench for 4 WAF hexagon socket screws (for installing and removing the filter cover)
- Replacement for the removed filter element
  ⇨ "12.2 Spare parts", page 87
- Replacements for O-rings to be replaced if necessary on the valve ports, filter cover and filter element
  ⇨ "12.2 Spare parts", page 87

9.1.2.2 Procedure

WARNING

Removed filter elements must not be reinstalled because the valve would be exposed to the risk of contamination if the filter element were incorrectly aligned!

Procedure for replacing the filter element:

Procedure for replacing the filter element

1. Remove the valve.
   ⇨ "5.3 Removal of the valves", page 52
2. Check the elasticity of the valve port O-rings and replace any hardened O-rings.
3. Release all 4 hexagon sockets screws on the filter cover.
   Position of the venting screws: ⇨ Figure 22, page 44 or ⇨ Figure 26, page 45
4. Remove the filter cover.
5. Check the elasticity of the filter cover O-rings and replace any hardened O-rings.
6. Remove the filter element.
7. Check the elasticity of the O-rings under the filter element and replace any hardened O-rings.
8. Install a new filter element.
   Make sure that the O-rings are correctly seated under the filter element.
   The alignment recess (Ø = 1 mm) on the filter element holder must be visible from the outside after the filter element has been fitted.
9. Refit the filter cover.
   Make sure that the filter cover O-rings are correctly seated.
10. Tighten the filter cover screws diagonally and evenly without distortion.
    Tightening torque: 8.3 Nm
11. Remount the valve.
    ⇨ "5.2 Mounting the valve", page 50

9.2 Repair

Safety instructions: repair

WARNING

Repaired valves or replacement valves are, like new valves, delivered with the factory settings. In the event of a repair job for defective valves, we and our authorized service centers shall not accept liability for software and data installed by the customer.
Valves must be checked prior to starting-up for correct configuration and possibly altered parameters. Altering the configuration or the parameters may change the function of the valve to such an extent that it will no longer function as specified in these operating instructions.
⇨ "3.10.1 Configuration of the valves", page 28

Incorrect configuration will result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Authentic Moog repairs

Authentic Moog repairs are performed exclusively by us or our authorized service centers. This is the only way of accessing the latest specifications required for repair work. With these specifications, the original valve performance data can be re-established and the customarily high reliability and long life cycle can be guaranteed even after repairs.

Repair quality seal

Figure 40: Repair quality seal

Our repair seal is a guarantee that an authentic Moog repair has been performed.

In the event of a repair job for defective valves, we and our authorized service centers reserve the right to perform a repair or, after consultation, alternatively to supply replacement valves with an identical or compatible equipment specification.

9.2.1 Contact persons for repairs

Contact persons for repairs

Please refer to the following page on our internet site for contact information relating to our service centers in your area:

http://www.moog.com/worldwide

For your notes.

10 Trouble Shooting

Safety instructions: trouble shooting

DANGER

During operation, do not perform any work, such as mounting or removal, electrical or hydraulic connection, trouble shooting or servicing, on the valves or the machine.
Failure to comply with this requirement result in danger due to:

- Uncontrolled sequences of motions
- Destruction
- Malfunction

Before working on the valves or the machine, shut down and switch off the machine without fail and de-energize and depressurize the machine.
For this purpose, switch off the supply voltage as well as that of connected peripherals (such as externally powered transducers, programming units, etc.).

Secure the machine without fail against restarting.
Examples of suitable securing measures:

- Lock the main command device and remove the key
- Attach a warning sign to the master switch

DANGER

Hydraulic fluid squirting out under high pressure can cause serious personal injuries, burns and fires.
Depressurize all pressure lines and accumulators in the hydraulic circuit before mounting or removing, electrically or hydraulically connecting, starting-up, trouble shooting or servicing the valves.

WARNING

Only properly qualified and authorized users may work with and on the valves.
⇨ "1.2 Selection and qualification of personnel", page 2

CAUTION

The valve and the hydraulic port lines may become very hot during operation.
To protect yourself against personal injury, wear suitable safety equipment, such as work gloves, when getting into contact with the valve during operations such as mounting, removal, electrical and hydraulic connection, trouble shooting or servicing.

Possible faults

The following faults may occur:

- Leak at the valve connecting surface
  ⇨ "10.1 Leak at the valve connecting surface", page 82
- No hydraulic response by the valve
  ⇨ "10.2 No hydraulic response by the valve", page 82
- Control loop instabilities
  ⇨ "10.3.2 Internal valve control loops", page 83
  ⇨ "10.3.1 External control loop", page 83
- Communication problems in networks
  ⇨ "10.4 Communication problems in networks", page 84

If the fault cannot be corrected by means of the measures set out below, please contact us or one of our authorized service centers.

