

# DIRECT DRIVE ANALOG CONTROL SERVO VALVES

D633 SIZE 03

D634 SIZE 05



Rev. C, April 2020

HIGH PRODUCTIVITY FOR DEMANDING APPLICATIONS  
THAT REQUIRE A HIGHLY DYNAMIC RESPONSE AND  
FLEXIBLE INTEGRATION.

Whenever the highest levels of motion control performance and design flexibility are required, you'll find Moog expertise at work. Through collaboration, creativity and world-class technological solutions, we help you overcome your toughest engineering obstacles. Enhance your machine's performance, and help take your thinking further than you ever thought possible.

INTRODUCTION..... 2

    Product Overview..... 3

    Description of Operation..... 5

    Features and Benefits ..... 6

TECHNICAL DATA ..... 7

    Size 03 - D633 Servo Valve ..... 7

    Size 05 - D634 Servo Valve ..... 12

BACKGROUND ..... 17

    Electronics ..... 17

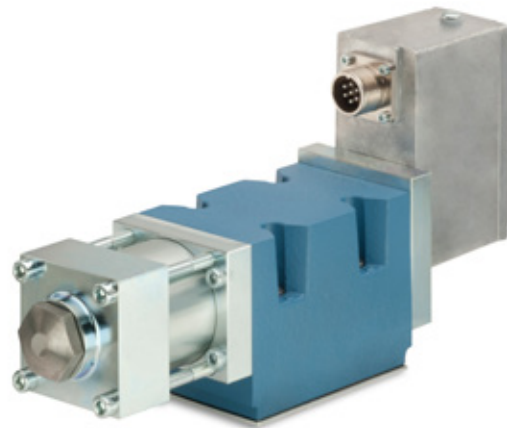
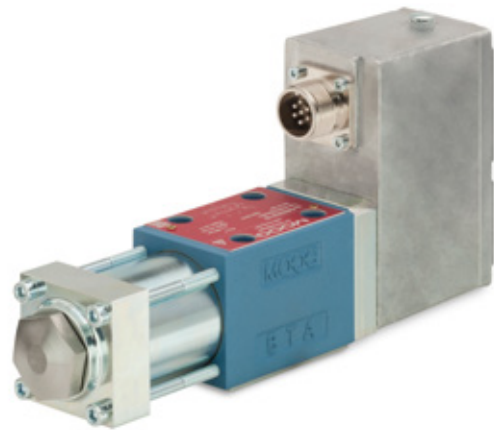
    Flow Calculation ..... 19

ORDERING INFORMATION..... 20

    Accessories and Spare Parts..... 20

    Moog Global Support..... 24

    Ordering Code..... 25



This catalog is for users with technical knowledge. To ensure all necessary characteristics for function and safety of the system, the user has to check the suitability of the products described herein. The products described herein are subject to change without notice. In case of doubt, please contact Moog.

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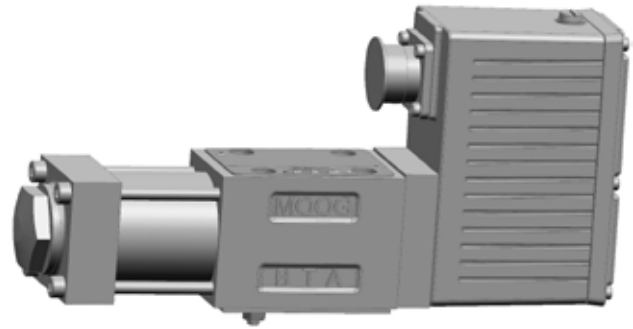
## PRODUCT OVERVIEW

The D633 and D634 Series are Direct Drive Valves (DDV) with electric closed loop spool position control.

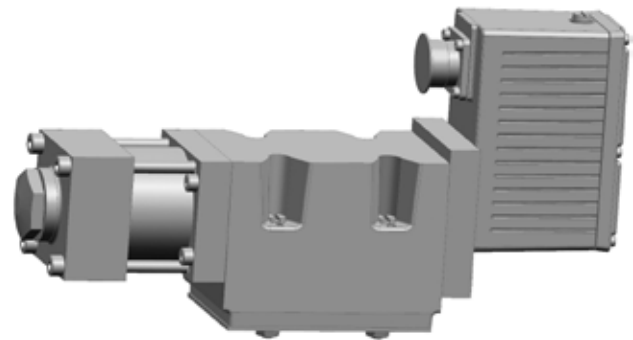
These valves are throttle valves for 3-, 4-, and 2x2-way applications. They are suitable for electrohydraulic position, velocity, pressure or force control systems including those with high dynamic response requirements.

The spool drive device is a permanent magnet linear force motor, which can actively stroke the spool from its spring centred position in both directions. This is an advantage compared with proportional solenoids with one force direction only. The closed loop spool position control and pulse width modulated (PWM) drive electronics are integrated into the valve.

The integrated electronics of the valves features SMD technology with pulse width modulated (PWM) current output stage, and requires a 24 V<sub>DC</sub> power supply.



D633



D634



|   | D633   |                       |                       |                        | D634   |                         |
|---|--|-----------------------|-----------------------|------------------------|--|-------------------------|
| <b>Valve design</b>   | 1 stage, with spool and bushing                                |                       |                       |                        |  |                         |
| <b>Size according ISO 4401</b>                                      | Size 03  |                       |                       |                        | Size 05  |                         |
| <b>Mounting pattern</b>   | ISO 4401-03-03-0-05 (with or without leakage oil connection Y) |                       |                       |                        | ISO 4401-05-05-0-05 (with or without leakage oil connection Y) |                         |
| <b>Rated flow at Δp<sub>N</sub> 35 bar (500 psi) per spool land</b> | 5 l/min<br>(1.3 gpm)   | 10 l/min<br>(2.6 gpm) | 20 l/min<br>(5.3 gpm) | 40 l/min<br>(10.6 gpm) | 60 l/min<br>(15.9 gpm)   | 100 l/min<br>(26.4 gpm) |
| <b>Maximum flow</b>   | 75 l/min (19.8 gpm)  |                       |                       |                        | 180 l/min (47.6 gpm)   |                         |
| <b>Maximum operating pressure - Port P, A, B</b>                    | 350 bar (5000 psi)   |                       |                       |                        |  |                         |
| <b>Step response time for 0 to 100 % stroke</b>                     | ≤ 12 ms  |                       |                       |                        | ≤ 20 ms  |                         |

## PRODUCT OVERVIEW

### Design and Application

A permanent magnet linear force motor is used to drive the spool. In contrast to proportional solenoid drives, the linear force motor drives the spool in both working directions from the spring-centered middle position. The strong actuating force of the spool, provides Moog Servo Valves with excellent static and dynamic characteristics.

### Spool Position Control

In this operating mode of the servo valve, the spool position is controlled. The command signal is proportional to a desired spool position. A position transducer (LVDT) measures the spool's actual position, and forwards this information to the valve electronics. The system electronics compare the actual spool position with the command signal. This generates a signal that drives the linear force motor and brings the spool to the correct position.

### Optional Valve Features

Moog offers a range of optional features. These include options to ruggedize valves for operation in extremely demanding environments, and valves designed for special applications and fluids. The following sections provide short overviews of these functions. Please contact Moog for more detailed information.

### Valves for Operation with Ester Based Fluids

Standard hydraulic seal materials such as HNBR and FKM, are frequently incompatible with fire resistant phosphate ester based fluids. In order to use valves with this type of fluid, Moog offers them as special seal versions that are mineral oil and phosphate ester resistant. Please note: These valve types are tested by Moog using mineral oil, remnants of which will remain in the valve after testing.



### Explosion Protection

Valves D633K and D634K available with explosion protection for **Gas:**

- **Ex II 2G Ex db eb IIB+H2 T\* Gb**  
according to EN 60079-0, EN 60079-1 and EN 60079-7.
- **Ex db eb IIB+H2 T\* Gb**  
according to IEC 60079-0, IEC 60079-1, IEC 60079-7.

Valves D633D available with explosion protection for **Dust:**

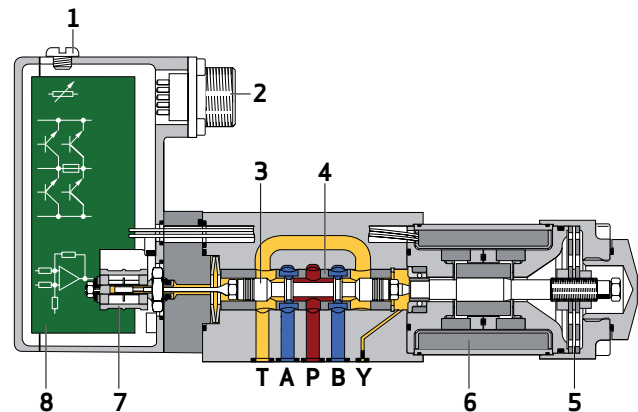
- **Ex II 2D Ex tb IIIC T155°C Db**
- **Ex II 3D Ex tc IIIC T155°C Dc**  
according to EN 60079-31, EN 60079-0.

