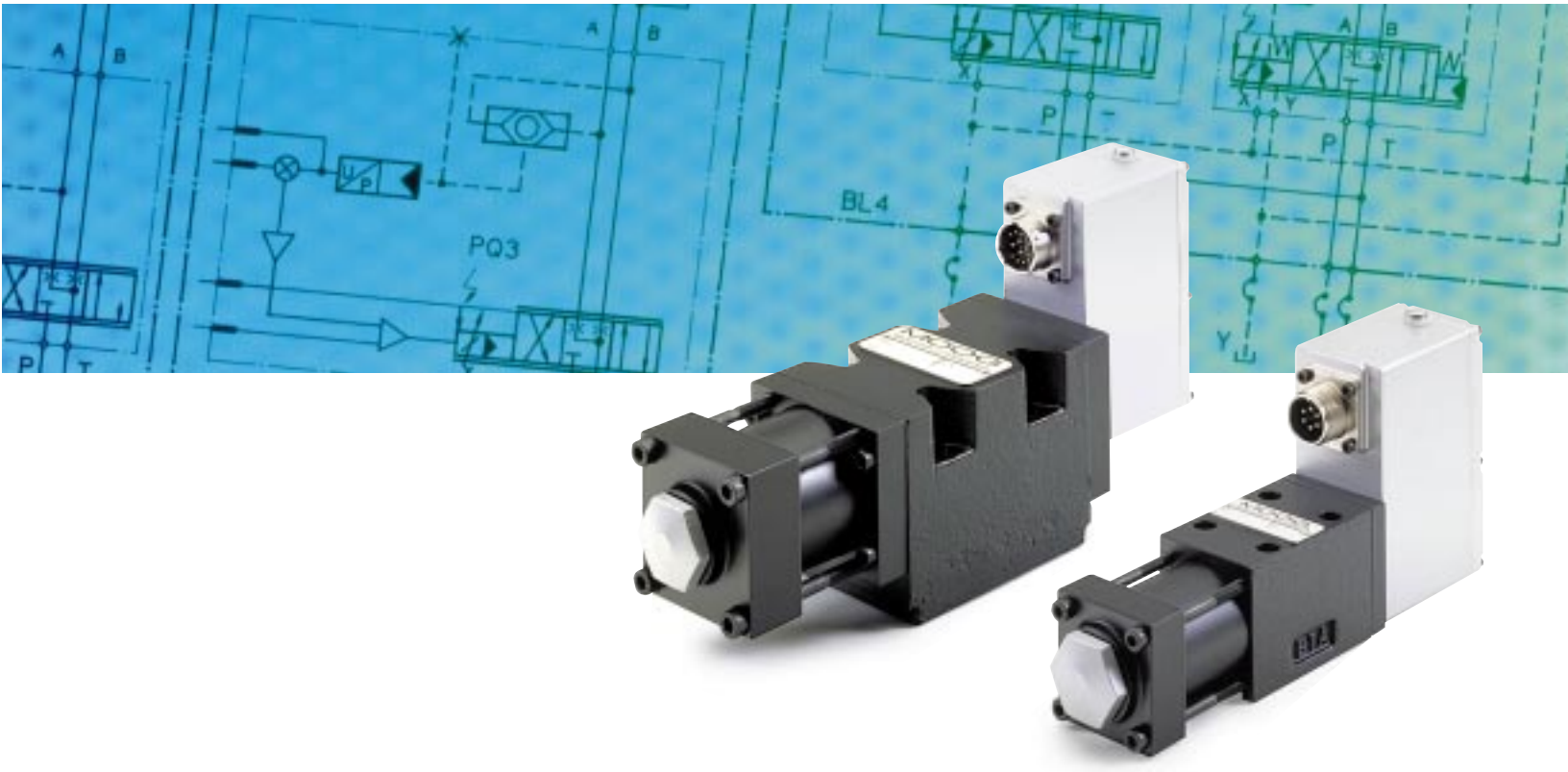
MOOG

D633, D634 Direct Drive Servo-Proportional Control Valves

Rated Flows to 11 and 26 gpm
System Pressure to 5,000 psi
NFPA D03/D05 (ISO 4401 Size 03/05)

DDV
Direct Drive Valve



MOOG DIRECT DRIVE VALVE FEATURES

- **Low leakage.** No pilot stage oil flow. Elimination of the pilot stage internal leakage saves energy, especially in applications requiring multiple valves.
- **High spool driving forces.** High force output permanent magnet linear force motor that offers twice the driving force of solenoids and insures consistent long term operational performance.
- **High dynamics.** Improved dynamics are independent of system pressure and result from the high natural frequency (250 Hz) of the linear force motor.
- **Low hysteresis** and high resolution result in excellent system repeatability.
- **With loss of supply voltage,** or broken cable, or emergency stop, the spool returns to its spring centered position without passing a load move position.

D633, D634 DIRECT DRIVE SERVO-PROPORTIONAL VALVES

The Moog D633 and D634 Direct Drive Valves (DDV) are closed loop servo-proportional valves with integral electronic spool position feedback.

A permanent magnet linear force motor directly drives the spring centered spool in both directions. This is an advantage compared to proportional solenoids with one force direction only. The closed loop spool position electronics and pulse width modulated (PWM) drive electronics are integrated into the valve.

An integral closed loop, using electronic spool position feedback and a high output linear force motor, provides excellent valve resolution resulting in superior system performance.

An electronic circuit board containing the pulse width modulated (PWM) circuitry used to drive the linear force motor and spool position electronics is mounted in an IP65 housing on the valve body.

The D633 and D634 DDV integrated electronics provide a simple interface between the servo-proportional valve and the customer's system computer.

If electrical power is lost, the spring centered spool will center the spool without passing a load movement.

NOTES

1. The valves are throttling devices and control flow. With changing pressure drop across the metering spool lands (due to changes of fluid viscosity, system pressure, load pressure, etc.), the valve flow will change while the spool position signal remains unchanged.
2. Before installation of the valve into the system, the complete hydraulic system should be flushed.
3. Please also read the notes in the section entitled "Electronics" on page 6.

