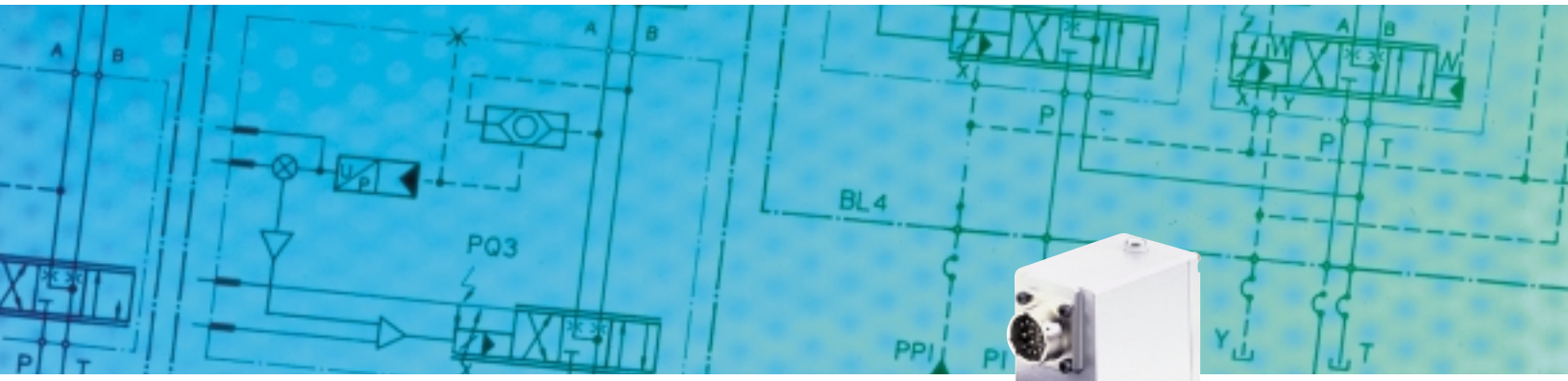
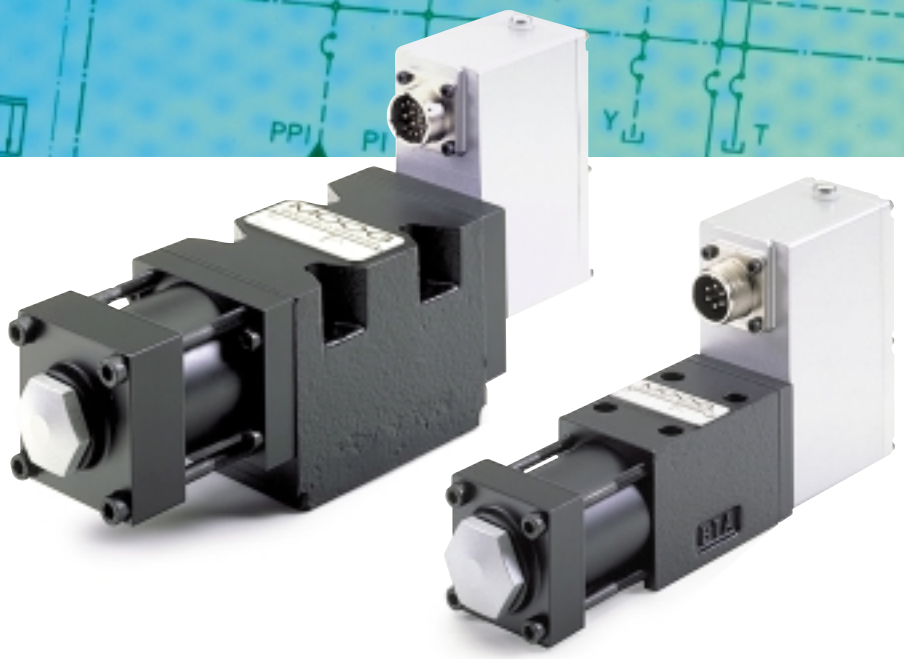
MOOG

D633 and D634 Series
Proportional Control Valves
with Integrated 24 Volt Electronics
ISO 4401 Size 03 and 05





MOOG SERVO-PROPORTIONAL CONTROL VALVES

For over 25 years Moog has manufactured proportional control valves with integrated electronics. During this time more than 150,000 valves have been delivered. These proportional control valves have been proven to provide reliable control of injection and blow molding equipment, die casting machines, presses, heavy industry equipment, paper and lumber processing and other applications.

D633/D634 SERVO-PROPORTIONAL CONTROL VALVES

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-centered position in both directions, as compared with most proportional solenoids with one force direction only.

Our DDV Servo-Proportional Control Valves have 24V DC onboard, closed loop spool position and drive electronics. This integrated electronic features SMD technology and is pulse width modulated (PWM).

Important
Before installation of the valve into the system, the complete hydraulic system must be flushed.

Please read the notes in section "Electronics", page 6.

Our quality management system is certified in accordance with DIN EN ISO 9001.

The valve series described in this catalog have successfully passed EMC tests required by EC Directive. Please refer to the respective references in the electronics section.

Valves available with explosion protection to EN 50018 and 55019, class II 2G EExde B+H2 T4, DMT 00 ATEX E 037, 0470 at D633 series and II 2G EExde B+H2 T3, DMT 00 ATEX E 037, 0470 at D634 series.
Note: Installation dimensions and electric connection altered. Special data sheet on request.

Meets EN60529 class IP65 requirement.

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 herein. In case of doubt, please contact Moog.