10.1 Leak at the valve connecting surface

Leak at the valve connecting surface

Measures:

- Check for the presence of O-rings on the valve's hydraulic ports (A, B, P, T, etc.) and make sure the O-rings are correctly seated and not damaged. If necessary, install O-rings, replace or correct the seating.
- Check the valve's mounting and connecting surfaces, the valve and the hydraulic system for damage, contamination and evenness.
- Check installation screws for secure and correct seating.
  Tightening torque of installation screws: ⇨ Table 17, page 50
  Retighten the screws if necessary.

10.2 No hydraulic response by the valve

No hydraulic response by the valve

Measures:

- Check whether the hydraulic installation is correct.
- Check whether hydraulic pressure is present.
- Check whether the hydraulic supply to the ServoJet® pilot stage is present or correctly configured (pilot mode: external or internal).
- Check whether the filter element in the valve is contaminated.
- Check whether the supply voltage is present (indicated by the status LEDs).
  ⇨ "3.9 Status display", page 27
- Check whether the connectors are correctly attached and non-corroded.
- Check whether there is a command signal failure or a faulty electric cable.
- Check the signals at the connector, particularly the enable input.
- Check whether the command signal is analog or applied via the CAN bus interface (depending on the model).
- Check whether the valve is in the fault status (indicated by the status LEDs).
  ⇨ "3.9 Status display", page 27
  If necessary, correct the fault and then cancel the fault via the CAN bus or reset the valve by switching the supply voltage off and then on again.

  Typical fault causes:
  - Supply voltage dips below 18 V
    ⇨ "4.3 Electrical data", page 39
  - Maximum permissible temperature exceeded
    ⇨ "4.1 General technical data", page 33
  - Control error (for example, due to the spool sticking, which can be caused for instance by contamination)
  - Absence of command signal 4–20 mA (e.g., due to open circuit)
- Check whether the enable signal is applied. If there is no enable signal, the 'ACTIVE' valve status cannot be achieved.
- Check whether the configuration of the internal valve software is correct.

10.3 Control loop instabilities

10.3.1 External control loop

Instability of the external control loop

Measures:

- Check whether the external control loop is stable.
  If necessary, reduce control loop gain.
- Check whether the internal valve control loops are stable.
  ⇨ "10.3.2 Internal valve control loops", page 83
- Check whether the controlled system was modified.

10.3.2 Internal valve control loops

10.3.2.1 Flow control

Instability of the internal valve control loops: flow control

Measures:

- Check whether the signal quality of the command signals is sufficient.
- Check whether the system and pilot pressures are stable.
- Check whether the quality and purity of the hydraulic fluid complies with the specifications of the manufacturer and the operator of the machine.
- Check whether the valve is operational.
  To do so, perform a comparison of the command/actual value signals.
- Check whether the filter element in the valve is contaminated.

10.3.2.2 Pressure control

Instability of the internal valve control loops: pressure control

Measures:

- Vent the valve or the hydraulic system.
  ⇨ "7.3.1 Venting", page 69
- Optimize control loop gain by adapting the parameters (P, I, D, etc.).
  ⇨ "3.4.5 Notes on control response", page 16
- Check whether the quality and purity of the hydraulic fluid complies with the specifications of the manufacturer and the operator of the machine.
- Check whether the valve is operational.
  To do so, perform a comparison of the command/actual value signals in flow control.
- Check whether the pressure controlled system was modified.
- Check whether the filter element in the valve is contaminated.

10.4 Communication problems in networks

Communication problems in CAN networks

CAN bus diagnostic tools allow you to monitor data traffic on the CAN bus, making it easier to identify the causes of problems.

Measures:

- Check the status LEDs.
  ⇨ "3.9 Status display", page 27
- Check the wiring of the CAN network.