- **Superior control.** Direct drive valves have high internal spool position loop gain. The high loop gain provides excellent static and dynamic response, resulting in superior control and system performance.
- **Ability to measure spool position.** The DDV output signal, proportional to actual spool position, can lead to improved preventative maintenance and system performance information.
- **Center position failsafe.** The DDV is a spring-centered design which eliminates the "flow transients" associated with single solenoid designs.
- **IP65 protection.**
- **Low power consumption.** Linear force motors consume less current than solenoids. The DDV also consumes little to no current at null.
- **Electric null adjust** to compensate for load drift.

Our Quality Management System is certified in accordance with DIN EN ISO 9001.

DIN ISO 9001 certified

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

DIRECT DRIVE VALVE OPERATION

An electrical signal corresponding to the desired spool position is applied to the integrated electronics and produces a pulse width modulated (PWM) current in the linear force motor coil. The resulting force causes the spool to move. An oscillator excites the spool position transducer (LVDT) producing an electrical signal proportional to spool position.

The demodulated spool position signal is compared with the command signal, and the resulting spool position error causes current in the force motor coil. The spool moves to its commanded position and the spool position error is reduced to zero. The resulting spool position is thus proportional to the command signal.

VALVE FLOW AND PRESSURE DROP

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

At 100% command signal (i.e. +10 VDC = 100% valve opening), the valve flow at rated pressure drop (Δp_N = 500 psi per metering land) is the rated flow Q_N. For other than rated pressure drop, the valve flow changes according to the square root function for sharp edged orifices.

The valve flow Q calculated in this way should result in an average flow velocity in ports P, A, B or T of less than 100 ft/s.

Function for sharp edged orifice (metering land):

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

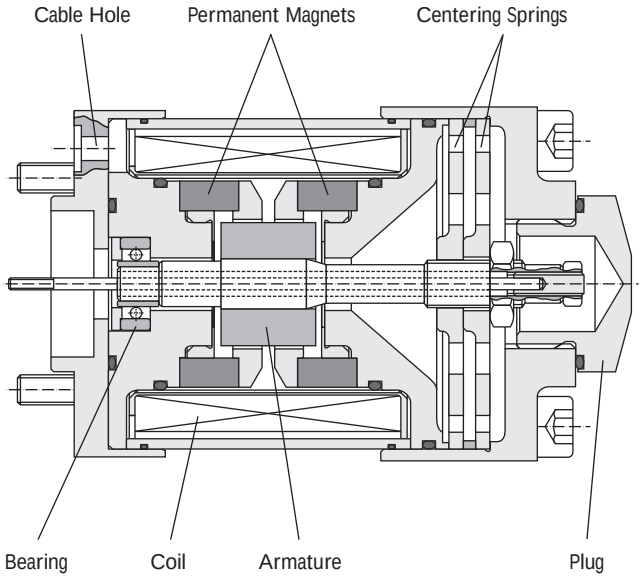
Q [gpm] = Calculated Flow
Q_N [gpm] = Rated Flow
Δp [psi] = Actual Valve Pressure Drop
Δp_N [psi] = Rated Valve Pressure Drop

PERMANENT MAGNET LINEAR FORCE MOTOR OPERATION

The linear force motor is a permanent magnet differential motor. The permanent magnets provide part of the required magnetic force. For the linear force motor, the current needed is considerably lower than would be required for a comparable proportional solenoid. The linear force motor has a neutral mid-position from which it generates force and stroke in both directions. Force and stroke are proportional to current.

High spring stiffness and the resulting centering force, plus external forces (i.e. flow forces, friction forces due to contamination), must be overcome during outstroking. During backstroking to center position, the spring force adds to the motor force and provides additional spool driving force making the valve less contamination sensitive. The linear force motor requires very low current in the spring centered position.

Proportional solenoid systems require two solenoids for the same function. This increases installation cost while decreasing valve dynamics. Another solution uses a single solenoid working against a spring. In case of current loss in the solenoid, the spring drives the spool to the end position by passing through a fully open position. This can lead to uncontrolled load movements.



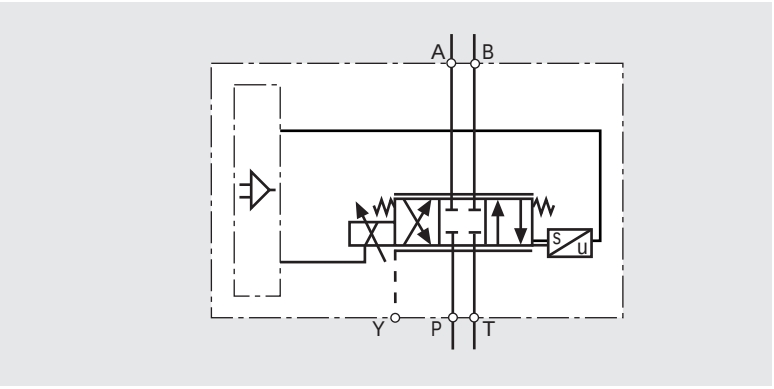
D633, D634 SERIES
HYDRAULIC SYMBOL / SECTIONAL VIEW

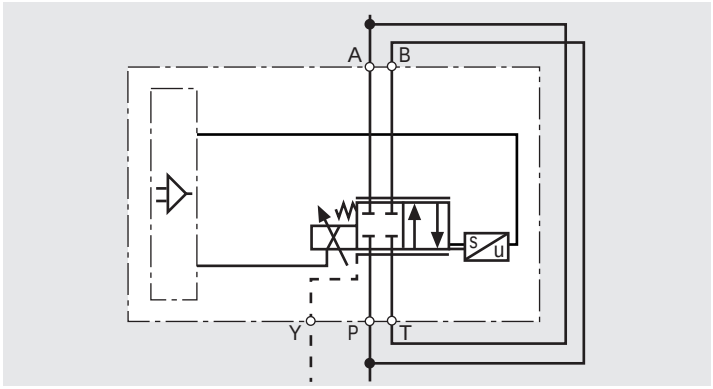
4-WAY FUNCTION

- Flow control (throttle valve) in port A and port B
- Port Y required if pressure p_T > 715 psi in port T
- For 3-way function, close port A or port B of the manifold
- Spools with exact axis cut, 1.5% to 3%, or 10% overlap are available