FEATURES & BENEFITS

High Dynamics for Faster Step Response
The high natural frequency of the Direct Drive Valve (300 Hz ± 10%) results in one of the highest dynamic servo-proportional valves on the market.

High Pressure Gain of Direct Drive Pilot Valve for Reliable Operation
The valve's high-pressure gain offers improved spool position control even in situations with high internal flow forces and contaminated fluids.

Direct Drive Pilot Valve for Dynamic Performance Independent of System Pressure
The electro-mechanical design of the Direct Drive Valve results in dynamic performance of the valve that is independent of system pressure.

Improved Resistance to Contamination Reduces Down Time
The DDV Series Valves have high spool driving forces offering greater chip shearing forces, making the valve more tolerant to contamination.

Flexible Design Elements Optimize the Valve to Your Application
The DDV Series Valves offer a variety of flow characteristics such as linear, dual-gain, and curvilinear in flow ranges from 1.5 to 26 gpm (5 to 40 lpm).

Fail-Safe Versions for Defined Spool Position at Loss of Power
The spring offers automatic centering of the spool at loss of power, without passing a load move position. In addition, a trim adjustment can be set to a customer's requirement.

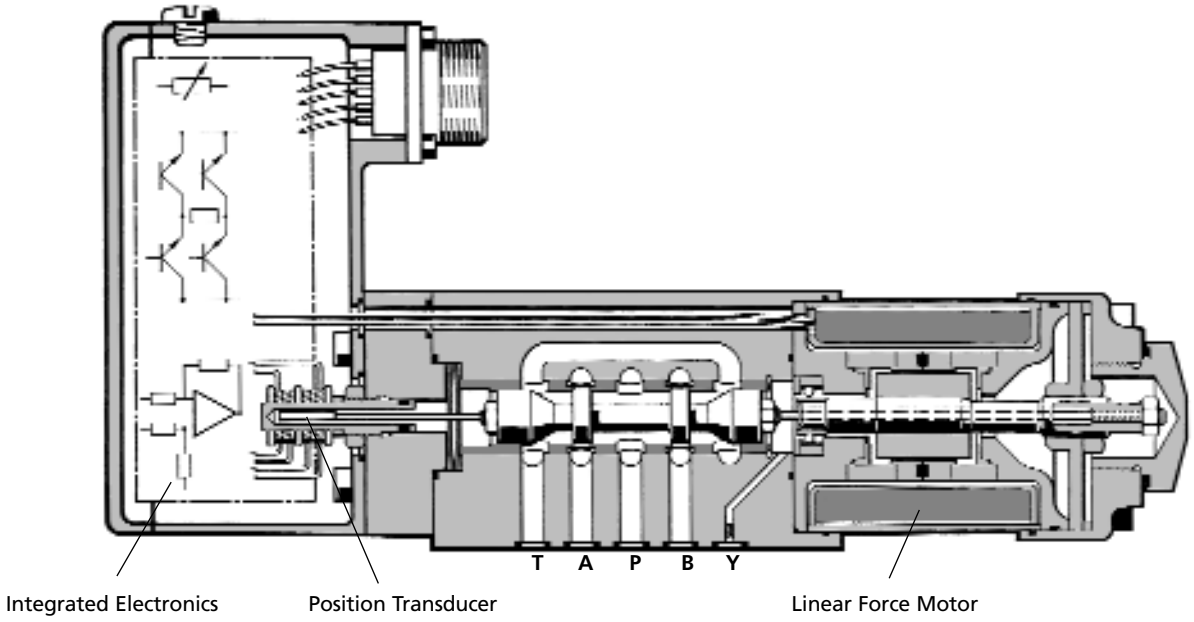
Low Current Consumption Saves Energy
The linear force motor allows for low current consumption in normal operation and near hydraulic null, saving energy especially in multiple valve applications.

Monitoring Signal for Evaluating System Integrity
6+PE pole connector allows access to a standardized spool positioning monitoring signal with low residual ripple.

High Flow Capability for High Velocity Applications
The D03 and D05 (NG6 and NG10) DDV Series valves offer high flow per body size.

Low Hysteresis and Low Threshold for Better Control
The linear force motor combined with a spool and bushing design offers better overall system control.

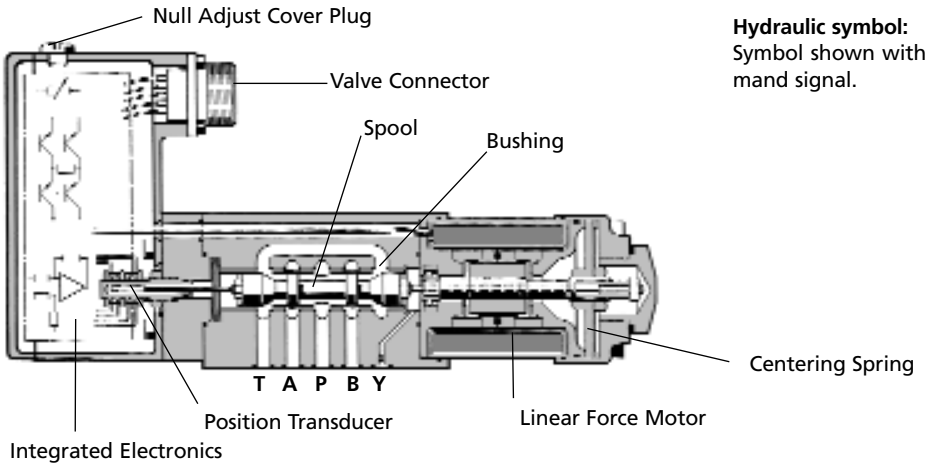
D633 Single Stage Proportional Control Valve



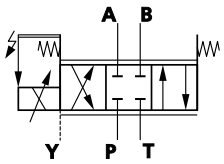
OPERATING PRINCIPLES OF THE DIRECT DRIVE VALVES (DDV)

The position control loop for the spool with position transducer and linear force motor is closed by the integrated electronics. An electric signal corresponding to the desired spool position is applied to the integrated electronics and produces a pulse width modulated (PWM) current to drive the linear force motor. An oscillator excites the spool position transducer (LVDT) producing an electric 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 until the spool has moved to its commanded position, and the spool position error is reduced to zero. The resulting spool position is thus proportional to the command signal.