Note: Installation dimensions and electric connection altered.

## DESCRIPTION OF OPERATION

### Main Features

- Direct drive with permanent magnet linear force motor that provides high actuating force, works in 2 directions.
- Direct operated - no pilot oil required.
- Pressure-independent dynamic response.
- Low hysteresis and high response characteristics.
- Lower power demand in and around the spool center position. This results in lower energy consumption during the majority of operating and stand by times.
- If the electrical supply fails, a cable breaks or emergency stop is activated, the spool returns to the predefined spring-centered position without passing a fully open control port position increasing safety.



- 1 Null adjust cover plug
- 2 Valve connector
- 3 Spool
- 4 Bushing
- 5 Centering spring
- 6 Linear force motor
- 7 Position transducer
- 8 Integrated electronics

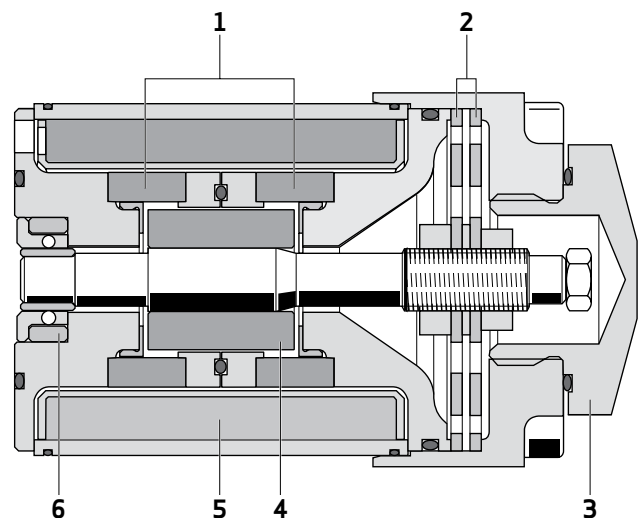
### Permanent Magnet Linear Force Motor

The Linear Force Motor (LFM) is a permanent magnet excited differential motor.

The LFM's armature (4) is connected to the valve spool via a rod. Also connected to this rod are the centering springs (2), which keep the LFM in its center position. The permanent magnets (1) supply part of the motor's force. In combination with the force created by the coil (5), the force level of a Linear Force Motor is higher than that of a proportional solenoid of similar size.

The LFM has a neutral mid-position from which it generates force and stroke in both directions. This is an advantage over a proportional solenoid drive, which can only operate in one direction. The LFM's force is roughly proportional to the coil current. To move out of the center position, a PWM current is applied to the coil and the spool is deflected against the centering springs. To move back towards the center position, a reverted PWM current is applied to the coil, which causes the LFM to actively move the spool towards the center. This movement is supported by the centering springs.

Due to the high force levels of the LFM it is able to overcome flow and frictional forces, and still guarantee a precise and dynamic positioning of the spool.



- 1 Permanent magnets
- 2 Centering springs
- 3 Screw plug
- 4 Armature
- 5 Coil
- 6 Bearing

## FEATURES AND BENEFITS

| Features  | Benefits  |
|---|---|
| <b>D633 and D634 Series Servo Valves</b>                                |   |
| Direct operated servo valves  | No pilot oil required, valve dynamics are not dependent on pilot pressure |
| Linear Force Motor with high force level and push-pull operation        | Precise and dynamic valve operation even at high pressure drops           |
| Precise spool positioning with low hysteresis and threshold             | High control accuracy for demanding closed loop control tasks             |
| High valve dynamics   | Supports highly dynamic control tasks                                     |
| Spool slides in precisely manufactured and fully hardened steel bushing | Low internal leakage, high control accuracy and high wear resistance      |

## SIZE 03 - D633

### General Technical Data

|   |   |
|---|---|
| <b>Valve design</b>                                       | 1 stage, with spool and bushing                                   |
| <b>Mounting pattern</b>                                   | ISO 4401-03-03-0-05<br>(with or without leakage oil connection Y) |
| <b>Installation position</b>                              | Any   |
| <b>Weight</b>   | 2.5 kg (5.51 lb)  |
| <b>Storage temperature range</b>                          | -40 - +80 °C (-40 - +176 °F)                                      |
| <b>Ambient temperature range</b>                          | -20 - +60 °C (-4 - +140 °F)                                       |
| <b>Vibration resistance</b>                               | 30 g, 3 axis, 10 Hz to 2 kHz                                      |
| <b>Shock resistance</b>                                   | 50 g, 6 directions, 3 ms  |
| <b>MTTF<sub>d</sub> value according to EN ISO 13849-1</b> | 150 years   |

### Hydraulic Data

|  |  |                         |                         |                         |
|--|--|-------------------------|-------------------------|-------------------------|
| <b>Maximum operating pressure - Port P, A, B</b>                             | 350 bar (5000 psi)   |                         |                         |                         |
| <b>Maximum operating pressure - Port T without Y</b>                         | 50 bar (725 psi)   |                         |                         |                         |
| <b>Maximum operating pressure - Port T with Y</b>                            | 350 bar (5000 psi)   |                         |                         |                         |
| <b>Maximum operating pressure - Port Y</b>                                   | Depressurized to tank <sup>2)</sup>  |                         |                         |                         |
| <b>Rated flow at <math>\Delta p_N</math> 35 bar (500 psi) per spool land</b> | 5 l/min<br>(1.3 gpm)   | 10 l/min<br>(2.6 gpm)   | 20 l/min<br>(5.3 gpm)   | 40 l/min<br>(10.6 gpm)  |
| <b>Maximum flow</b>  | 75 l/min (19.8 gpm)  |                         |                         |                         |
| <b>Hydraulic fluid</b>   | Hydraulic oil as per DIN 52524 parts 1 to 3 and ISO 11158.<br>Other fluids upon request. |                         |                         |                         |
| <b>Leakage flow (rate) (<math>\approx</math> zero lap)<sup>1)</sup></b>      | 0.15 l/min<br>(0.04 gpm)   | 0.3 l/min<br>(0.08 gpm) | 0.6 l/min<br>(0.16 gpm) | 1.2 l/min<br>(0.32 gpm) |
| <b>Temperature range</b>   | -20 - +80 °C (-4 - +176 °F)  |                         |                         |                         |
| <b>Recommended viscosity range at 38 °C (100 °F)</b>                         | 15 - 100 mm <sup>2</sup> /s (cSt)  |                         |                         |                         |
| <b>Maximum permissible viscosity range at 38 °C (100 °F)</b>                 | 5 - 400 mm <sup>2</sup> /s (cSt)   |                         |                         |                         |
| <b>Recommended cleanliness class as per ISO 4406 for functional safety</b>   | 18/15/12   |                         |                         |                         |
| <b>Recommended cleanliness class as per ISO 4406 for longer service life</b> | 17/14/11   |                         |                         |                         |

<sup>1)</sup> Measured at 140 bar (2,000 psi) system pressure, oil viscosity 32 mm<sup>2</sup>/s and oil temperature 40 °C (104 °F).

<sup>2)</sup> In order to avoid an emptying of the return line, a back-pressure of 2 bar (29 psi) should be maintained on the T, T1 and Y connections.

### Typical Static and Dynamic Data<sup>1)</sup>

|  |         |
|--|---------|
| <b>Step response time for 0 to 100 % stroke</b>            | ≤ 12 ms |
| <b>Threshold, typical</b>                                  | 0.05 %  |
| <b>Threshold, maximum</b>                                  | < 0.1 % |
| <b>Hysteresis, typical</b>                                 | 0.1 %   |
| <b>Hysteresis, maximum</b>                                 | < 0.2 % |
| <b>Null shift at <math>\Delta T = 55</math> K (131 °F)</b> | < 1.5 % |
| <b>Sample deviation of rated flow</b>                      | < 10 %  |

<sup>1)</sup> Measured at 140 bar (2,000 psi) system pressure, oil viscosity 32 mm<sup>2</sup>/s and oil temperature 40 °C (104 °F).