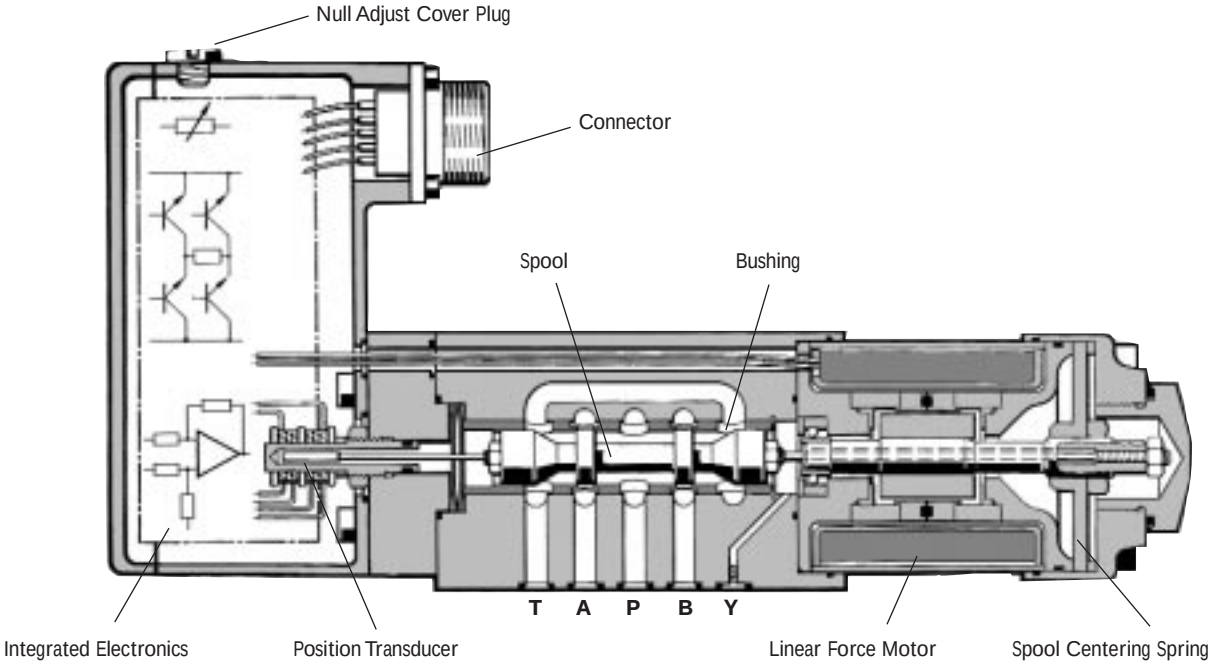
2X2-WAY FUNCTION

- Flow control (throttle valve) in port A
- Port Y required
- Connect externally port P with port B, and port A with port T