Hydraulic symbol:
Symbol shown with pilot pressure and electric supply on and zero command signal.

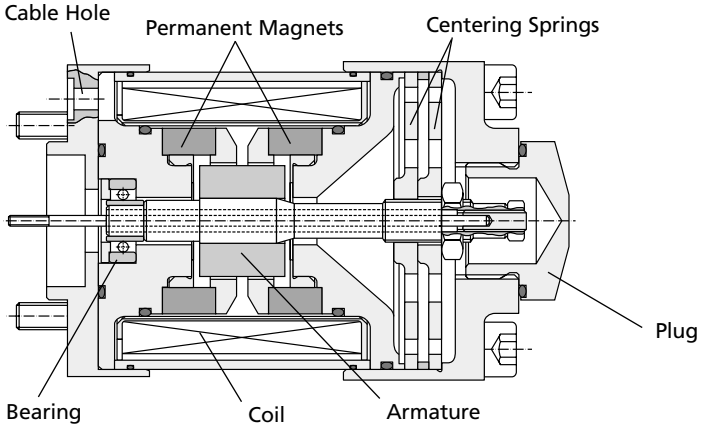


OPERATING PRINCIPLES OF THE PERMANENT LINEAR FORCE MOTOR

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 resulting centering force plus external forces (i.e. flow forces, friction forces due to contamination) must be overcome during out-stroking. During back-stroking to centre position the spring force adds to the motor force and provides additional spool driving force which makes the valve very less contamination sensitive. The linear force motor needs very low current in the spring centered position.

Proportional solenoid systems require for the same function two solenoids with more cabling. 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.



PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

Operating Pressure Range

Port P, A and B	up to 5,000 psi [350 bar]
Port T	see data of individual series

Temperature Range

Ambient	-4°F to +140°F [-20°C to +60°C]
Fluid	-4°F to +176°F [-20°C to +80°C]

Seal Material NBR, FPM and others on request

Operating Fluid mineral oil based hydraulic fluid (DIN 51524, part 1 to 3), other fluids on request

Viscosity

Recommended	15 to 100 mm^2/s
Allowable	5 to 400 mm^2/s

System Filtration

High pressure filter (without bypass, but with dirt alarm) mounted in the main flow and if possible directly upstream of the valve.

Class of Cleanliness

The cleanliness of the hydraulic fluid greatly effects the performance (spool positioning, high resolution) and wear (metering edges, pressure gain, leakage) of the valve.

Recommended Cleanliness Class

For normal operation:	ISO 4406 < 15/12
For longer life:	ISO 4406 < 14/11

Filter Rating recommended

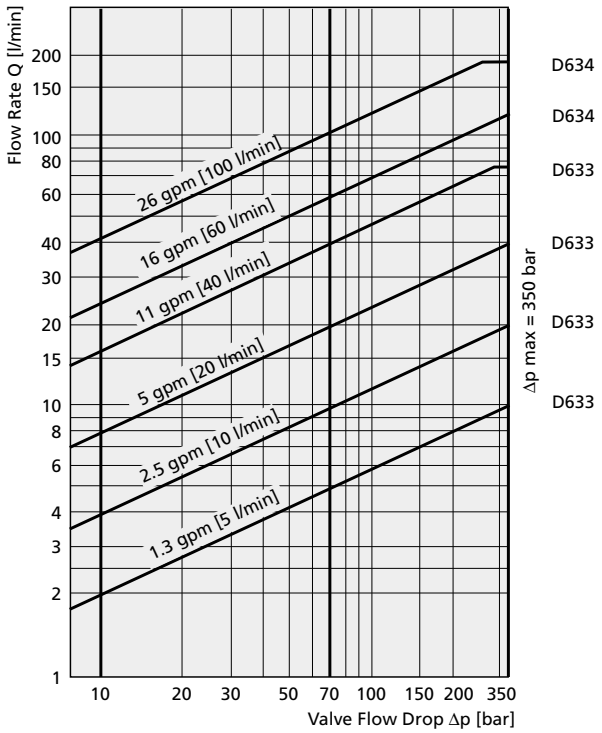
For normal operation:	$ß_{10} \geq 75$ (10 µm absolute)
For longer life (wear):	$ß_6 \geq 75$ (6 µm absolute)

Installation Options any position, fixed or movable

Vibration 30 g, 3 axes

Degree of Protection EN60529 class IP 65, with mating connector mounted

Shipping Plate Delivered with an oil sealed shipping plate under the mounting surface.



Valve Flow Diagram
Valve flow for maximum valve opening (100% command signal) as a function of the valve pressure drop

VALVE FLOW CALCULATIONS

A valve's 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 Dp_N = 35 bar per metering land is the rated flow Q_N. For other than rated pressure drop the valve flow changes at constant command signal according to the square root function for sharp edged orifices.