  Typical fault causes:
  - Absence of terminal resistors
  - Open circuit
  - Corroded, loose, incorrectly seated or missing connectors
  - Altered CAN bus topology

  ⇨ "6.2 Wiring CAN networks", page 60
- Check the module address (node ID) of the CAN bus nodes.
  Each module address (node ID) may only be used once within a CAN network!
  ⇨ "7.2.1 Module address (node ID) of the valve", page 68
- Check to make sure that the valve's transmission rate matches the transmission rates of the other CAN bus nodes.
  ⇨ "7.2.2 Transmission rate of the valve", page 68
- Check the communication parameters of the valve software.
  Typical fault causes:
  - NMT state is not set to 'OPERATIONAL'
    (only with process data transmission)
  - PDO CAN identifiers are not correctly set
    (only with process data transmission)
  - PDO mapping parameters are not correctly set
    (only with process data transmission)

11 Transportation and Storage

Safety instructions: transportation and storage

WARNING

The permissible ambient conditions for the valves must be maintained at all times also in the case of transportation and storage.
⇨ "4 Technical Data", page 33
The valves must be protected in particular to prevent entry of dust and moisture.
Fault-free, reliable and safe operation cannot be guaranteed if the above requirements are not observed.

WARNING

The valves must not be transported or stored without their shipping plate fitted.
Fitting the shipping plate is the only way of adequately protecting the valves against entry of dirt and moisture.

CAUTION

The valve shipping plate may only be removed from the valve hydraulic ports directly prior to mounting and must be reinstalled directly after the valve has been removed.
Fitting the shipping plate is the only way of adequately protecting the valves against entry of dirt and moisture.
Store the shipping plate and the associated attachment screws.

CAUTION

To avoid condensation after valves have been transported or stored, wait before starting-up the valves until they have reached the ambient temperature.

CAUTION

To avoid damage, always transport or store valves, spare parts and accessories only in the properly sealed original packaging. Warranty and liability claims for personal injury and damage to property are excluded among other things if they are caused by valves, spare parts or accessories having been stored or transported outside their original packaging.
⇨ "1.10 Warranty and liability", page 6

CAUTION

After transporting or storing valves, spare parts and accessories, check the original packaging and contents for possible damage.
Do not start-up the system if the packaging or contents show signs of damage. In this case, notify us or the supplier responsible immediately.
In the event of transportation damage, store the damaged packaging so that if necessary damages can be claimed from the transport contractor.

11.1 Checking/unpacking a delivery

Checking/unpacking a delivery

Upon receiving a delivery, check whether the parts/equipment listed in the delivery note are present. If this is not the case, notify us or the supplier responsible immediately.

Storing original packaging

It is recommended to keep original packaging for later transportation or storage operations.

For your notes.

12 Scope of Delivery, Spare Parts, Accessories and Tools

12.1 Scope of delivery

Scope of delivery

The scope of delivery of the valve consists of:

- Valve with installed filter element and mounted oilproof shipping plate on the hydraulic ports
- 5 O-rings ID 12.4 x Ø 1.8 [mm] for ports P, T, T_1, A, B
- 2 O-rings ID 15.6 x Ø 1.8 [mm] for ports X, Y

12.2 Spare parts

CAUTION

Incorrect or faulty spare parts can cause valve or machine damage, malfunction or failure.
For this reason, original spare parts must be used.
Warranty and liability claims for personal injury and damage to property are excluded among other things if they are caused by the use of non-original spare parts.
⇨ "1.10 Warranty and liability", page 6

Item designation	Number required	Comments		Item number
O-rings				
for ports P, T, T_1, A, B	5	ID 12.4 x Ø 1.8 [mm]	NBR 85 Shore FPM 85 Shore	-45122-004 -42082-004
for ports X, Y	2	ID 15.6 x Ø 1.8 [mm]	NBR 85 Shore FPM 85 Shore	-45122-011 -42082-011
O-rings for changing the filter element				
for filter element	1	ID 12.0 x Ø 2.0 [mm]	NBR 85 Shore FPM 85 Shore	-66117-012-020 A25163-012-020
for filter cover	1	ID 17.1 x Ø 2.6 [mm]	HNBR 85 Shore FPM 85 Shore	B97009-080 -42082-050
Service sealing set (includes all O-rings for ports P, T, T_1, A, B, X and Y, and the O-rings for changing the filter element)		Not included in scope of delivery		
	1 1	Set Set	NBR 85 Shore FPM 85 Shore	B97215-N661F10 B97215-N661F10
Replaceable filter element	1			A67999-200
Shipping plate	1			A40508
Operating Instructions D941		Not included in scope of delivery		
English version	1			C43357-001
German version	1			C43357-002