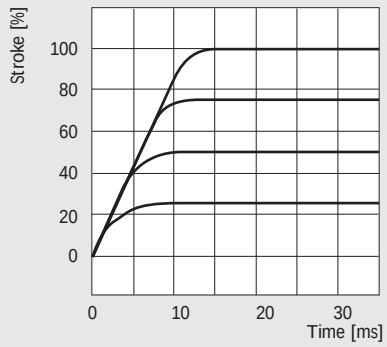
SECTIONAL VIEW OF DDV



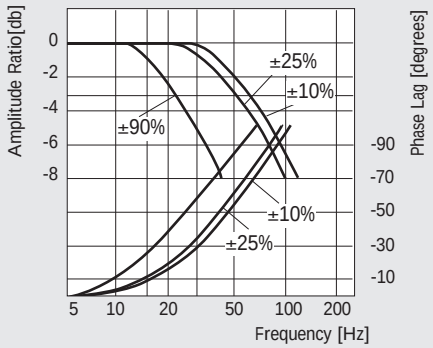
D633, D634 SERIES

TYPICAL CHARACTERISTIC CURVES

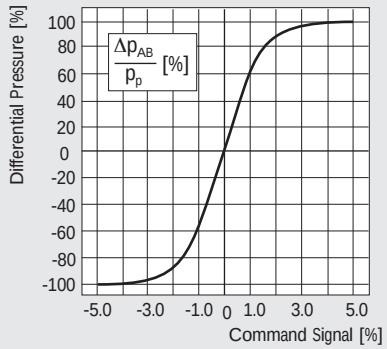
Step Response D633 Series



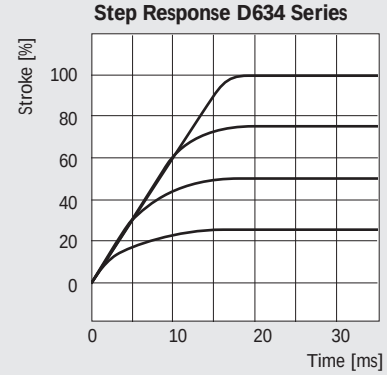
Frequency Response D633 Series



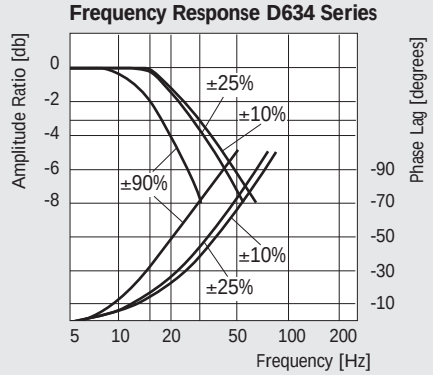
Pressure Gain D633 Series



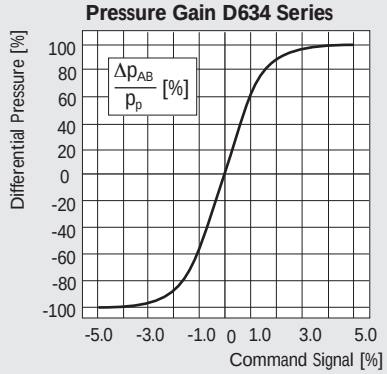
Step Response D634 Series



Frequency Response D634 Series

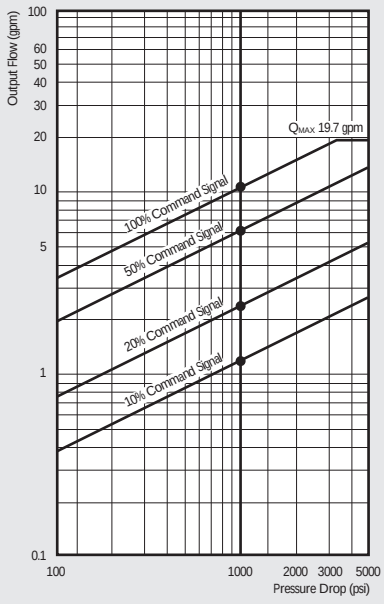


Pressure Gain D634 Series

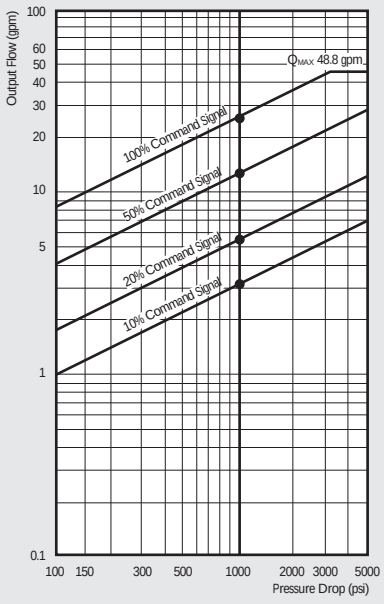


All curves measured at p_S = 2000 psi and a fluid viscosity of v = .05 in²

Valve Flow Diagram D633 Series



Valve Flow Diagram D634 Series



NOTES

1. Supply voltage U_A = +24 VDC (22 to 28 VDC).
   Current consumption I_{Amax} = 1.2 A for D633 and
   I_{Amax} = 2.2 A for D634.
   External fuse per valve D633 1.6 A (slow)
   D634 2.5 A (slow)

2. Input signal (command signal)

   2.1 Voltage command 0…±10 V
   The spool stroke of the valve is proportional to (U_D-U_E).
   100% valve opening P ◗ A and B ◗ T with (U_D-U_E) = +10 VDC.
   With single ended signals either pin D or E, depending on the desired flow phasing, is connected to reference voltage level (usually ground ⊥).

   2.2 Current command 0…±10 mA
   The spool stroke of the valve is proportional to (I_D - I_E).
   100% valve opening P ◗ A and B ◗ T with (I_D - I_E) = +10 mA.
   Either pin D or E is used according to the desired flow phasing. The unused pin is left open.

   2.3 Current command +4…+20 mA
   The spool stroke of the valve is proportional to (I_D - 12 mA).
   100% valve opening P ◗ A and B ◗ T with I_D = +20 mA.
   100% valve opening P ◗ B and A ◗ T with I_D = +4 mA.
   Use pin D as signal input. Pin E is left open.

3. Measuring output (actual spool position)
   For the actual spool position signal I_F is available (+4 ... +20 mA).
   100% valve opening P ◗ A and B ◗ T with +20 mA.
   100% valve opening P ◗ B and A ◗ T with +4 mA.

4. All signal lines (also those of external transducers) should be twisted pairs and shielded. Shielding connected radially to ⊥ (0 V), power supply side, and connected to the mating connector housing (EMC).

5. **EMC**: Meets the requirements of EN 55011/3.91 class B, EN 50081-1/01.92, and EN 50082-2/03.95, performance criterion class A.

6. Protective grounding lead ≈ 0.001 in²

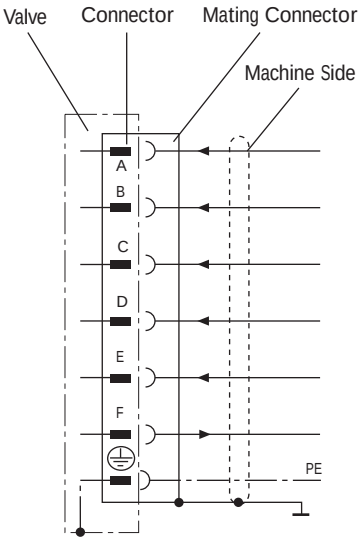
7. When making electrical connections to the valve (shield, protective grounding), appropriate measures must be taken to ensure that locally different earth potentials do not result in excessive ground currents. See Moog Application Note AM 353E.

8. Valves available with explosion protection to EN 50018, class EEx d IIB+H2 T4 and EEx d I. Installation dimensions and connector changed. Special data sheet on request.

All subscripts indicate the corresponding pin.