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

Q [gpm] = calculated flow

Q_N [gpm] = rated flow

Δp [psi] = actual valve pressure drop

Δp_N [psi] = rated valve pressure drop

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 30 m/s.

GENERAL REQUIREMENTS FOR VALVE ELECTRONICS

- Supply 24 VDC, min. 19 VDC, max. 32 VDC

Current consumption I_{Amax}	for D633	1,2 A
	for D634	2,2 A
External fuse per valve	for D633	1,6 A (slow)
	for D634	2,5 A (slow)

- All signal lines, also those of external transducers, shielded.
- Shielding connected radially to ^ (0 V), power supply side, and connected to the mating connector housing (EMC).
- **EMC**: Meets the requirements of EN 55011:1998, class B, EN 50082-2:1995, performance criterion class A.
- Minimum cross-section of all leads ≈ 0,75 mm2. Consider voltage losses between cabinet and valve.
- Note: When making electric connections to the valve (shield, protective earth) appropriate measures must be taken to ensure that locally different earth potentials do not result in excessive ground currents. See also Moog Application Note AM353E.

VALVE ELECTRONICS WITH SUPPLY VOLTAGE 24 VOLT AND 6+PE POLE CONNECTOR

Command signal 0 to ±10 mA floating,
Valves with current command input
The spool stroke of the valve is proportional to $I_D = -I_E$.
100% valve opening P ⧫ A and B ⧫ T is achieved at I_D = +10 mA. At 0 mA command the spool is in centered position. The input pins D and E are inverting. Either pin D or E is used according to the required operating direction. The other pin is connected to signal ground at cabinet side.

Command signal 0 to ±10 V,
Valves with voltage command input
The spool stroke of the valve is proportional to $(U_D - U_E)$.
100% valve opening P ⧫ A and B ⧫ T is achieved at $(U_D - U_E)$ = +10 V. At 0 V command the spool is in centered position. The input stage is a differential amplifier. If only one command signal is available, pin D or E is connected to signal ground at cabinet side, according to the required operating direction.

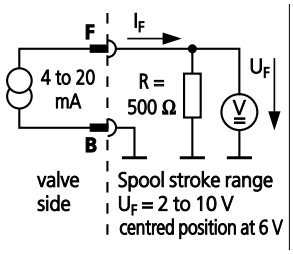
Actual value 4 to 20 mA
The actual spool position value can be measured at pin F (see diagram below). This signal can be used for monitoring and fault detection purposes. The spool stroke range corresponds to 4 to 20 mA.

The centered position is at 12 mA. 20 mA corresponds to 100% valve opening P ⧫ A and B ⧫ T. The position signal output 4 to 20 mA allows to detect a cable break when I_F = 0 mA.

For failure detection purposes it is advised to connect pin F of the mating connector and route this signal to the control cabinet.

CIRCUIT DIAGRAM

Circuit diagram for measurement of actual I_F (position of main spool) for valves with 6+PE pole connector

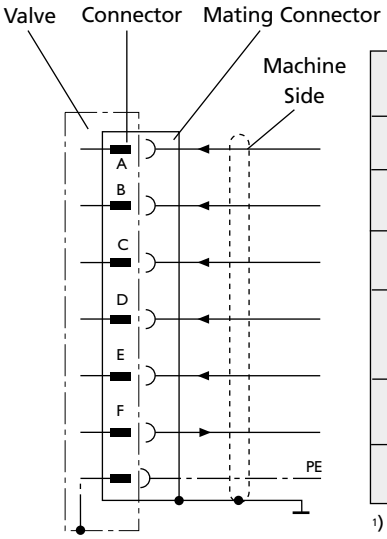


Note: Enable input
With enable signal off, the main spool will move to a safe position.
a) Centered position (unbiased pilot valve function code A[1])
b) End position (biased pilot valve function code B[1])

[1]) see type designation

CONNECTOR WIRING

Wiring for valves with 6+PE pole connector to EN 175201 Part 804[2]), and mating connector (type R and S, metal shell) with leading protective earth connection ⏚.



Function	Voltage Command 0 to ±10 VDC	Current Command 0 to ±10 mA	Current Command + 4 … +20 mA
Supply	24 VDC (19 to 32 VDC) (D633 only 22 to 28 VDC)*		
Supply / Signal Ground	⊥ (0 V)		
Not Used			
Input Rated Command (Differential)	U_{D-E} = 0 to ±10 V R_e = 10 kΩ Input Voltage U_{D-E} and U_{E-B} for both signal types is limited to min. -15V, max. +24V	Input Command $I_D = -I_E$:0 to ± 10mA (R_e = 200 Input Command (Inverted) $I_E = -I_D$:0 to ± 10mA	
Output Actual Spool Position	I_{F-B} = 4 to 20mA. At 12 mA spool is centered position R_L = 300 to 500 Ω.		
Protective Earth			

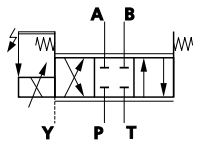
[1]) formerly DIN 43563, *before 01.01.2001

PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

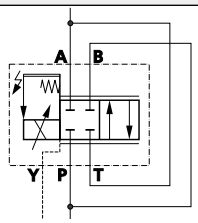
		English [Metric]	D633
Mounting Pattern	(with or without leakage port Y*)		ISO 4401 - 03 - 03 - 0 - 94
Port Diameter		in [mm]	0.31 [7.9]
Valve Body Version			Single stage, spool in bushing 3-way, 4-way, 2x2-way directly, with permanent magnet linear force motor
Pilot Stage			
Pilot Connection			
Mass		lb [kg]	5.5 [2.5]
Rated Flow	(±10%) at Δp_N = 500 psi [35 bar] per land	gpm [l/min]	1.3 [5] / 2.6 [10] / 5.3 [20] / 10.6 [40]
Max. Valve Flow		gpm [l/min]	19.8 [75]
Operating Pressure	max.		
Ports P, A, B		psi [bar]	5,075 [350]
Port T without Y		psi [bar]	725 [50]
port T with Y		psi [bar]	5,075 [350]
Port Y		psi [bar]	directly to tank
Response Time*	for 0 to 100% stroke	[ms]	≤ 12
Threshold*		[%]	0.10
Hysteresis*		[%]	0.20
Null Shift*	with ΔT = 55K	[%]	1.5
Null Leakage Flow**	total max. (~ critical lap)	gpm [l/min]	0.04 [0.15] / 0.08 [0.30] / 0.16 [0.60] / 0.32 [1.2]
Pilot Leakage Flow**		gpm [l/min]	
Pilot Flow**	max., for 100% step input	gpm [l/min]	
Main Spool Stroke		in [mm]	
Spool Drive Area		in² [cm²]	

* Leakage port Y must be used; with 3- and 4-way function and p_T > 725 psi [50 bar]; with 2x2-way function

** measured at 3,000 psi [210 bar] pilot or operating pressure, respectively, fluid viscosity of 32 mm²/s and fluid temperature of 104°F [40°C]



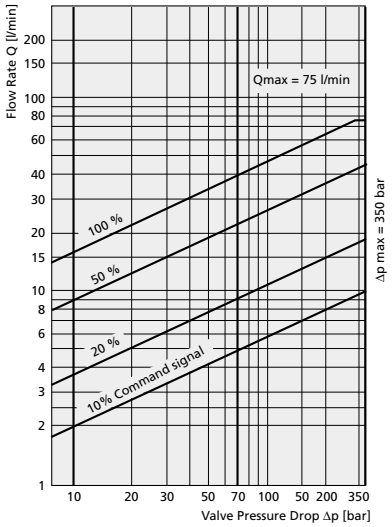
4-way version



2x2-way version

PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

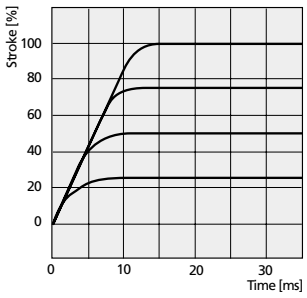
Flow vs. Signal Curve
at Δp_N = 75 psi [5 bar] per land



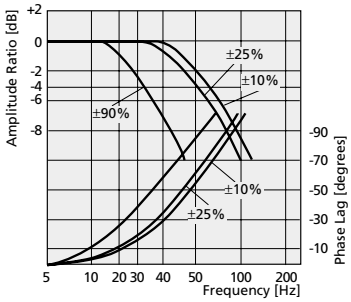
Spool version A: **~critical lap, linear characteristic (21)**
Spool version D: **10% overlap, linear characteristic**
Spool version Y: **~critical lap, curvilinear characteristic (21)**

Typical characteristic curves measured at 3,000 psi [210 bar] pilot or operating pressure, fluid viscosity of 32 mm2/s and fluid temperature of 104°F [40°C]