## SIZE 03 - D633

### Electrical Data

|  |   |
|--|---|
| <b>Duty cycle</b>  | 100 %   |
| <b>Degree of protection according to IEC/EN 60529</b>    | IP65 with mounted mating plugs  |
| <b>Supply voltage<sup>1)</sup></b>                       | 24 V <sub>DC</sub> , min. 19 V <sub>DC</sub> , max. 32 V <sub>DC</sub>    |
| <b>Permissible ripple of supply voltage<sup>2)</sup></b> | ±3 V <sub>RMS</sub>   |
| <b>Maximum current consumption<sup>3)</sup></b>          | 1.2 A   |
| <b>Power consumption of the motor in middle position</b> | 9.6 W (0.4 A @ 24 V <sub>DC</sub> )                                       |
| <b>Power consumption maximum</b>                         | 28.8 W (1.2 A @ 24 V <sub>DC</sub> )                                      |
| <b>Fuse protection, external, per valve</b>              | 1.6 A (slow)  |
| <b>EM compatibility</b>                                  | Immunity to interference as per DIN EN 61000-6-2 (evaluation criterion A) |

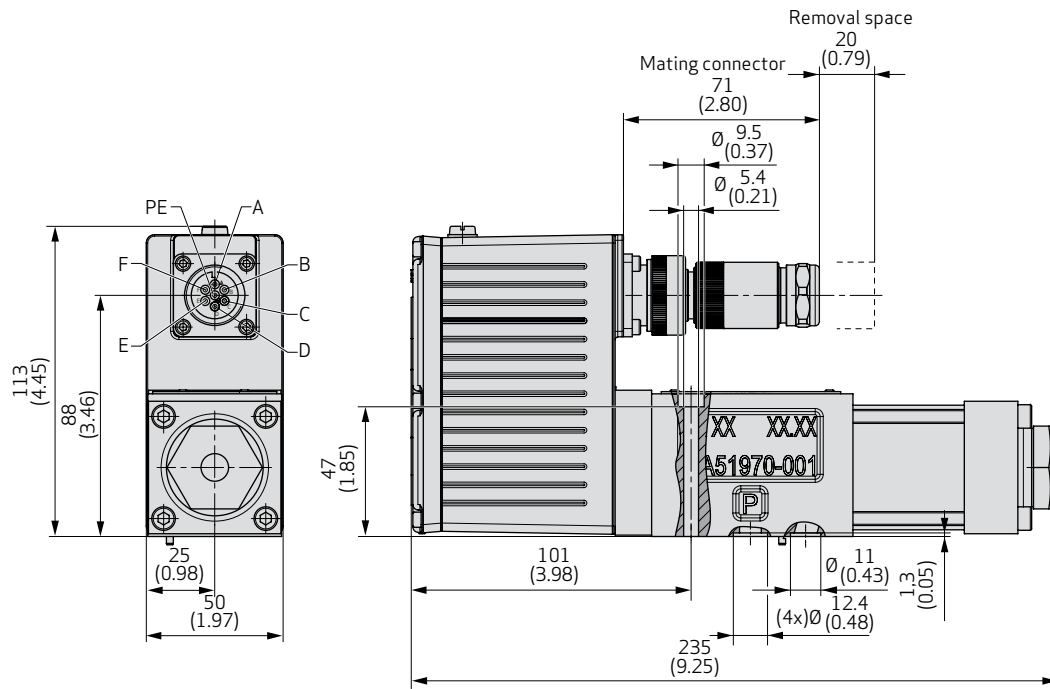
<sup>1)</sup> All connected circuits must be isolated from the main supply by „electrical separation“ in accordance with IEC/EN 61558-1 and IEC/EN 61558-2-6. Voltages must be limited to the safety extra-low voltage range in accordance with EN 60204-1. We recommend the use of SELV/PELV power packs.

<sup>2)</sup> Frequency from 50 Hz to 10 kHz.

<sup>3)</sup> Measured at ambient temperature 25 °C (77 °F) and supply voltage 24 V.



# INSTALLATION DRAWING SIZE 03 - D633

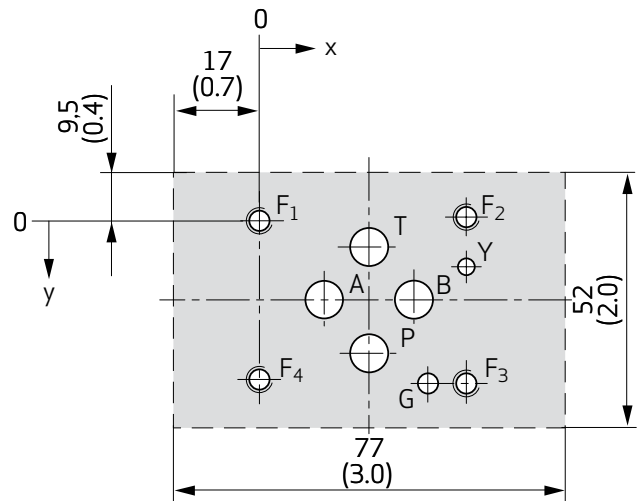


## Port Pattern of Mounting Surface

The mounting surface must conform to ISO 4401-03-03-0-05. Observe mounting length of minimum 77 mm (3.0 in) and O-ring recesses for Y.

For maximum flow the ports for P, T, A and B must be designed with  $\varnothing 7.5$  mm (0.3 in), not according to the standard.

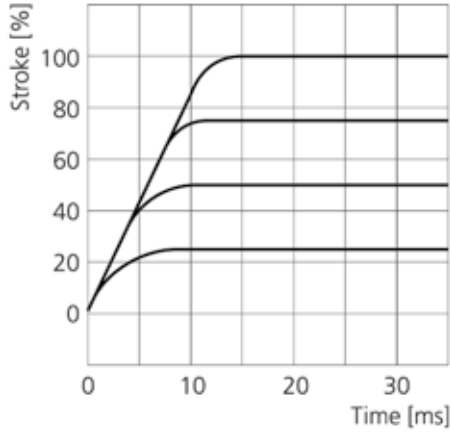
Evenness of connecting surface has to be 0.01 mm (0.0004 in) over 100 mm (3.94 in), average surface finish  $R_a$  better than 0.8  $\mu$ m (0.000314 in).



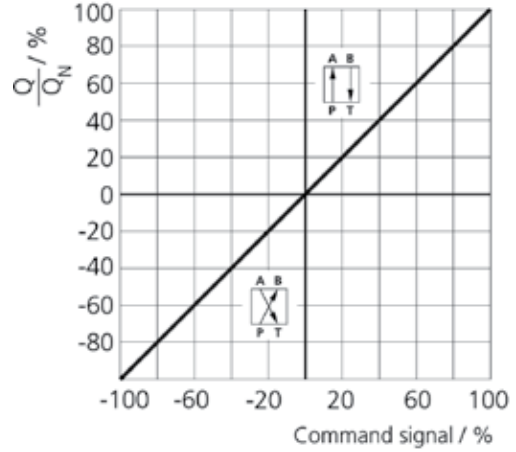
| Designation        | P  | A     | B    | T     | Y     | F1    | F2 | F3    | F4    | G    |       |
|--------------------|----|-------|------|-------|-------|-------|----|-------|-------|------|-------|
| Size $\varnothing$ | mm | 7.5   | 7.5  | 7.5   | 7.5   | 3.3   | M5 | M5    | M5    | M5   | 4.0   |
|                    | in | 0.30  | 0.30 | 0.30  | 0.30  | 0.13  | M5 | M5    | M5    | M5   | 0.16  |
| Position X         | mm | 21.5  | 12.7 | 30.2  | 21.5  | 40.5  | 0  | 40.5  | 40.5  | 0    | 33    |
|                    | in | 0.846 | 0.5  | 1.189 | 0.846 | 1.594 | 0  | 1.594 | 1.594 | 0    | 1.299 |
| Position Y         | mm | 25.9  | 15.5 | 15.5  | 5.1   | 9     | 0  | -0.75 | 31.75 | 31   | 31.75 |
|                    | in | 1.02  | 0.61 | 0.61  | 0.201 | 0.354 | 0  | -0.03 | 1.25  | 1.22 | 1.25  |