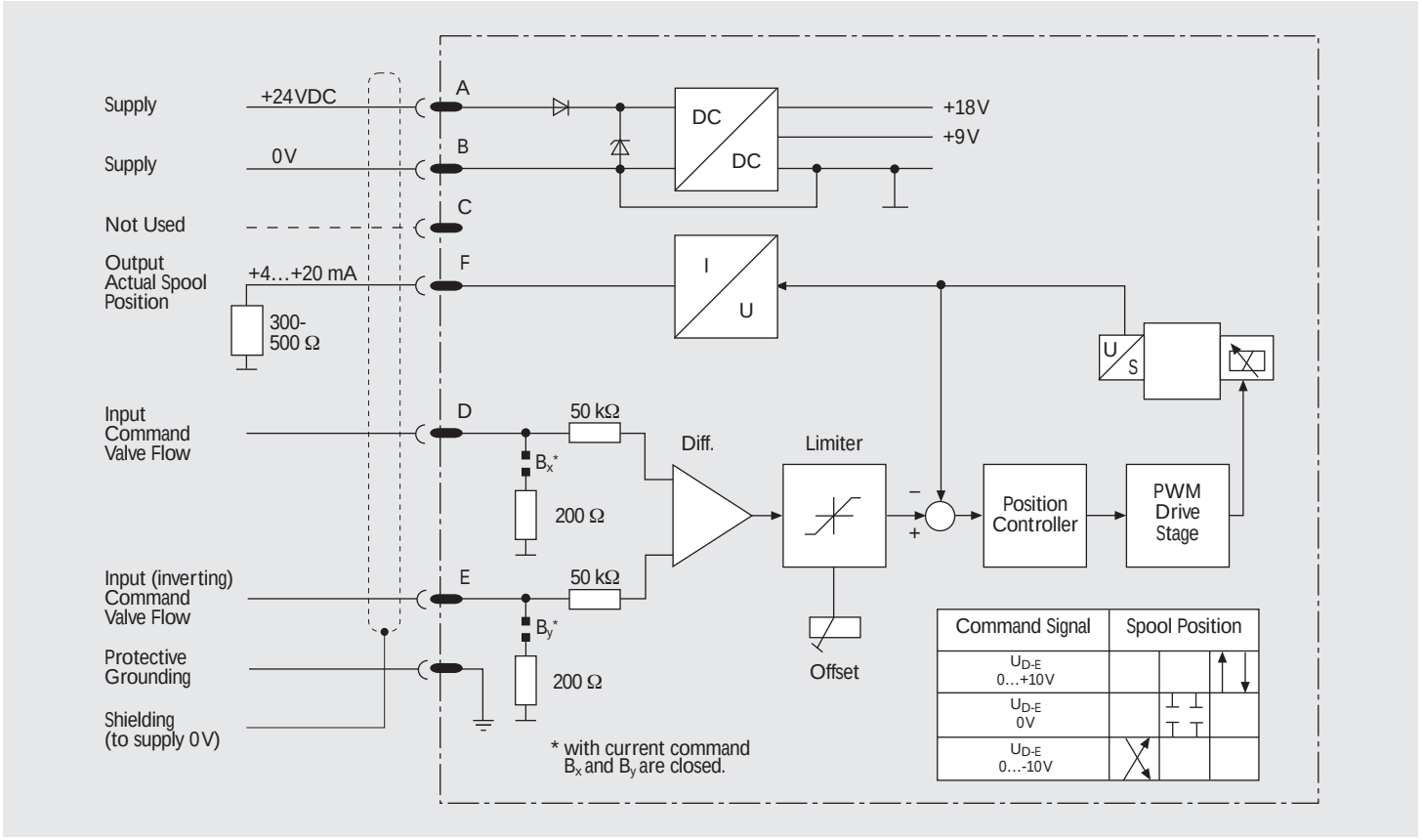
CONNECTOR WIRING

Valve with 6+PE pole connector to DIN 43563 and mating connector (metal shell) with advancing protective grounding connection (⏚). Thread 7/8-20 UNF 2A.



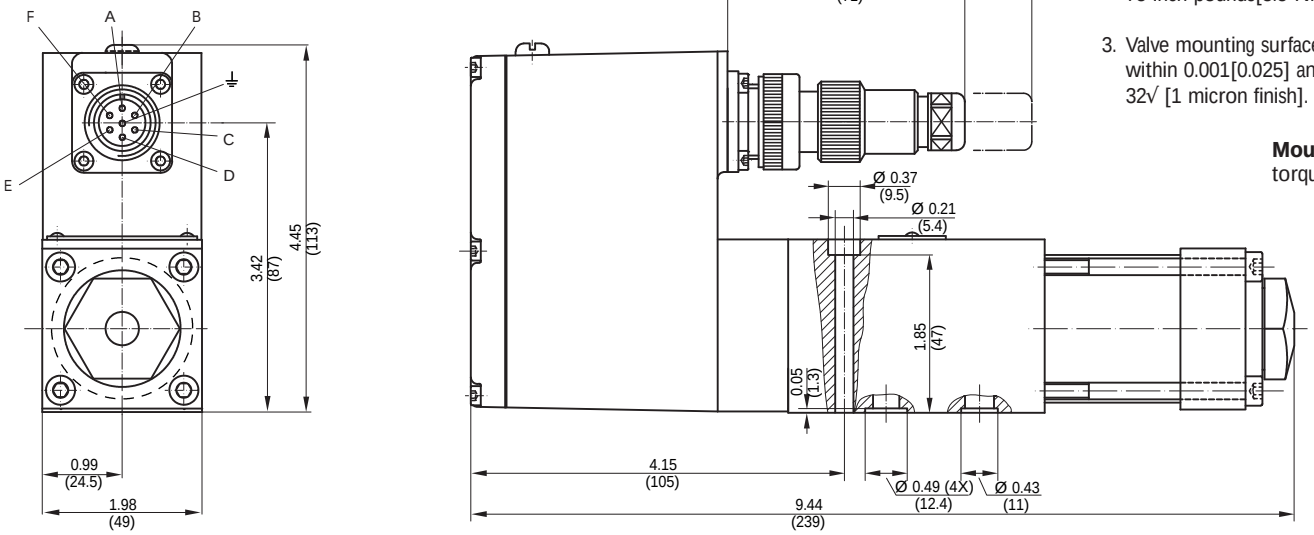
Function	Voltage Command 0 ... ±10 VDC	Current Command 0 ... ±10 mA	Current Command + 4 ... +20 mA
Supply	+24 VDC (22 to 28 VDC)		
Supply / Signal Ground	⊥ (0 V)		
Not Used			
Input Command Valve Flow	0...±10 VDC Input Resistance = 50 kΩ	0...±10 mA Load Resistance = 200 Ω	+4...+20 mA Load Resistance = 200 Ω
Input Inverted Command Valve Flow	0...±10 VDC Input Resistance = 50 kΩ	0...±10 mA Load Resistance = 200 Ω	Not Used
Output Actual Spool Position	+4...+20 mA Load Resistance 300 to 500 Ω with respect to ⊥ (0V)		
Protective Grounding			