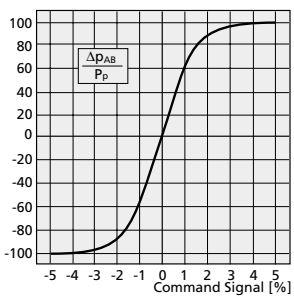
D633
Step Response



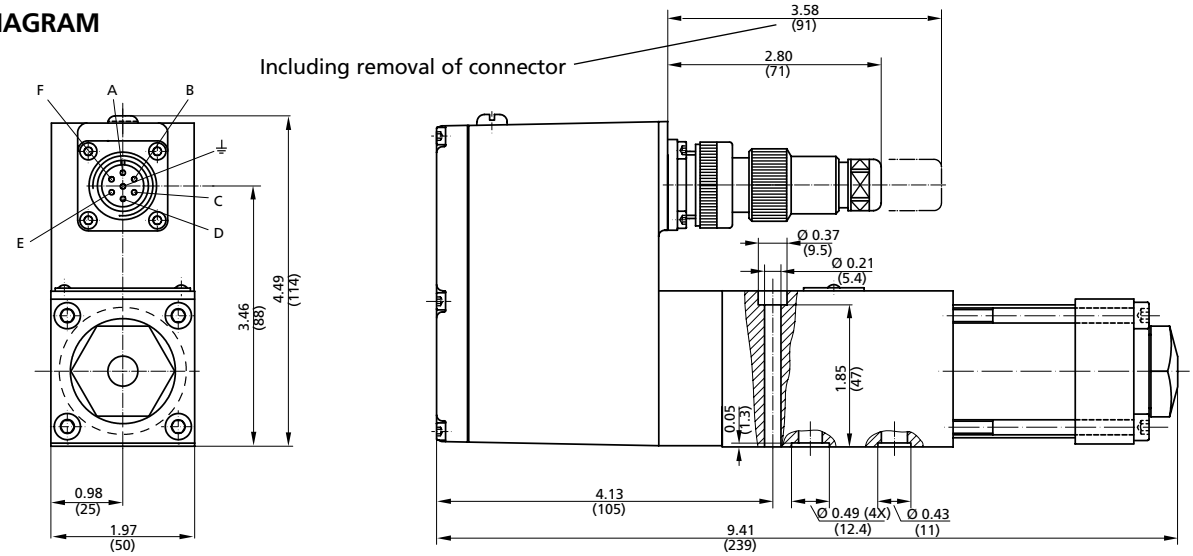
Frequency Response

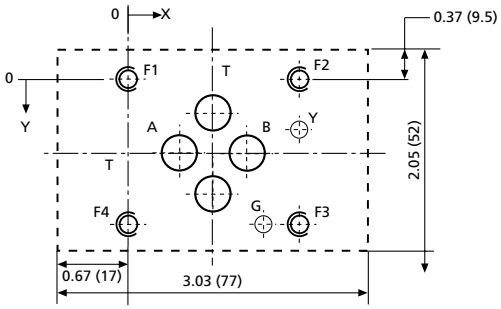


Pressure Gain



INSTALLATION DIAGRAM





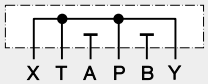
The mounting manifold must conform to ISO 4401-03-03-0-94 without X port.

Mounting surface needs to be flat within .0004 in [0.01 mm] over a distance of 3.9 in [100 mm]. Average surface finish value, Ra, better than $\sqrt{32}$.

	P	A	B	T	X*	Y	F_1	F_2	F_3	F_4	G
	Ø 0.295 [7.5]	**Ø 0.295 [7.5]**	**Ø 0.295 [7.5]**	**Ø 0.295 [7.5]**		**Ø 0.13 [3.3]**	M5	M5	M5	M5	0.157 [4.0]
x	0.846 [21.5]	0.50 [12.7]	1.189 [30.2]	0.846 [21.5]		1.59 [40.5]	0	1.59 [40.5]	1.59 [40.5]	0	1.30 [33.0]
y	1.02 [25.9]	0.61 [15.5]	0.61 [15.5]	0.20 [5.1]		0.345 [9.0]	0	-0.03 [-0.75]	1.25 [31.75]	1.22 [31.0]	1.25 [31.75]

* Port X must not be drilled, not sealed at valve base.

SPARE PARTS AND ACCESSORIES

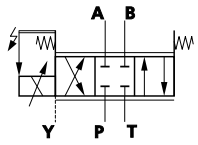
O-rings (included in delivery) for ports P, T, A, B for port Y	 4 pieces ID 0.36 [9.25] x Ø 0.07 [1.8] 1 piece ID 0.30 [7.65] x Ø 0.07 [1.8]		NBR 90 Shore / FPM 90 Shore 45122-013 / 42082-013 45122-012 / 42082-012
Mating connector, waterproof IP65 (not included in delivery) 6+PE-pole	B97007-061	EN 175201 Part 804	for cable dia min. 0.39 [10.0 mm], max. 0.47 [12.0 mm]
Flushing Plates	for P, A, B, T, X, Y B46634-002		
Mounting Manifolds	see special data sheet		
Mounting Bolts (not included in delivery) M 5 x 55 DIN EN ISO 4762-10.9	A03665-050-055	required torque 8.5 Nm	required 4 pieces

PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

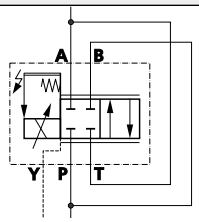
		English [Metric]	D634
Mounting Pattern	(with or without leakage port Y*)		ISO 4401 - 05 - 05 - 0 - 94
Port Diameter		in [mm]	0.45 [11.5]
Valve Body Version			Single stage, spool in bushing 3-way, 4-way, 2x2-way directly, with permanent magnet linear force motor
Pilot Stage			
Pilot Connection			
Mass		lb [kg]	13.9 [6.3]
Rated Flow	(±10%) at Δp_N = 500 psi [35 bar] per land	gpm [l/min]	16 [60] / 26 [100]
Max. Valve Flow		gpm [l/min]	48.9 [185]
Operating Pressure	max.		
Ports P, A, B		psi [bar]	5,075 [350]
Port T without Y		psi [bar]	725 [50]
port T with Y		psi [bar]	5,075 [350]
Port Y		psi [bar]	directly to tank
Response Time*	for 0 to 100% stroke	[ms]	≤ 20
Threshold*		[%]	0.10
Hysteresis*		[%]	0.20
Null Shift*	with ΔT = 55K	[%]	1.5
Null Leakage Flow**	total max. (~ critical lap)	gpm [l/min]	0.32 [1.2] / 0.53 [2.0]
Pilot Leakage Flow**		gpm [l/min]	
Pilot Flow**	max., for 100% step input	gpm [l/min]	
Main Spool Stroke		in [mm]	
Spool Drive Area		in² [cm²]	

* Leakage port Y must be used; with 3- and 4-way function and p_T > psi [50 bar]; with 2x2-way function

** measured at 3,000 psi [210 bar] pilot or operating pressure, respectively, fluid viscosity of 32 mm²/s and fluid temperature of 104°F [40°C]