# CHARACTERISTIC CURVES SIZE 03 - D633

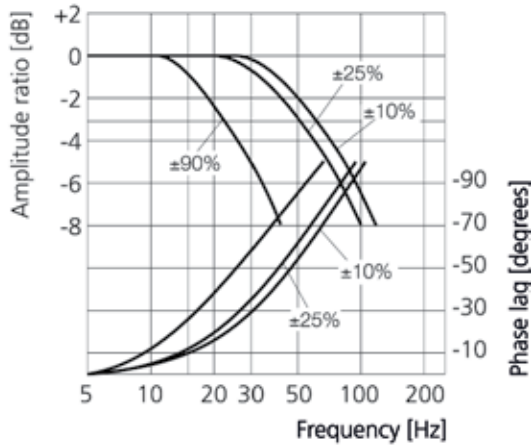
## Step Response



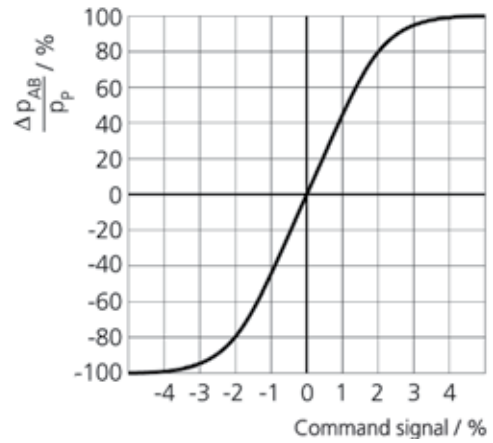
## Flow Signal



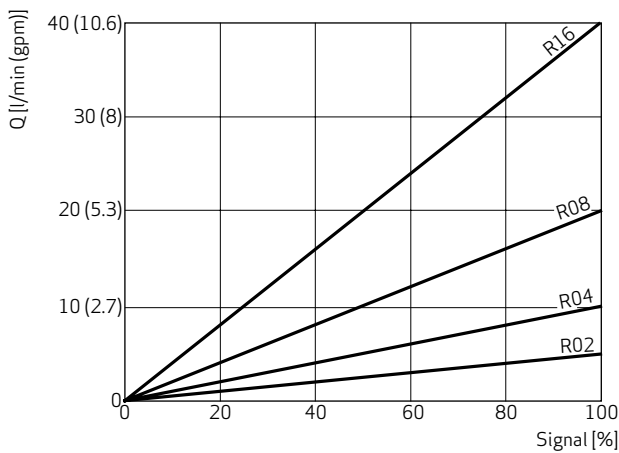
## Frequency Response



## Pressure Signal



## Flow signal curves at $\Delta p_N = 35$ bar (500 psi) per pool land



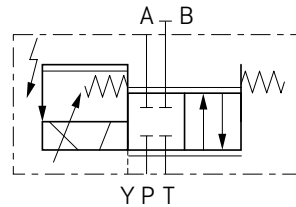
Measured with system pressure  $p_p$  of 140 bar (2,000 psi), oil viscosity 32 mm<sup>2</sup>/s and oil temperature of 40 °C (104 °F).

## HYDRAULIC SYMBOLS - D633 2-WAY AND 2X2-WAY OPERATION

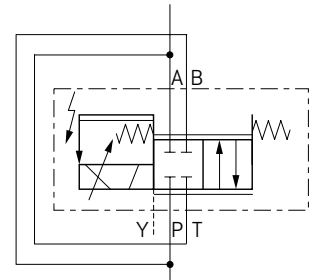
### 2-way and 2x2-way operation

In 2-way and 2x2-way operation the servo valves can be used to control the flow in one direction (used as 2-way throttle valves). In 2x2-way operation the valve can be used in 2-way applications for higher flows. It is necessary to connect ports P with B and A with T externally for this purpose.

2-way operation



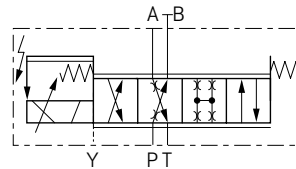
2x2-way operation



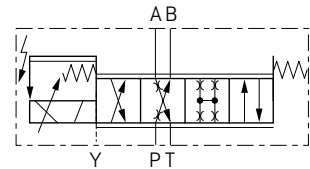
### 4-way and 3-way operation

In 4-way operation the servo valves can be used to control the flow in ports A and B (used as 4/3-way throttle valves). Port A or B must be closed in order to obtain 3-way operation. Leakage port Y must be used if the pressure in tank port T exceeds a value of 50 bar (725 psi). The valves are available with zero lap, less than 3 % or 10 % positive overlap.

3-way operation with failsafe option F



4-way operation with failsafe option F



Note: The specified flow directions must be observed.

## SIZE 05 - D634

### General Technical Data

|   |   |
|---|---|
| <b>Valve design</b>                                       | 1 stage, with spool and bushing                                   |
| <b>Mounting pattern</b>                                   | ISO 4401-05-05-0-05<br>(with or without leakage oil connection Y) |
| <b>Installation position</b>                              | Any   |
| <b>Weight</b>   | 7.9 kg (17.42 lb)   |
| <b>Storage temperature range</b>                          | -40 - +80 °C (-40 - +176 °F)                                      |
| <b>Ambient temperature range</b>                          | -20 - +60 °C (-4 - +140 °F)                                       |
| <b>Vibration resistance</b>                               | 30 g, 3 axis, 10 Hz to 2 kHz                                      |
| <b>Shock resistance</b>                                   | 50 g, 6 directions, 3 ms  |
| <b>MTTF<sub>d</sub> value according to EN ISO 13849-1</b> | 150 years   |

### Hydraulic Data

|  |  |                      |
|--|--|----------------------|
| <b>Maximum operating pressure - Port P, A, B</b>                             | 350 bar (5000 psi)   |                      |
| <b>Maximum operating pressure - Port T without Y</b>                         | 50 bar (725 psi)   |                      |
| <b>Maximum operating pressure - Port T with Y</b>                            | 210 bar (3000 psi)   |                      |
| <b>Maximum operating pressure - Port Y</b>                                   | Depressurized to tank <sup>2)</sup>  |                      |
| <b>Rated flow at <math>\Delta p_N</math> 35 bar (500 psi) per spool land</b> | 60 l/min (15.9 gpm)  | 100 l/min (26.4 gpm) |
| <b>Maximum flow</b>  | 180 l/min (47.6 gpm)   |                      |
| <b>Hydraulic fluid</b>   | Hydraulic oil as per DIN 52524 parts 1 to 3 and ISO 11158.<br>Other fluids upon request. |                      |
| <b>Leakage flow (rate) (<math>\approx</math> zero lap)<sup>1)</sup></b>      | 1.2 l/min (0.32 gpm)   | 2.0 l/min (0.53 gpm) |
| <b>Temperature range</b>   | -20 - +80 °C (-4 - +176 °F)  |                      |
| <b>Recommended viscosity range at 38 °C (100 °F)</b>                         | 15 - 100 mm <sup>2</sup> /s (cSt)  |                      |
| <b>Maximum permissible viscosity range at 38 °C (100 °F)</b>                 | 5 - 400 mm <sup>2</sup> /s (cSt)   |                      |
| <b>Recommended cleanliness class as per ISO 4406 for functional safety</b>   | 18/15/12   |                      |
| <b>Recommended cleanliness class as per ISO 4406 for longer service life</b> | 17/14/11   |                      |

<sup>1)</sup> Measured at 140 bar (2,000 psi) system pressure, oil viscosity 32 mm<sup>2</sup>/s and oil temperature 40 °C (104 °F).

<sup>2)</sup> In order to avoid an emptying of the return line, a back-pressure of 2 bar (29 psi) should be maintained on the T, T1 and Y connections.

### Typical Static and Dynamic Data<sup>1)</sup>

|  |              |
|--|--------------|
| <b>Step response time for 0 to 100 % stroke</b>            | $\leq$ 20 ms |
| <b>Threshold, typical</b>                                  | 0.05 %       |
| <b>Threshold, maximum</b>                                  | < 0.1 %      |
| <b>Hysteresis, typical</b>                                 | 0.1 %        |
| <b>Hysteresis, maximum</b>                                 | < 0.2 %      |
| <b>Null shift at <math>\Delta T = 55</math> K (131 °F)</b> | < 1.5 %      |
| <b>Sample deviation of rated flow</b>                      | < 10 %       |

<sup>1)</sup> Measured at 140 bar (2,000 psi) system pressure, oil viscosity 32 mm<sup>2</sup>/s and oil temperature 40 °C (104 °F).