Table 26: Spare parts

12.3 Accessories

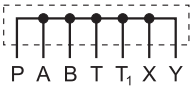
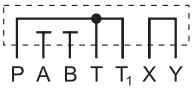
Item designation	Number required	Comments	Item number
Flushing plates		Not included in scope of delivery	
for ports P, A, B, T, T_1, X, Y	1		B67728-001
for ports P, T, T_1, X, Y	1		B67728-002
for ports P, T, T_1 and X, Y	1		B67728-003
Connecting plates		On request	
Installation screws		Not included in scope of delivery	
	4	M6x60 as per DIN EN ISO 4762, quality class: 10.9, tightening torque: 11 Nm ± 10 %	A03665-060-060
Starting-up and configuration software Moog Valve Configuration Software	1	Not included in scope of delivery	B99104
Dust protection caps		Not included in scope of delivery	
for CAN-IN/OUT connectors with external thread	1	Metal cap with O-rings	C55823-001
for CAN-IN/OUT connectors with internal thread	1	Metal cap with O-rings	C54141-001
Adapter USB to CAN	1	Not included in scope of delivery	C43094-001
CAN starting-up cable with terminal resistor (2 m)	1	Not included in scope of delivery	TD3999-137
Mating connector, waterproof		Not included in scope of delivery	
for 11+PE-pin valve connector, IP65 (metal)	1	as per DIN EN 175201-804 Usable cable with min. Ø 11 mm and max. Ø 13 mm	B97067-111
Power unit (10 A)	1	Not included in scope of delivery	D137-003-001
Power supply cord (2 m)	1	Not included in scope of delivery	B95924-002

Table 27: Accessories

12.4 Tools for mating connector

Item designation		Item number
Tools for 11+PE-pin mating connector	Crimping tool for mating connector	B97136-001
	Removal tool	B97137-001

Table 28: Tools for mating connector

13 Appendix

13.1 Abbreviations, symbols and identification letters

Abb.	Explanation
β_x	Symbol for filter fineness
Δp	Symbol for pressure drop
Δp_N	Symbol for rated pressure drop
ν	Symbol for viscosity
µP	Microprocessor
A	Valve port (control port)
A	Pin of 6+PE-pin valve connector
B	Valve port (control port)
B	Pin of 6+PE-pin valve connector
C	Pin of 6+PE-pin valve connector
CAL	**C**AN **a**pplication **l**ayer (as per CiA DS 201–207)
CAN	**C**ontroller **a**rea **n**etwork
CANopen	Standardized communication profile
CAN_GND	**CAN gro**u**nd** (CAN-IN/OUT connector ground)
CAN_H	**CAN h**igh (CAN bus signal (dominant high))
CAN_L	**CAN l**ow (CAN bus signal (dominant low))
CAN_SHLD	**CAN sh**i**eld** (CAN-IN/OUT connector shield)
CAN_V+	Supply voltage for CAN bus node
CiA	**C**AN **i**n **A**utomation e. V. (International Manufacturers' and Users' Organization for CAN Users; http://www.can-cia.org)
D	**D**ifferential (e.g., in PID controller)
D	Fail-safe function **D** of valve
D	Pin of 6+PE-pin valve connector
DC	**D**irect **c**urrent
DIN	**D**eutsches **I**nstitut für **N**ormung e. V. (German Institute for Standardization) (http://www.din.de)
DIS	**D**raft **i**nternational **s**tandard (initial standard)
DS	**D**raft **s**tandard
DSP	**D**raft **s**tandard **p**roposal
DSP	**D**igital **s**ignal **p**rocessor
E	Pin of 6+PE-pin valve connector
EMC	**E**lectro**m**agnetic **c**ompatibility
EN	**E**uropa-**N**orm (European standard)
ESD	**E**lectro**s**tatic **d**ischarge
EU	**E**uropean **U**nion
F	Fail-safe function **F** of valve
F	Pin of 6+PE-pin valve connector
F_1–F_4	Mounting holes on valve mounting surface
FDIS	**F**inal **D**raft **I**nternational **S**tandard
FPM	Fluorocarbon rubber (material for O-rings)
F.S.	**F**ull **s**cale
GND	**G**rou**nd**
HNBR	**H**ydrogenated **N**itrile **B**utadiene **R**ubber (material for O-rings)

Table 29: Abbreviations, symbols and identification letters

Table 29: Abbreviations, symbols and identification letters (Part 1 of 3)