BLOCK DIAGRAM



D633, D634 SERIES
DIMENSIONS

D633 SERIES

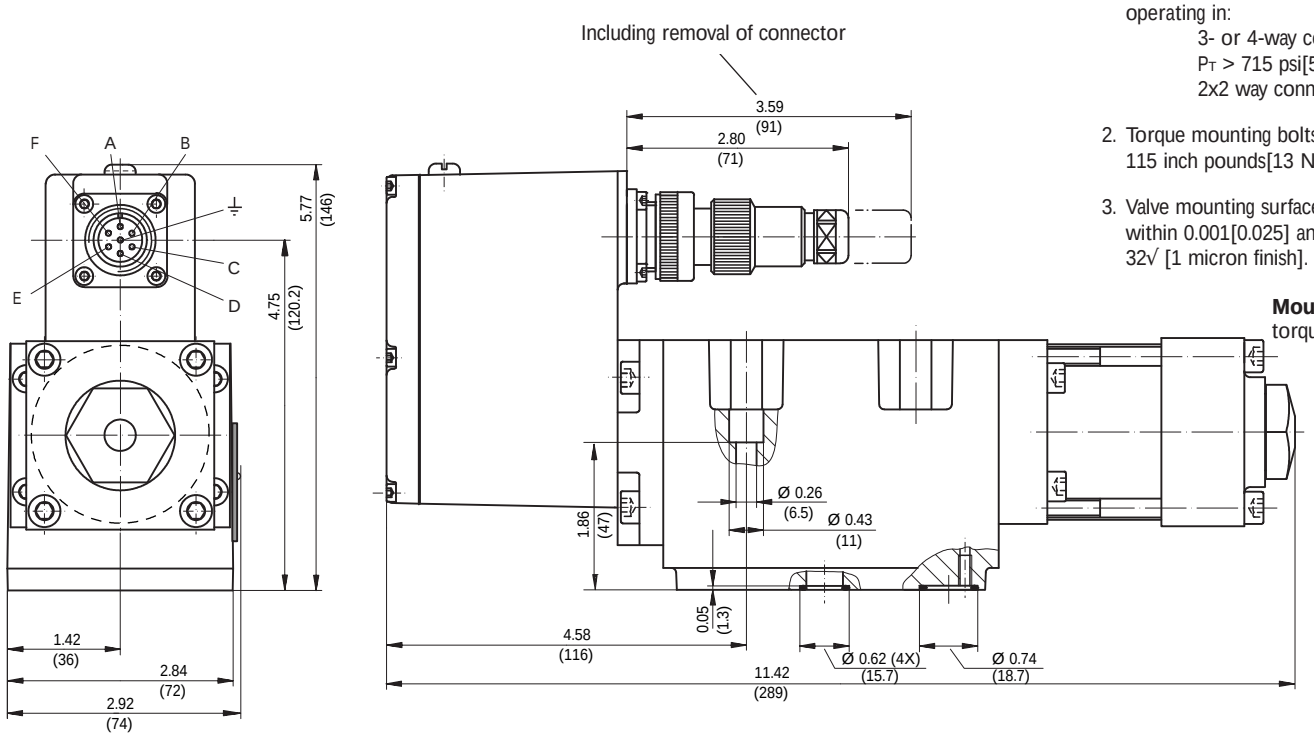


NOTES:

1. Manifold to ISO 4401-03-03-0-94. Port Y must be used if valve is operating in:
   3- or 4-way connection and P_T > 715 psi[50 bar] or:
   2x2 way connection.
2. Torque mounting bolts to 75 inch pounds[8.5 Nm].
3. Valve mounting surface must be flat within 0.001[0.025] and requires a 32√ [1 micron finish].

Mounting bolts
torque to 8.5 Nm

D634 SERIES



NOTES:

1. Manifold to ISO 4401-05-05-0-94. Port Y must be used if valve is operating in:
   3- or 4-way connection and P_T > 715 psi[50 bar] or:
   2x2 way connection.
2. Torque mounting bolts to 115 inch pounds[13 Nm].
3. Valve mounting surface must be flat within 0.001[0.025] and requires a 32√ [1 micron finish].

Mounting bolts
torque to 13 Nm

MOUNTING PATTERN / ACCESSORIES

MOUNTING PATTERN D633
ISO 4401 - 03 - 03 - 0 - 94

METRIC	P	A	B	T	X[1]	Y	F1	F2	F3	F4	G
	Ø7.5	Ø7.5	Ø7.5	Ø7.5		Ø3.3	M5	M5	M5	M5	4
x	21.5	12.7	30.2	21.5		40.5	0	40.5	40.5	0	33
y	25.9	15.5	15.5	5.1		9	0	-0.75	31.75	31	31.75

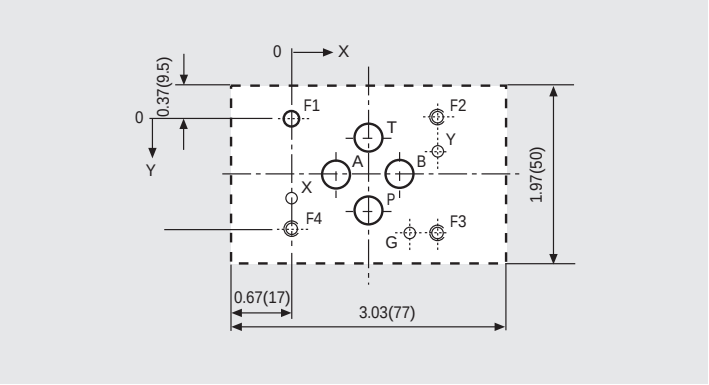
U.S.	P	A	B	T	X[1]	Y	F1	F2	F3	F4	G
	Ø0.30	Ø0.30	Ø0.30	Ø0.30		Ø0.13	M5	M5	M5	M5	0.16
x	0.85	0.50	1.19	0.85		1.60	0	1.60	1.60	0	1.30
y	1.02	0.61	0.61	0.20		0.35	0	-0.03	1.25	1.22	1.25