## SIZE 05 - D634

### Electrical Data

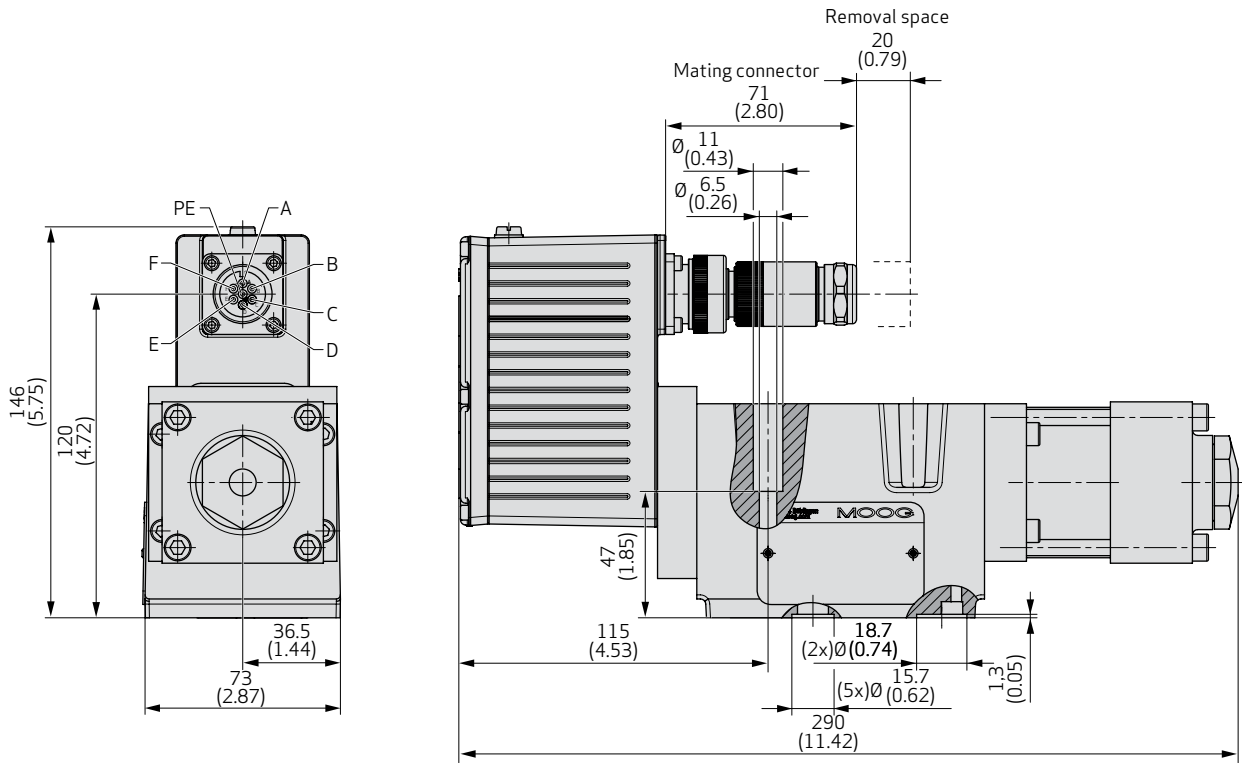
|  |   |
|--|---|
| <b>Duty cycle</b>  | 100 %   |
| <b>Degree of protection according to IEC/EN 60529</b>    | IP65 with mounted mating plugs  |
| <b>Supply voltage<sup>1)</sup></b>                       | 24 V <sub>DC</sub> , min. 18 V <sub>DC</sub> , max. 32 V <sub>DC</sub>    |
| <b>Permissible ripple of supply voltage<sup>2)</sup></b> | ±3 V <sub>RMS</sub>   |
| <b>Maximum current consumption<sup>3)</sup></b>          | 3.0 A   |
| <b>Power consumption of the motor in middle position</b> | 9.6 W (0.4 A @ 24 V <sub>DC</sub> )                                       |
| <b>Power consumption maximum</b>                         | 55.2 W (2.3 A @ 24 V <sub>DC</sub> )                                      |
| <b>Fuse protection, external, per valve</b>              | 3.15 A (slow)   |
| <b>EM compatibility</b>                                  | Immunity to interference as per DIN EN 61000-6-2 (evaluation criterion A) |

<sup>1)</sup> All connected circuits must be isolated from the main supply by „electrical separation“ in accordance with IEC/EN 61558-1 and IEC/EN 61558-2-6. Voltages must be limited to the safety extra-low voltage range in accordance with EN 60204-1. We recommend the use of SELV/PELV power packs.

<sup>2)</sup> Frequency from 50 Hz to 10 kHz.

<sup>3)</sup> Measured at ambient temperature 25 °C (77 °F) and supply voltage 24 V.

# INSTALLATION DRAWING SIZE 05 - D634

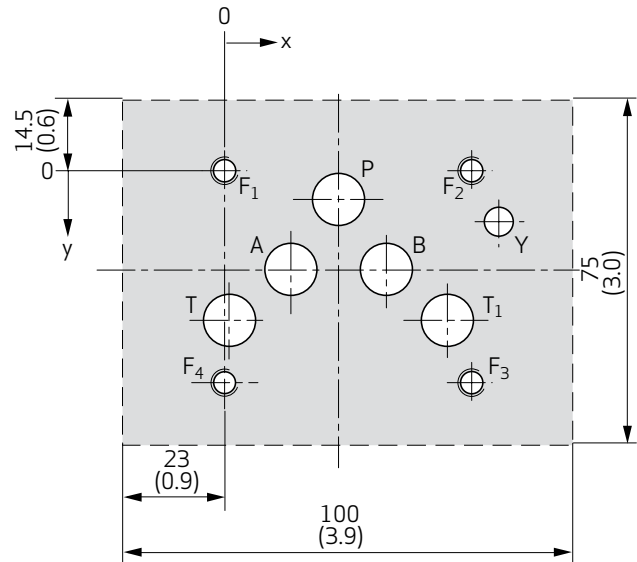


## Port Pattern of Mounting Surface

The mounting pattern must confirm to ISO 4401-05-05-0-05 with additional T1. Observe mounting length of minimum 100 mm (3.94 in) and O-ring recesses for Y. For 4-way valves with  $Q > 60\text{l/min}$  (15.9 gpm) the second tank port T1 is required.

For maximum flow the ports for P, T, T1, A and B must be designed with  $\varnothing 11.5\text{ mm}$  (0.45 in), not according to the standard.

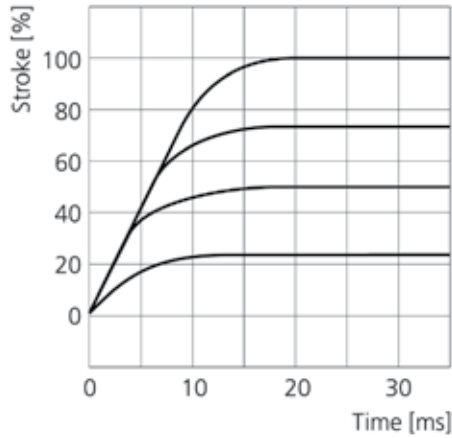
Evenness of connecting surface has to be 0.01 mm (0.0004 in) over 100 mm (3.94 in), average surface finish  $R_a$  better than  $0.8\ \mu\text{m}$  (0.0000314 in).



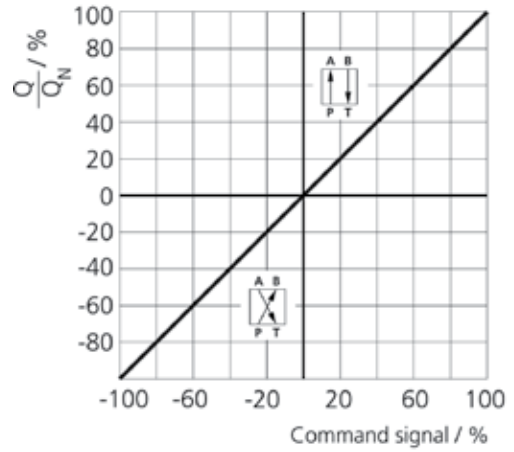
| Designation        |    | P     | A     | B     | T     | T1   | Y     | F1 | F2    | F3    | F4    |
|--------------------|----|-------|-------|-------|-------|------|-------|----|-------|-------|-------|
| Size $\varnothing$ | mm | 11.2  | 11.2  | 11.2  | 11.2  | 11.2 | 6.3   | M6 | M6    | M6    | M6    |
|                    | in | 0.44  | 0.44  | 0.44  | 0.44  | 0.44 | 0.25  | M6 | M6    | M6    | M6    |
| Position X         | mm | 27    | 16.7  | 37.3  | 3.2   | 50.8 | 62    | 0  | 54    | 54    | 0     |
|                    | in | 1.063 | 0.657 | 1.469 | 0.126 | 2    | 2.441 | 0  | 2.126 | 2.126 | 0     |
| Position Y         | mm | 6.3   | 21.4  | 21.4  | 23.5  | 23.5 | 11    | 0  | 0     | 46    | 46    |
|                    | in | 0.248 | 0.843 | 0.843 | 1.28  | 1.28 | 0.433 | 0  | 0     | 1.811 | 1.811 |