Table 29: Abbreviations, symbols and identification letters

Abb.	Explanation
I	**I**ntegral (e.g., in PID controller)
I_{in}	Symbol for input current
I_{out}	Symbol for output current
ID	**Id**entifier
ID	**I**nner **d**iameter (e.g., on O-rings)
IEC	**I**nternational **E**lectrotechnical **C**ommission (http://www.iec.ch)
IEEE	**I**nstitute of **E**lectrical and **E**lectronics **E**ngineers, Inc. (http://www.ieee.org)
IP	**I**nternational **p**rotection (IP code; degree of protection by enclosure as per DIN EN 60529)
ISO	**I**nternational **O**rganization for **S**tandardization (http://www.iso.org)
L	Symbol for stub cable length
LED	**L**ight **e**mitting **d**iode
LSS	**L**ayer **s**etting **s**ervices as per CiA DSP 305 (LSS offers the possibility of setting the node parameters, such as module address or transmission rate of a CAN node via the CAN bus)
LVDT	**L**inear **v**ariable **d**ifferential **t**ransformer (position transducer; senses the position of the spool in the valve)
M	Fail-safe function **M** of valve
MS	**M**odule **s**tatus LED
n	Number
NBR	**N**itrile **B**utadiene **R**ubber (material for O-rings)
NMT	**N**etwork **m**anagemen**t** (for configuration, initialization and fault handling in CAN networks)
NS	**N**etwork **s**tatus LED
P	Symbol for pressure
p_N	Symbol for rated pressure
p_P	Symbol for operating pressure
p_X	Symbol for pilot pressure
P	Valve port (pressure port)
P_1	Valve port (pressure port)
P	**P**roportional (e.g., in PID controller)
PC	**P**ersonal **c**omputer
PDO	**P**rocess **d**ata **o**bject (CAN message containing process data)
PE	**P**rotective **e**arth
PE	Pin of 6+PE-pin valve connector
PWM	**P**ulse **w**idth **m**odulation
Q	Symbol for flow
Q	Symbol for flow rate of a pump
Q_L	Symbol for leakage flow
Q_N	Symbol for rated flow
R_a	Symbol for average roughness
R_{in}	Symbol for input resistance
R_L	Symbol for load impedance
SHLD	**Sh**ie**ld**
T	Symbol for time
T	Symbol for temperature
T	Valve port (tank port)
T_1	Valve port (tank port)
TN	**T**echnical **N**ote

Table 29: Abbreviations, symbols and identification letters (Part 2 of 3)

Abb.	Explanation
U_{in}	Symbol for input voltage
U_{out}	Symbol for output voltage
USB	**U**niversal **s**erial **b**us
V	Symbol for tank capacity
VDI	**V**erein **D**eutscher **I**ngenieure e. V. (Association of German Engineers) (http://www.vdi.de)
VDMA	**V**erband **D**eutscher **M**aschinen- und **A**nlagenbau e. V. (German Machinery and Plant Manufacturers' Association) (http://www.vdma.org)
W	Fail-safe function **W** of valve
WAF	**W**idth **a**cross **f**lats
X	Valve port (control pressure port)
Y	Valve port (leakage port)

Table 29: Abbreviations, symbols and identification letters (Part 3 of 3)

Table 29: Abbreviations, symbols and identification letters

13.2 Additional literature

13.2.1 Moog publications

http://www.moog.com/imc/news

Additional literature: Moog publications

Articles in technical journals:
http://www.moog.com/Industrial/Articles
Newsletters:
http://www.moog.com/Industrial/Newsletter
Press releases:
http://www.moog.com/Industrial/Press
Presentations and scientific publications:
http://www.moog.com/techpapers

13.2.1.1 Technical Notes (TNs)

TN 353
Protective earthing/ground and shielding of hydraulic valves with integrated electronics

Additional literature: Technical Notes (TNs)

13.3 Quoted standards

13.3.1 CiA DS

CiA DS 201–207
CiA Draft Standard: CAN Application Layer (CAL)

Quoted standards: CiA DS

CiA DS 301
CiA Draft Standard: CANopen Communication Profile for Industrial Systems – Based on CAL

CiA DSP 305
CiA Draft Standard Proposal: CANopen Layer Setting Services and Protocol (LSS)

CiA DSP 408
CiA Draft Standard Proposal: CANopen Device Profile Fluid Power Technology Proportional Valves and Hydrostatic Transmissions

13.3.2 DIN

Quoted standards: DIN

DIN 51524-1
Pressure fluids; Hydraulic oils; Hydraulic oils HL; Minimum requirements

DIN 51524-2
Pressure fluids; Hydraulic oils; Hydraulic oils HLP; Minimum requirements

DIN 51524-3
Pressure fluids; Hydraulic oils; Hydraulic oils HVLP; Minimum requirements