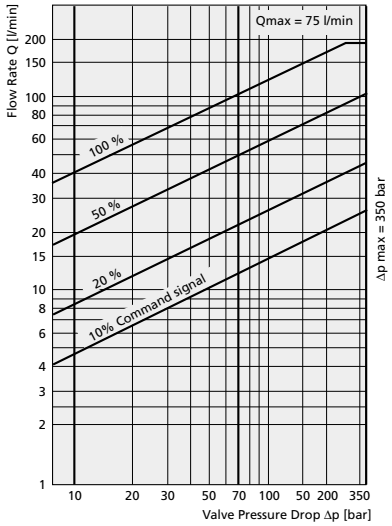
4-way version



2x2-way version

PERFORMANCE SPECIFICATIONS FOR STANDARD MODELS

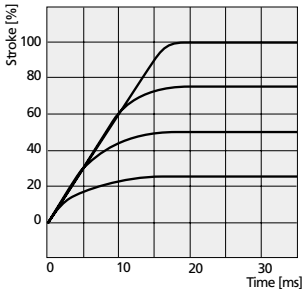
Flow vs. Signal Curve
at Δp_N = 75 psi [5 bar] per land



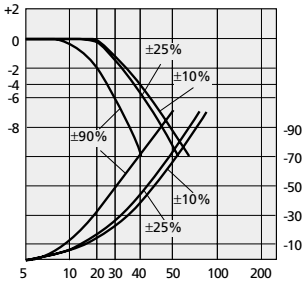
Spool version A: **~critical lap, linear characteristic (21)**
Spool version D: **10% overlap, linear characteristic**
Spool version Y: **~critical lap, curvilinear characteristic (21)**

Typical characteristic curves measured at 3,000 psi [210 bar] pilot or operating pressure, fluid viscosity of 32 mm2/s and fluid temperature of 104°F [40°C]

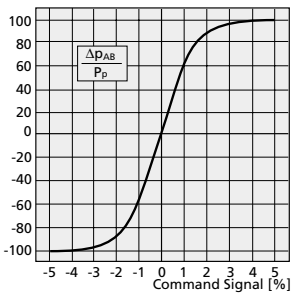
D634
Step Response



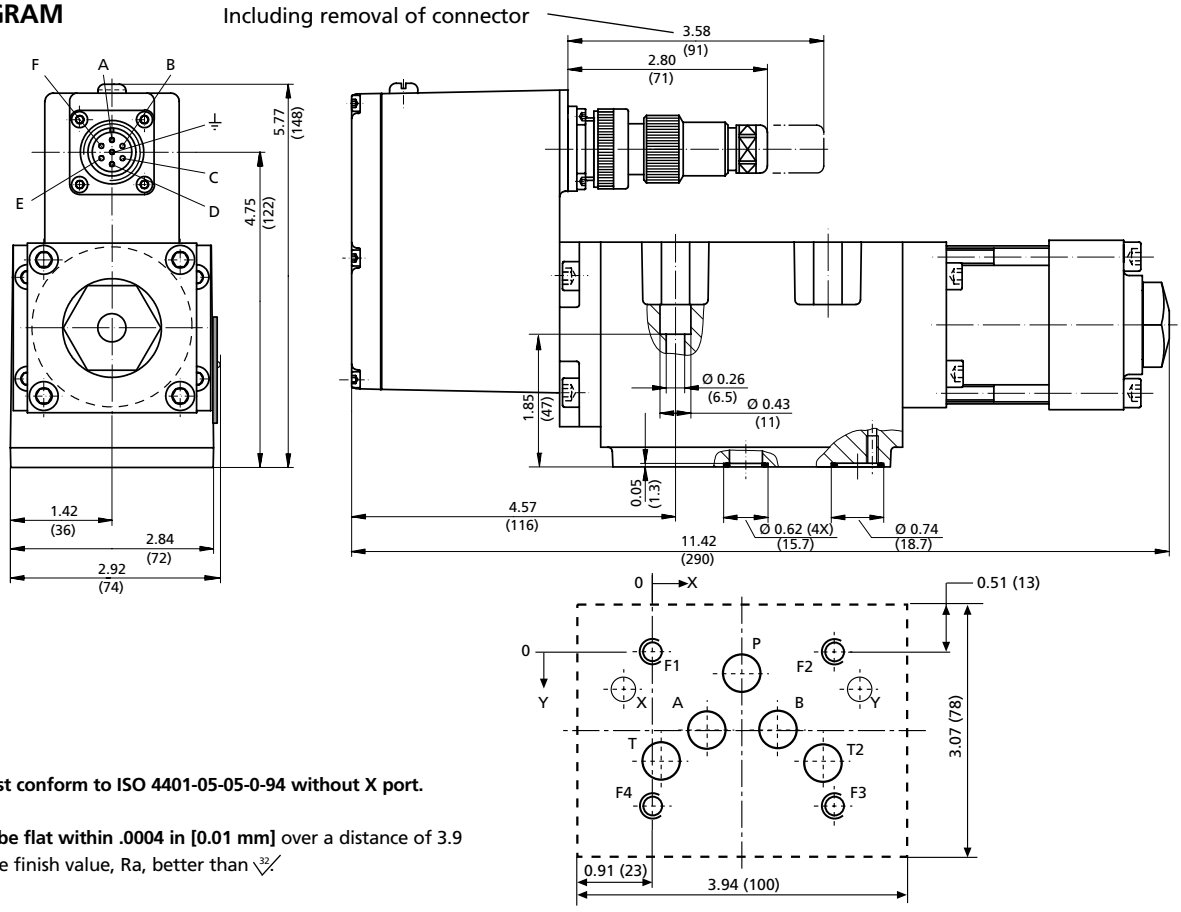
Frequency Response



Pressure Gain



INSTALLATION DIAGRAM



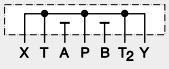
The mounting manifold must conform to ISO 4401-05-05-0-94 without X port.