# CHARACTERISTIC CURVES SIZE 05 - D634

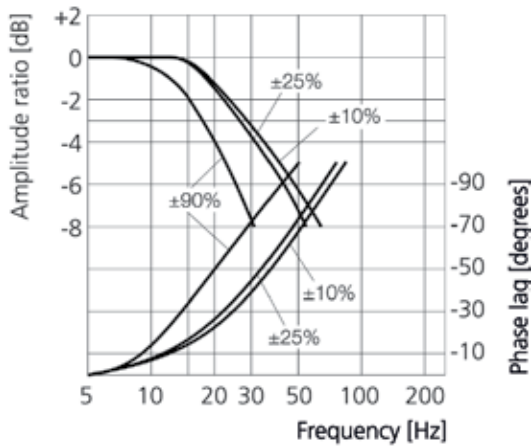
## Step Response



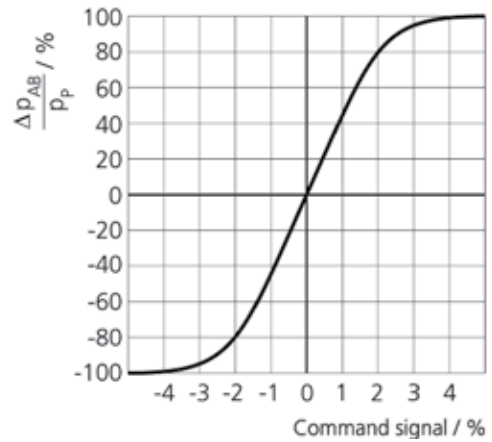
## Flow Signal



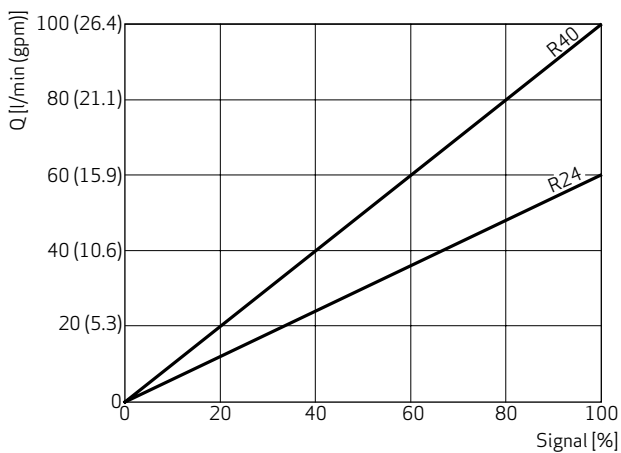
## Frequency Response



## Pressure Signal



## Flow signal curves at $\Delta p_N = 35$ bar (500 psi) per pool land



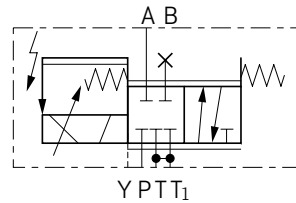
Measured with system pressure  $p_p$  of 140 bar (2,000 psi), oil viscosity 32 mm<sup>2</sup>/s and oil temperature of 40 °C (104 °F).

# HYDRAULIC SYMBOLS SIZE 05 - D634

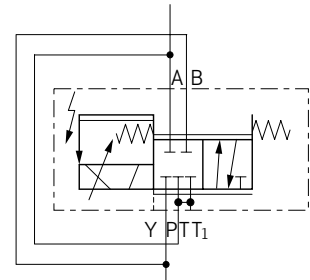
## 2-way and 2x2-way operation

In 2-way and 2x2-way operation the servo valves can be used to control the flow in one direction (used as 2-way throttle valves). In 2x2-way operation the valve can be used in 2-way applications for higher flows. It is necessary to connect ports P with B and A with T externally for this purpose.

2-way operation



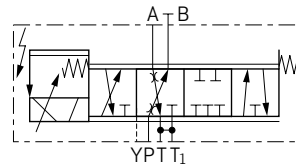
2x2-way operation



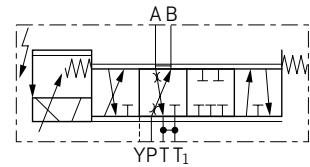
## 4-way and 3-way operation

In 4-way operation the servo valves can be used to control the flow in ports A and B (used as 4/3-way throttle valves). Port A or B must be closed in order to obtain 3-way operation. Leakage port Y must be used if the pressure in tank port T exceeds a value of 50 bar (725 psi). The valves are available with zero lap, less than 3 % or 10 % positive overlap.

3-way operation with failsafe option F



4-way operation with failsafe option F



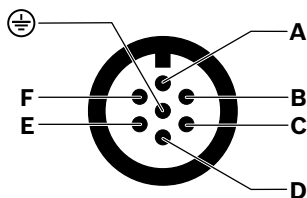
Note: The specified flow directions must be observed.



## ELECTRONICS

## Pin Assignment for Valves with 6-pole + PE Connector, Pin Contacts (X1)

According to EN 175201-804, mating connector (type R or S, metal) with preleading protective earth pin (⏚)



| Pin | Pin Assignment                      | Signal type <sup>1)</sup>   |  |
|-----|-------------------------------------|---|--|
|     |                                     | Voltage floating  | Current floating <sup>3)</sup>   |
| A   | Supply voltage                      | $U_{\text{Supply}} = 24 V_{\text{DC}}$ (18 to 32 $V_{\text{DC}}$ ) referenced to GND (reverse polarity protected against GND)   |  |
| B   | GND                                 | Power ground/signal ground  |  |
| C   | Enable input                        | $U_{\text{CB}} > 8.5$ to 32 $V_{\text{DC}}$ referenced to GND: Valve ready for operation (enabled) $U_{\text{CB}} < 6.5 V_{\text{DC}}$ referenced to GND: Valve disabled<br>The input resistance is 10 k $\Omega$ |  |
| D   | Command signal - spool position     | $U_{\text{in}} = U_{\text{DE}}$<br>$R_{\text{in}} = 10 \text{ k}\Omega$   | $I_{\text{in}} = I_{\text{D}} = -I_{\text{E}}$<br>$R_{\text{in}} = 200 \Omega$<br>$I_{\text{max}} = \pm 25 \text{ mA}$   |
| E   | Reference point Input rated command | Reference for pin D <sup>2)</sup>   |  |
| F   | Actual value - spool position       | $U_{\text{F-B}} = 2$ to 10 V; $U_{\text{F-B}}$ is proportional to the spool position; 6 V corresponds to the spool center position; $R_{\text{L}} = 500 \Omega$   | $I_{\text{out}} = 4$ to 20 mA referenced to GND; $I_{\text{out}}$ is proportional to the spool position; 12 mA corresponds to the spool center position; the output is short-circuit-proof; $R_{\text{L}} = 0$ to 500 $\Omega$ |
| ⏚   | Protective earth (PE)               | Connected with valve body   |  |

<sup>1)</sup> Signal ranges see next page.

<sup>2)</sup> The potential difference between pins D or E referenced to pin B must be between -15 and +32 V.

<sup>3)</sup> Command signals  $I_{\text{in}} < 3 \text{ mA}$  (due to cable break, for example) indicates a failure of 4 to 20 mA signals. The valve reaction to this failure may be customized and activated by the customer.

# ELECTRONICS

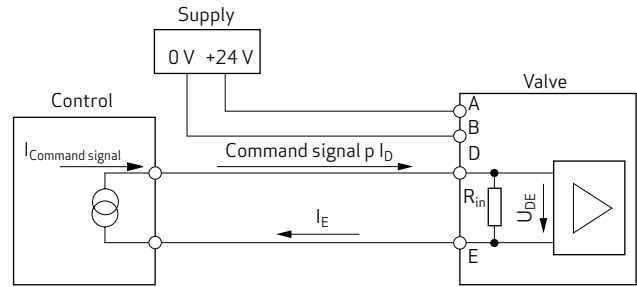
## Ordering Codes and Signals for Valves with 6-pole + PE Connector (X1)

| Ordering Code | Command signal $\pm 100\%$ spool position | Actual value $\pm 100\%$ spool position |
|---------------|---|---|
| M             | $U_D - U_E$                               | -10 to +10 V                            |
| X             | $I_D$                                     | -10 to +10 mA                           |
| E             | $I_D$                                     | 4 to 20 mA                              |
| D             | $U_D - U_E$                               | -10 to +10 V                            |

Note: See inside back cover for complete ordering information.

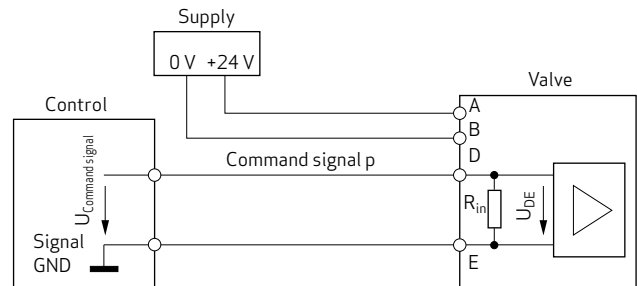
### Command Signal Current Floating, Ordering Code X or E

The spool position is proportional to  $I_D = -I_E$ . For a command signal  $I_D = 20$  mA (code E) or +10 mA (code X) the spool moves to 100 % P  $\rightarrow$  A and B  $\rightarrow$  T. For a command signal  $I_D = 12$  mA (code E) or 0 mA (code X) the spool is in the defined center position.



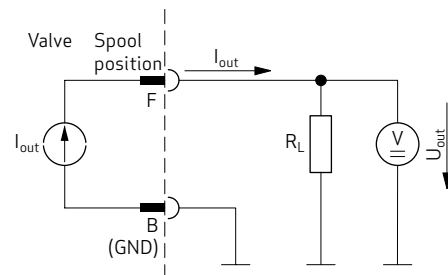
### Command Signal Voltage Floating, Ordering Code D or M

The spool position is proportional to  $U_D - U_E$ . For a command signal  $U_D - U_E = +10$  V the spool moves to 100 % P  $\rightarrow$  A and B  $\rightarrow$  T. For a command signal  $U_D - U_E = 0$  V the spool is in the defined center position.