13.3.3 DIN EN

Quoted standards: DIN EN

DIN EN 954-1
Safety of machinery – Safety-related parts of control systems – Part 1: General design principles

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

DIN EN 60068-2-6
Environmental tests – Part 2: Tests; test Fc: Oscillations, sinusoidal (IEC 60068-2-6:1995 + Corrigendum 1995)

DIN EN 60068-2-27
Environmental tests – Part 2: Tests; test Ea and guide: Shocks (IEC 60068-2-27:1987)

DIN EN 60204
Safety of machinery – Electrical equipment of machines

DIN EN 60529
Degrees of protection provided by enclosures (IP code)

DIN EN 61000-6-2
Electromagnetic compatibility (EMC) – Part 6-2: Generic standards; immunity for industrial environments

DIN EN 61000-6-4
Electromagnetic compatibility (EMC) – Part 6-4: Generic standards; emitted interference for industrial environments

DIN EN 175201-804
Detail specification: Circular connectors – Round contacts size diameter 1.6 mm – Threaded coupling

DIN EN 175301-803
Detail specification: Rectangular connectors – Flat contacts 0.8 mm thickness – Captive locking screw

13.3.4 DIN EN ISO

Quoted standards: DIN EN ISO

DIN EN ISO 1302
Geometric Product Specification (GPS) - Specification of surface quality in technical product documentation

DIN EN ISO 4762
Hexagon socket head cap screws

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

13.3.5 ISO

Quoted standards: ISO

ISO/FDIS 4401
Hydraulic fluid power – Four-port directional control valves – Mounting surfaces

ISO 4406
Hydraulic fluid power – Fluids – Method for coding level of contamination by solid particles

ISO/DIS 11898
Road vehicles – CAN protocol

13.4 Quoted directives

Quoted directives

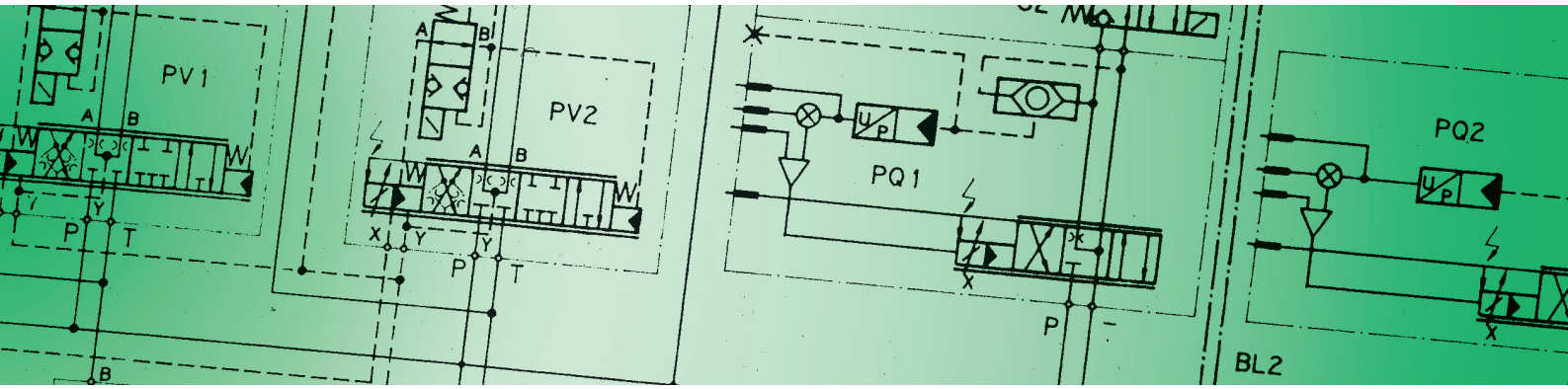
98/37/EC
Directive 98/37/EC of the European Parliament and Council for alignment of the legal and administrative provisions of the Member States for machinery

89/336/EEC
Directive 89/336/EEC concerning electromagnetic compatibility (EMC)

VDI offers numerous directives for downloading:
http://www.vdi-nachrichten.com/ce-richtlinien/basics/richtlinien.asp

For your notes.

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

GmbH / HEM-1 / PDF

Moog GmbH
Hanns-Klemm-Straße 28
71034 Böblingen
Germany
Telephone: +49 7031 622-0
Telefax: +49 7031 622-191
Our locations:
www.moog.com/worldwide

Operating Instructions D941
(C43357-001; Version 1.0, 03/07)