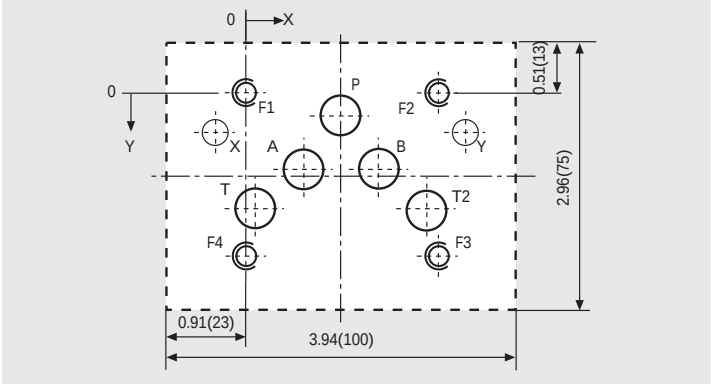
MOUNTING PATTERN D634
ISO 4401 - 05 - 05 - 0 - 94

METRIC	P	A	B	T	T2	X[1]	Y	F1	F2	F3	F4
	Ø11.2	Ø11.2	Ø11.2	Ø11.2	Ø11.2		Ø6.3	M6	M6	M6	M6
x	27	16.7	37.3	3.2	50.8		62	0	54	54	0
y	6.3	21.4	21.4	32.5	32.5		11	0	0	46	46

U.S.	P	A	B	T	T2	X[1]	Y	F1	F2	F3	F4
	Ø0.44	Ø0.44	Ø0.44	Ø0.44	Ø0.44		Ø0.25	M6	M6	M6	M6
x	1.06	0.66	1.47	0.13	2.00		2.44	0	2.13	2.13	0
y	0.25	0.84	0.84	1.28	1.28		0.43	0	0	1.81	1.81

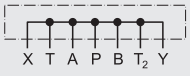
[1] Port X must not be drilled, not sealed in valve.





Mounting surface must be flat within .001(.025), average surface finish must be better than 32*v*

ACCESSORIES*

Moog Part #	Description	Dimensions / Notes	Qty.	D633	D634
B97007-061	Mating Connector, 6 + PE Pole	Protection IP65		X	X
A03665-050-060	Mounting Bolts	M5 x 60, DIN 912-10.9	4 pcs.	X	
A03665-060-060	Mounting Bolts	M6 x 60, DIN 912-10.9	4 pcs.		X
B46634-002	Flushing Plate			X	
B67728-001	Flushing Plate				X
B67728-002	Flushing Plate				X
B67728-003	Flushing Plate				X

*Accessories are not included at delivery

TECHNICAL DATA

Series			D633	D634
Mounting Pattern			ISO 4401 - 03 - 03 - 0 - 94 with or without leakage Port Y [4])	ISO 4401 - 05 - 05 - 0 - 94 with or without leakage port Y [4s])
Port Diameter	P, A, B and T	in[mm]	0.31[7.9]	0.45[11.5]
Valve Version [1])			single stage, spool type with bushing 3-, 4-, 2x2-way	Single stage, spool type with bushing 3-, 4-, 2x2-way
Spool Actuation			directly, with permanent magnet linear force motor	directly, with permanent magnet linear force motor
Pilot Supply			none	none
Mounting Direction			any	any
Vibration			30 g, 3 axes	30 g, 3 axes
Mass		1b[kg]	5.5[2.5]	13.9[6.3]
Rated Flow Q_N at Δp_N = 1,000 psi, tolerance ±10%		gpm[l/min]	1.3[5] / 2.6[10] / 5.3[20] / 10.6[40]	15.8[60] / 26.3[100]
Max. Valve Flow Q_{max} [3])		gpm[l/min]	19.8[75]	48.8[185]
Max. Operating Pressure p_{max}				
Ports P, A, B		psi[bar]	5,000[350]	5,000[350]
Port T without use of Port Y		psi[bar]	715[50]	715[50]
Port T with use of Port Y		psi[bar]	5,000[350]	5,000[350]
Port Y			directly to tank	directly to tank
Fluid Temperature Range		°F[°C]	-4 to +176[-20 to +80]	-4 to +176[-20 to +80]
Seal Material			NBR, FPM	NBR, FPM
Operating Fluid			mineral oil based hydraulic fluid to DIN 51524, others on request	mineral oil based hydraulic fluid to DIN 51524, others on request
Viscosity	recommended	sus[mm²/s]	70 to 210[15 to 45]	70 to 210[15 to 45]
	allowable	sus[mm²/s]	25 to 1,800[5 to 400]	25 to 1,800[5 to 400]
System Filter			high pressure filter, mounted in the main flow without bypass, but with dirt indicator	high pressure filter, mounted in the main flow without bypass, but with dirt indicator
Class of Cleanliness				
NAS 1638			6 or better [5])	6 or better [5])
ISO 4406			15 / 12 or better [5])	15 / 12 or better [5])
Filter Rating	for normal operation:		$b_{10} \geq 75$ (10 µm absolute)	$b_{10} \geq 75$ (10 µm absolute)
for longer life:			$b_6 \geq 75$ (6 µm absolute)	$b_6 \geq 75$ (6 µm absolute)
Step Response	0...100 % [2]) [3])	[ms]	≤ 12	≤ 20
Threshold [2])		[%]	< 0.1	< 0.1
Hysteresis [2])		[%]	< 0.2	< 0.2
Nullshift	with ΔT = 55 K	[%]	< 1.5	< 1.5
Null Leakage Flow Q_L	with axis cut [2])	gpm[l/min]	0.04[0.15] / 0.08[0.3] / 0.16[0.6] / 0.32[1.2]	0.26[1.2] / 0.43[2.0]

[1]) See symbols page 4

[2]) Measured at P_P = 2,000 psi and viscosity of v =.05 in²/s

[3]) See characteristics page 5

[4]) Leakage Port Y must be used
- ➢ with 3- and 4-way function and p_T > 715 psi
- ➢ with 2x2-way function

[5]) For long life wear protection of metering lands

ORDERING INFORMATION / SPARE PARTS

Model Number

D63 . . . . . .