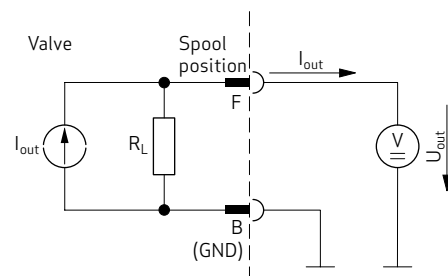
### Actual Value 4 to 20 mA, Ordering Code M, X or E

The signal can be used for monitoring and fault detection purposes. The spool position is proportional to  $I_{out}$ . The spool position corresponds to 4 to 20 mA. At 12 mA the spool is in center position. 20 mA corresponds to 100 % valve opening P  $\rightarrow$  A and B  $\rightarrow$  T. A cable fault is detected by  $I_{out} = 0$  mA. Optional use: Actual value  $U_{out} = 2$  to 10 V with resistor  $R_L = 500 \Omega$  (0.25 W) provided by customer.



### Actual Value 2 to 10 V, Ordering Code D

The signal can be used for monitoring and fault detection purposes. The spool position is proportional to  $U_{out}$ . The spool position corresponds to 2 to 10 V. At 6 V the spool is in center position. 10 V corresponds to 100 % valve opening P  $\rightarrow$  A and B  $\rightarrow$  T. A cable fault is detected by  $U_{out} = 0$  V.  $R_L = 500 \Omega$  (0.25 W).



Note: For more information see Technical Notes TN 353 „Protective Grounding and Electrical Shielding of Valves“ and TN 494 „Maximum Permissible Length of Electric Cables for Valves with Integrated Electronics“. Visit [www.moog.com/industrial/literature](http://www.moog.com/industrial/literature) to download document.

## FLOW CALCULATION

When the valve is open, the prevailing flow is dependent not only on the spool position, (i.e. the opening cross section of the valve), but also on the pressure drop at the individual lands. When the valve is deflected at 100 %, it delivers the rated flow with the rated pressure drop.

The rated flow of a servo valve corresponds to a pressure drop of 35 bar (500 psi) per land, equating to 70 bar (1,000 psi) for two lands. When a valve is opened at 100 %, the flow can be calculated as a function of the actual pressure drop with the aid of the formula below or taken from the diagram.

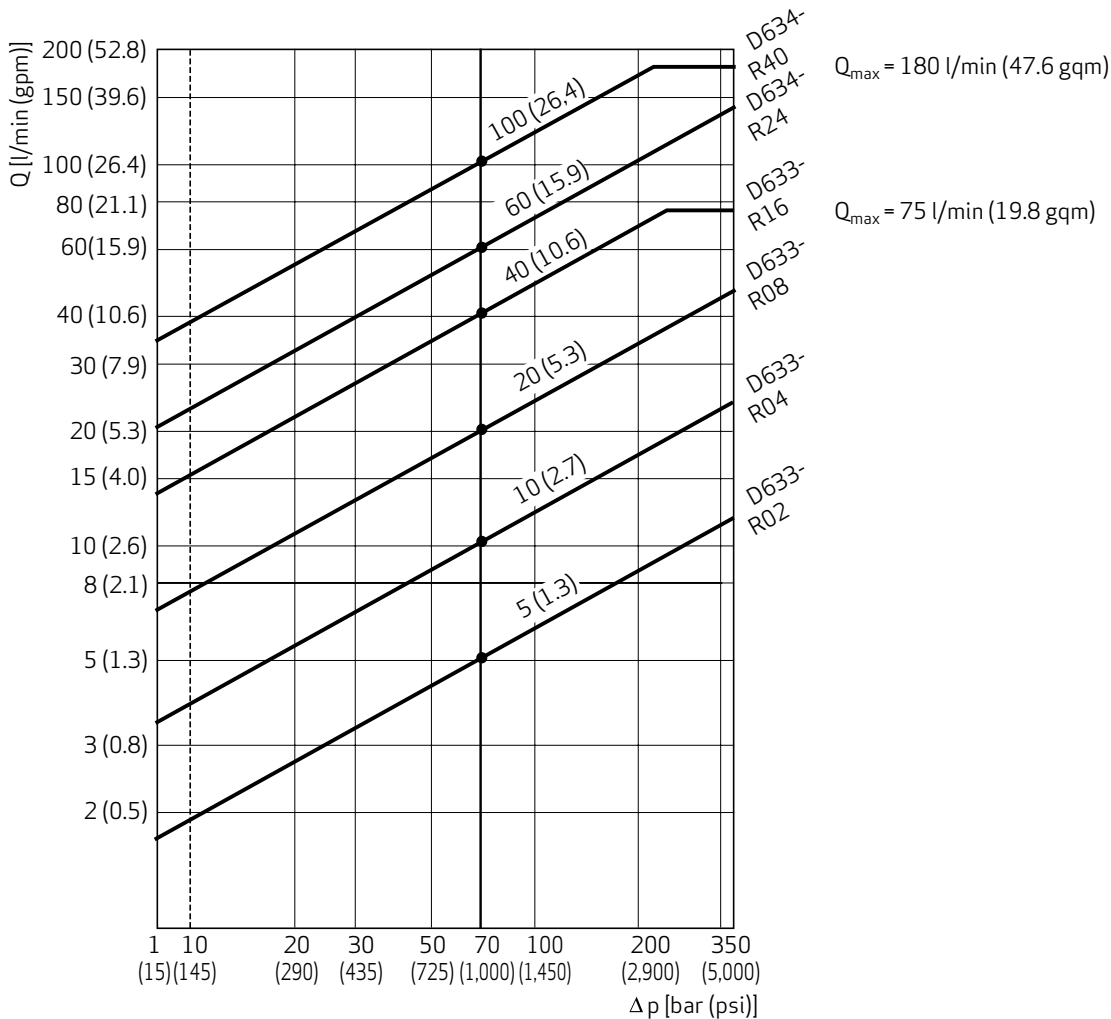
$$Q = Q_N \cdot \sqrt{\frac{\Delta p}{\Delta p_N}}$$

Q [l/min (gpm)]      actual flow  
 Q<sub>N</sub> [l/min (gpm)]      rated flow  
 Δp [bar (psi)]      actual pressure drop per spool land  
 Δp<sub>N</sub> [bar (psi)]      rated pressure drop per spool land

The actual flow in the valve ports must not exceed a mean flow velocity of approximately 30 m/s (96.5 ft/s) due to the risk of cavitation. When operating the valves close to these application limits, it is necessary to drill the ports to the maximum possible diameters (see specifications for the respective valve).

For ISO 4401 size 05 mounting surfaces the second tank port must additionally be connected starting from a flow Q exceeding 60 l/min (15.9 gpm).

### Flow Diagram



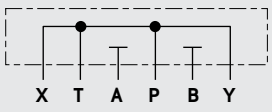
## ACCESSORIES AND SPARE PARTS

### Series-specific

#### Spare Parts Size 03 - D633

| Part designation    | Description   | Material      | Part number    |
|---------------------|---|---------------|----------------|
| Service sealing set | Contains the following O-rings: <ul style="list-style-type: none"> <li>4 pieces for P, T, A, B inner <math>\varnothing</math> 9.25 mm (0.36 in) x <math>\varnothing</math> 1.8 mm (0.07 in)</li> <li>1 piece for Y inner <math>\varnothing</math> 7.65 mm (0.3 in) x <math>\varnothing</math> 1.8 mm (0.07 in)</li> </ul> | FKM 90 Shore  | B97215-V630F63 |
|                     |   | HNBR 90 Shore | B97215-H630F63 |

#### Accessories Size 03 - D633

| Part designation | Description   | Image  | Part number |
|------------------|---|--|-------------|
| Flushing plate   | P, A, B, T, X, Y  |  | B46634-002  |
| Shipping plate   | 1 piece   |  | B46035-001  |
| Mounting screws  | 4 pieces M5x55, ISO 4762-10.9, tightening torque 6.8 Nm (60 lbf in) |  |             |

#### Documents

#### Size 03 - D633

| Part designation | Description  | Image | Part number         |
|------------------|--|-------|---------------------|
| ATEX manual      | Operating Instructions for Proportional Valves D633D Series ISO 4401 Size 03 for category 2D |       | B97264-002 (German) |
| ATEX manual      | Operating Instructions for Proportional Valves D633D Series ISO 4401 Size 03 for category 3D |       | B97256-002 (German) |

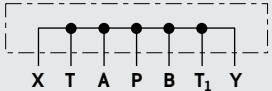
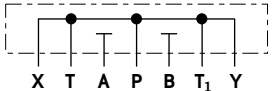

## ACCESSORIES AND SPARE PARTS

### Series-specific

#### Spare Parts Size 05 - D634

| Part designation    | Description   | Material      | Part number    |
|---------------------|---|---------------|----------------|
| Service sealing set | Contains the following O-rings: <ul style="list-style-type: none"> <li>• 5 pieces for P, T, T<sub>1</sub>, A, B<br/>inner Ø 12.4 mm (0.49 in) x Ø 1.8 mm (0.07 in)</li> <li>• 2 pieces for X, Y<br/>inner Ø 15.6 mm (0.61 in) x Ø 1.8 mm (0.07 in)</li> <li>• 1 piece for filter<br/>inner Ø 12.0 mm (0.47 in) x Ø 2.0 mm (0.08 in)</li> <li>• 1 piece for filter cover<br/>inner Ø 17.1 mm (0.67 in) x Ø 2.6 mm (0.10 in)</li> </ul> | FKM 90 Shore  | B97215-V681-10 |
|                     |   | HNBR 90 Shore | B97215-H681-10 |