Mounting surface needs to be flat within .0004 in [0.01 mm] over a distance of 3.9 in [100 mm]. Average surface finish value, Ra, better than $\sqrt{32}$

	P	A	B	T	T_2	X*	Y	F_1	F_2	F_3	F_4
	Ø 0.441 [11.2]	**Ø 0.441 [11.2]**	**Ø 0.441 [11.2]**	**Ø 0.441 [11.2]**	**Ø 0.441 [11.2]**		**Ø 0.248 [6.3]**	M5	M5	M5	M5
x	1.063 [27.0]	0.657 [16.7]	1.469 [37.3]	0.126 [3.2]	2.0 [50.8]		2.44 [62.0]	0	2.126 [54.0]	2.126 [54.0]	0
y	0.248 [6.3]	0.843 [21.4]	0.843 [21.4]	1.28 [32.5]	1.28 [32.5]		0.433 [11.0]	0	0	1.811 [46.0]	1.811 [46.0]

* Port X must not be drilled, not sealed at valve base.

SPARE PARTS AND ACCESSORIES

O-rings (included in delivery) for ports P, T, A, B for port Y	 5 pieces ID 0.48 [12.4] x Ø 0.07 [1.8] 1 piece ID 0.61 [15.6] x Ø 0.07 [1.8]		NBR 90 Shore 45122-004 45122-011	FPM 90 Shore 42082-004 42082-011
Mating connector, waterproof IP65 (not included in delivery) 6+PE-pole	B97007-061	EN 175201 Part 804	for cable dia min. 0.39 [10.0 mm], max. 0.47 [12.0 mm]	
Flushing Plates	for P, A, B, T, T2, X, Y B67727-001			
Flushing Plates	for P, A, B, T, T2, X, Y B67727-002			
Flushing Plates	for P, A, B, T, T2, X, Y B67727-003			
Mounting Manifolds	see special data sheet			
Mounting Bolts (not included in delivery) M 6 x 60 DIN EN ISO 4762-10.9	A03665-060-060		required torque 13 Nm	required 4 pieces

ORDERING INFORMATION

Model Number

D63	.	.	. . .	.

Series	
3	Size 03
4	Size 05

Specification Status	
–	Series specification
E	Preseries specification
K	explosion proof version upon request
Z	Special specification

Model Designation	
	Assigned at the factory

Factory Identification

Type Designation

.	.	.	.	.	.	.	.	.	.	.	.

Valve Version	
R	With integrated electronics

Rated Flow			
	Q_N[l/min] at Δp_N = 500 psi[35 bar]	Δp_N = 75 psi[5 bar] per land	Series
02	5	2	D633
04	10	4	D633
08	20	8	D633
16	40	16	D633
24	60	24	D634
40	100	40	D634

Maximum Operating Pressure	
K	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 spool on request

Linear Force Motor		Series
1	Standard	D633
2	Standard	D634

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

Y - Port		
0	Closed with plug	PT max = 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

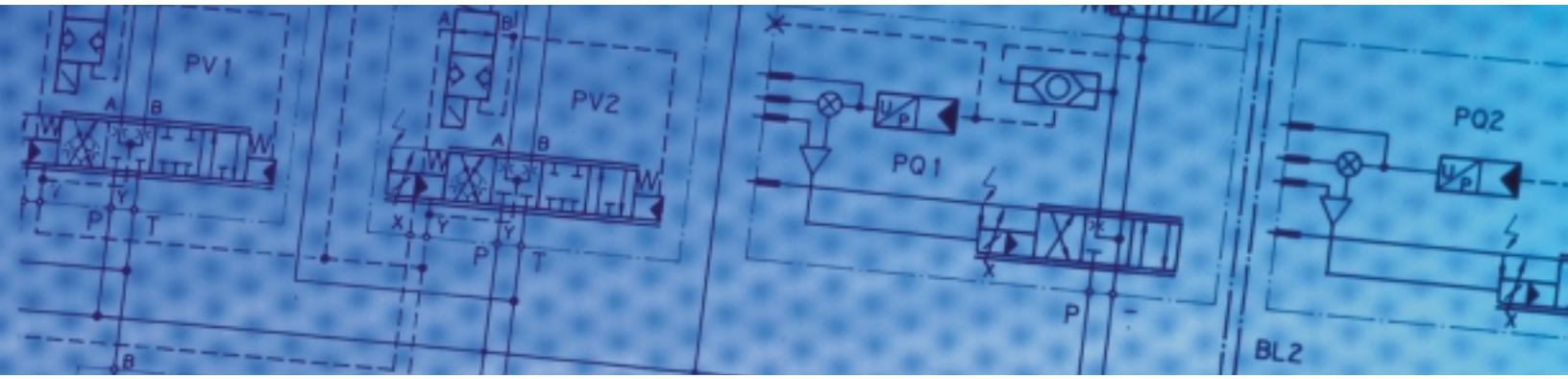
Valve Connector	
S	6+PE pole (7/8-20 UNF 2A) DIN 43563

Signals for 100% Spool Stroke		
	Command	Output
M	±10 VDC	+4 to +20 mA
P	0 to ±10 mA	+4 to +20 mA
S	+4 to +20 mA	+4 to +20 mA
X	±10 mA, floating	+4 to +20 mA

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

Preferred configurations are highlighted. Options may increase price.
Technical changes are reserved.
All combinations may not be available. For special options, letters not on the information above may be applied.
Please contact Moog.

Argentina
Australia
Austria
Brazil
China
England
Finland
France
Germany



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