Series	
3	Size 03
4	Size 05

Specification Status	
–	Series specification
E	Preseries specification
Z	Special specification

Model Designation	
	Assigned at the factory

Factory Identification

Type Designation

. . . . . .

Valve Version	
R	With integrated electronics

Rated Flow			
	Q_N[gpm] at Δp_N = 1,000 psi	Q_N[l/min] at Δp_N = 1,000 psi	series
02	1.3	5	D633
04	2.6	10	D633
08	5.3	20	D633
16	10.6	40	D633
24	15.8	60	D634
40	26.3	100	D634

Maximum Operating Pressure	
K	5,000 psi[350 bar]

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

Linear Force Motor		
1	Standard	D633
2	Standard	D634

Spool Position without Electrical Supply	
M	Mid-position
A	P ◗ B, A ◗ T (10% open, min.)
B	P ◗ A, B ◗ T (10% open, min.)
	Other openings on request

Y - Port		
0	Closed with plug	P_{Tmax} = 715 psi[50 bar]
1	Open, with filter insert	P_T > 715 psi[50 bar]

Seal Material	
N	NBR (Buna)
V	FPM (Viton)
	Other materials on request

Valve Connector		
S	6+PE pole	(7/8-20 UNF 2A) DIN 43563

Signals for 100% Spool Stroke		
	Command	Spool Position Output
M	0…±10 VDC	+4…+20 mA
P	0…±10 mA	+4…+20 mA
S	+4…+20 mA	+4…+20 mA
	Deadband compensation upon request	

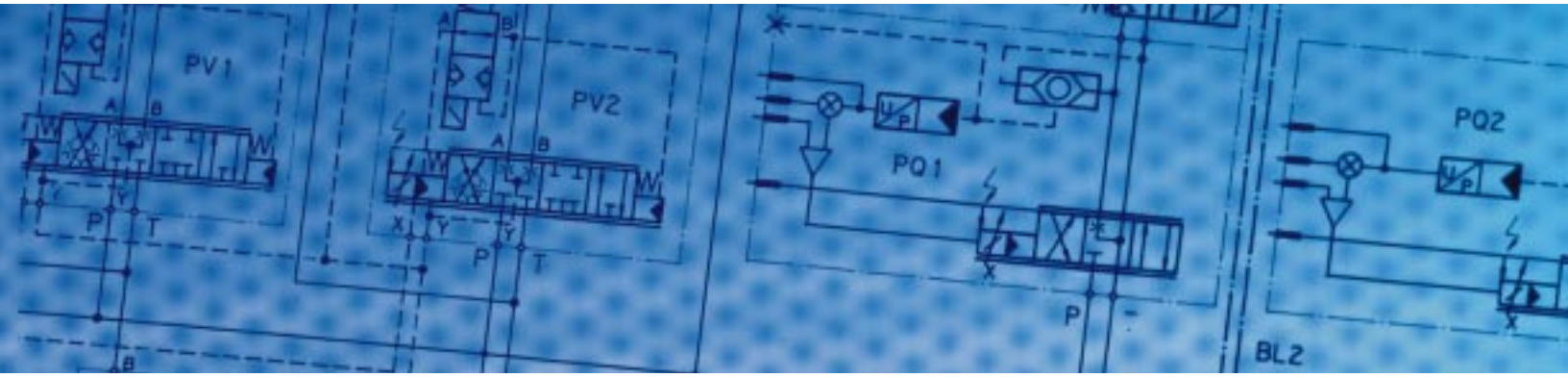
Supply Voltage	
2	+24 VDC (22 to 28 VDC)

Preferred configurations highlighted.
All combinations may not be available.
Options may increase price and delivery.
Technical changes are reserved.

SPARE PARTS

Moog Part #	Description	Dimensions	Material	Qty.	D633	D634
45122-013	O-Ring, ports P,T,A, B	ID 0.36 x ∅.07	NBR Sh 90	4 pcs.	X	
45122-012	O-Ring, port Y	ID 0.30 x ∅.07	NBR Sh 90	1 pc.	X	
42082-013	O-Ring, ports P,T,A, B	ID 0.36 x ∅.07	FPM Sh 90	4 pcs.	X	
42082-012	O-Ring, port Y	ID 0.30 x ∅.07	FPM Sh 90	1 pc.	X	
45122-004	O-Ring, ports P,T,A, B	ID 0.49 x ∅.07	NBR Sh 90	5 pcs.		X
45122-011	O-Ring, port X,Y	ID 0.61 x ∅.07	NBR Sh 90	2 pcs.		X
42082-004	O-Ring, ports P,T,A, B	ID 0.49 x ∅.07	FPM Sh 90	5 pcs.		X
42082-011	O-Ring, port X,Y	ID 0.61 x ∅.07	FPM Sh 90	2 pcs.		X

Australia	Mulgrave
Brazil	São Paulo
China	Shanghai
Denmark	Cöpenhagen
England	Tewkesbury
Finland	Espoo
France	Rungis



Germany	Böblingen
Hong Kong	Hong Kong
India	Bangalore
Ireland	Ringaskiddy
Italy	Malnate
Japan	Hiratsuka
Korea	Seoul
Philippines	Baguio
Singapore	Singapore
Spain	Orio
Sweden	Askim
USA	East Aurora

MOOG

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