#### Accessories Size 05 - D634

| Part designation | Description  | Image  | Part number |
|------------------|--|--|-------------|
| Flushing plate   | P, A, B, T, T <sub>1</sub> , X, Y                                  |  | B67728-001  |
| Flushing plate   | P, A, B, T, T <sub>1</sub> , X, Y                                  |  | B67728-002  |
| Flushing plate   | P, A, B, T, T <sub>1</sub> , X, Y                                  |  | B67728-003  |
| Shipping plate   | 1 piece  |  | A40503      |
| Mounting screws  | 4 pieces M6x60, ISO 4762-10.9, tightening torque 11 Nm (97 lbf in) |  |             |

# ACCESSORIES AND SPARE PARTS

## Series-independent

### Accessories Size 04 - D633 and Size 05 - D634

| Part designation                                 | Description   | Image | Part number    |
|--|---|-------|----------------|
| Cable with straight mating connector 6-pole + PE | 5, 10, 20 or 25 m, e.g. for 5 m specify 005, other length upon request  |       | C21033-xxx-001 |
| Mating connector, elbow 6-pole + PE              | In accordance with EN 175201-804, type S, metal, IP65, cable Ø 8 to 12 mm (0.31 to 0.47 in)   |       | B97069-061     |
| Mating connector, straight 6-pole + PE           | In accordance with EN 175201-804, type R, metal, IP65, crimp contact Ø 0.75 to 1.5 mm <sup>2</sup> (0.0012 to 0.0023 in <sup>2</sup> ), conus Ø 12.2 mm (0.48 in), cable Ø 9 to 12 mm (0.35 to 0.47 in), sealing element Ø 9 to 13 mm (0.35 to 0.51 in) |       | B97007-061     |
| Mains power connection                           | Power supply cable, length 2 m (6.4 ft)   |       | B95924-002     |
| Mains power connection                           | SELV power pack 24 V <sub>DC</sub> 10 A   |       | D137-003-001   |

## ACCESORIES AND SPARE PARTS

### Series-specific

#### Documents Size 04 - D633 and Size 05 - D634

| Part designation      | Description  | Part number |
|-----------------------|--|-------------|
| ATEX and IECEx manual | Operating Instructions for Proportional Valves D633K, D634K and D635K Series ISO 4401 Size 03 and 05 | CA49304-200 |
| Technical note TN 353 | Protective Grounding and Electrical Shielding of Hydraulic Valves with Integrated Electronics        | CA58437     |
| Technical note TN 494 | Maximum Permissible Length of Electric Cables for Valves with Integrated Electronics                 | CA48851     |

## MOOG GLOBAL SUPPORT

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# ORDERING CODE

## Model number (assigned at the factory)

D 63 - [ ] [ ] [ ] [ ] [ ]

| Size |         |
|------|---------|
| 3    | Size 03 |
| 4    | Size 05 |

| Specification status |   |
|----------------------|---|
| -                    | Series specification                          |
| E                    | Preseries specification                       |
| K                    | Explosion proof version for gas upon request  |
| D                    | Explosion proof version for dust upon request |
| Z                    | Special specification                         |

**Model designation**  
(assigned at the factory)

**Factory identification**

| 1 Valve type |                   |
|--------------|-------------------|
| R            | Standard response |

| 2 Rated flow per spool land [l/min (gpm)] |        |                                     |                                   |
|---|--------|-------------------------------------|-----------------------------------|
|   | Series | For $\Delta p_N = 35$ bar (500 psi) | For $\Delta p_N = 5$ bar per land |
| 02  | D633   | 5 (1.3)                             | 2                                 |
| 04  | D633   | 10 (2.6)                            | 4                                 |
| 08  | D633   | 20 (5.3)                            | 8                                 |
| 16  | D633   | 40 (10.6)                           | 16                                |
| 24  | D634   | 60 (15.8)                           | 24                                |
| 40  | D634   | 100 (26.3)                          | 40                                |

| 3 Pressure range [bar (psi)] |     |         |
|------------------------------|-----|---------|
| Maximum operating pressure   |     |         |
| K                            | 350 | (5,000) |

| 4 Bushing/spool design |  |
|------------------------|--|
| O                      | 4-way: axis cut, linear characteristic           |
| A                      | 4-way: 1.5 to 3 % overlap, linear characteristic |
| D                      | 2x2-way: 10 % overlap, linear characteristic     |
| Z                      | 2x2-way: P→A, B→T, with Y-port only              |
| X                      | Special spool on request                         |

## Type designation

1 2 3 4 5 6 7 8 9 10 11  
R [ ] [ ] K [ ] [ ] [ ] [ ] [ ] S [ ] 2

| 11 Supply voltage |   |
|-------------------|---|
| 2                 | 24 V <sub>DC</sub> , for more information, see section on "Electronics" |

| 10 Signals for position control <sup>1)</sup> |                  |   |
|---|------------------|---|
|   | Command signal   | Actual valve                                |
| M   | ±10 V            | 4 to 20 mA                                  |
| X   | ±10 mA, floating | 4 to 20 mA deadband compensation on request |
| E   | 4 to 20 mA       | 4 to 20 mA                                  |
| D   | ±10 V            | 2 to 10 mA                                  |

| 9 Valve connector |                         |
|-------------------|-------------------------|
| S                 | 6+PE pole EN 175201-804 |

| 8 Seal material |                                  |
|-----------------|----------------------------------|
| N               | NBR (Buna)                       |
| V               | FKM                              |
|                 | Other seal material upon request |

| 7 Y-port |   |
|----------|---|
| 0        | Closed with screw plug p <sub>Tmax</sub> = 50 bar (725 psi) |
| 3        | Open, with filter insert p <sub>T</sub> > 50 bar (725 psi)  |

| 6 Spool position without electrical signal |  |
|--|--|
| M  | Center position                              |
| F  | P→A, B→T connected (approximately 10 % open) |
| D  | P→A, B→T connected (approximately 10 % open) |
|  | Other openings on request                    |

| 5 Series |      | Linear motor |
|----------|------|--------------|
| 1        | D633 | Standard     |
| 2        | D634 | Standard     |

<sup>1)</sup> Input voltage limited, see section "ELECTRONICS"

## MORE PRODUCTS. MORE SUPPORT.

Moog designs a range of motion control products to complement those featured in this document. Moog also provides service and support for all of our products. For more information, contact the Moog facility closest to you.

Australia  
+61 3 9561 6044  
Service + 61 3 8545 2140  
info.australia@moog.com  
service.australia@moog.com

Brazil  
+55 11 3572 0400  
info.brazil@moog.com  
service.brazil@moog.com

Canada  
+1 716 652 2000  
info.canada@moog.com

China  
+86 21 2893 1600  
Service +86 21 2893 1626  
info.china@moog.com  
service.china@moog.com

France  
+33 1 4560 7000  
Service +33 1 4560 7015  
info.france@moog.com  
service.france@moog.com

Germany  
+49 7031 622 0  
Service +49 7031 622 197  
info.germany@moog.com  
service.germany@moog.com

Hong Kong  
+852 2 635 3200  
info.hongkong@moog.com

India  
+91 80 4057 6666  
Service +91 80 4057 6604  
info.india@moog.com  
service.india@moog.com

Ireland  
+353 21 451 9000  
info.ireland@moog.com

Italy  
+39 0332 421 111  
Service 800 815 692  
info.italy@moog.com  
service.italy@moog.com

Japan  
+81 46 355 3767  
info.japan@moog.com  
service.japan@moog.com

Korea  
+82 31 764 6711  
info.korea@moog.com  
service.korea@moog.com

Luxembourg  
+352 40 46 401  
info.luxembourg@moog.com

The Netherlands  
+31 252 462 000  
info.thenetherlands@moog.com  
service.netherlands@moog.com

Russia  
+7 831 713 1811  
Service +7 831 764 5540  
info.russia@moog.com  
service.russia@moog.com

Singapore  
+65 677 36238  
Service +65 651 37889  
info.singapore@moog.com  
service.singapore@moog.com

South Africa  
+27 12 653 6768  
info.southafrica@moog.com

Spain  
+34 902 133 240  
info.spain@moog.com

Sweden  
+46 31 680 060  
info.sweden@moog.com

Turkey  
+90 216 663 6020  
info.turkey@moog.com

United Kingdom  
+44 (0) 1684 858000  
Service +44 (0) 1684 278369  
info.uk@moog.com  
service.uk@moog.com

USA  
+1 716 652 2000  
info.usa@moog.com  
service.usa@moog.com

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