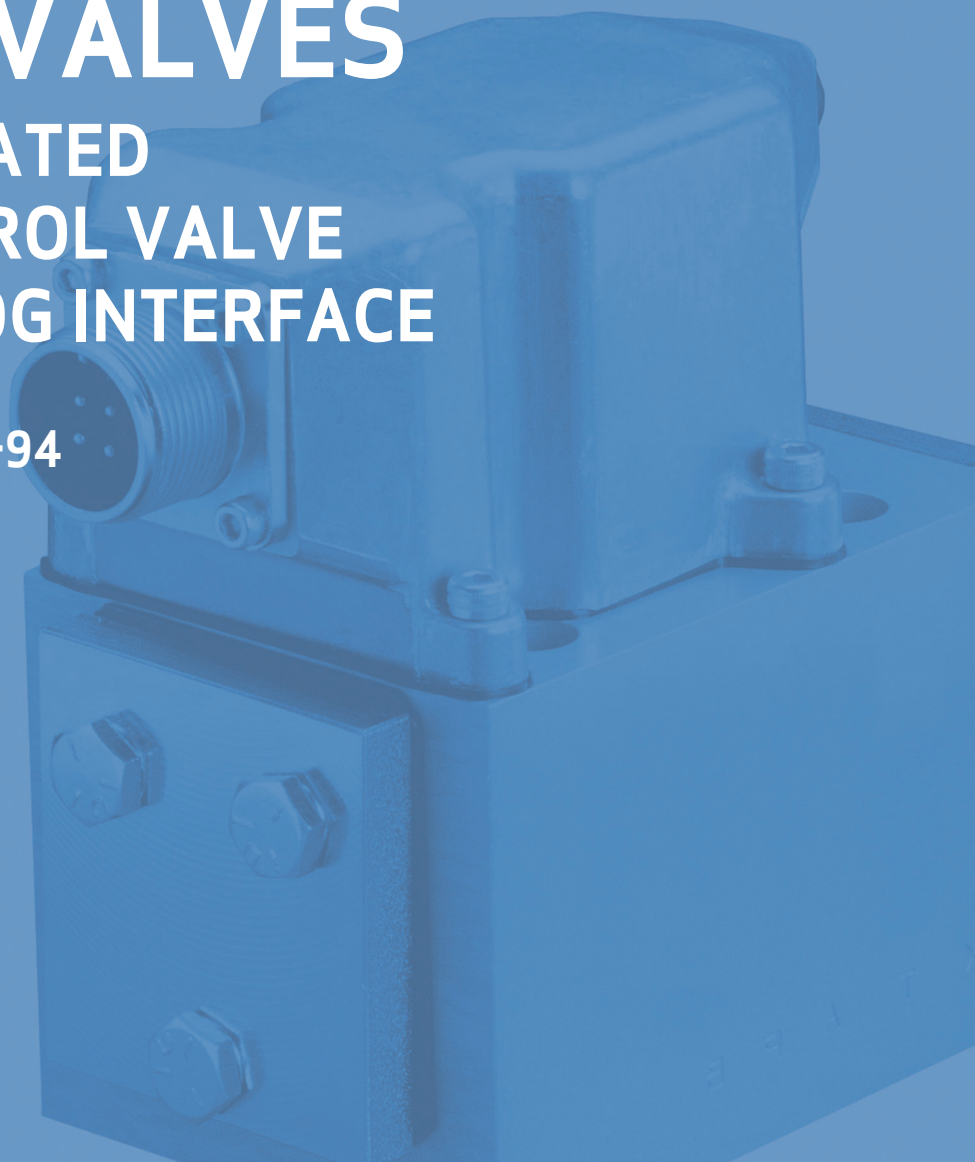


SERVO VALVES

PILOT OPERATED FLOW CONTROL VALVE WITH ANALOG INTERFACE

631 SERIES

ISO 4401-05-05-0-94



Rev. R, April 2024

HIGH PERFORMANCE, TWO-STAGE DESIGN
PROVIDING FLOW CONTROL IN A SIMPLE,
RUGGED, DEPENDABLE, LONG LIFE DESIGN

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.

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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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For the most current information, visit www.moog.com/industrial or contact your local Moog office.

PRODUCT OVERVIEW

The 631 Series flow control servo valves are throttle valves for 3 and preferably 4-way applications. They are a high performance, 2-stage design that covers the range of rated flows from 5 to 75 l/min (1.3 to 20 gpm) at 35 bar (500 psi) valve drop per spool land.

The output stage is a closed center, four-way sliding spool. The pilot stage is a symmetrical double-nozzle and flapper, driven by a double air gap, dry torque motor. Mechanical feedback of spool position is provided by a cantilever spring. The valve design is simple and rugged for dependable, long life operation.

These valves are suitable for electrohydraulic position, speed, pressure or force control systems with high dynamic response requirements.

Valve design	2-stage, with spool and bushing and dry torque motor					
Mounting pattern	ISO 4401-05-05-0-94					
Maximum operating pressure to ports P, T, A, B	315 bar (4,500 psi)					
Pilot stage	Nozzle Flapper					
Rated flow at Δp_N 35 bar/spool land (500 psi/spool land)	5 l/min (1.3 gpm)	10 l/min (2.5 gpm)	20 l/min (5 gpm)	40 l/min (10 gpm)	60 l/min (15 gpm)	75 l/min (20 gpm)
Step response time for 0 to 100% stroke with spool and bushing design	18 ms	18 ms	18 ms	18 ms	18 ms	18 ms



Intrinsically safe valve versions are available for use in potentially hazardous environments. Specific models are certified to FM, ATEX and CSA standards. Contact Moog for details.

FEATURES AND BENEFITS

The 631 Series is proven technology that performs reliably in machines where high performance, stability and accuracy are required. Moog's Mechanical Feedback Valves are designed to provide high reliability and long service life.

Features	Benefits
100% factory tested to ensure critical specification performance	Ensures smooth and easy startup, reduces downtime and insures long life in critical industrial applications
2-stage design	Enables high machine performance, faster cycle times and greater accuracy - all resulting in higher productivity
Dual Coil torque motor	Redundancy for high reliability
Dual Precision Nozzles in Torque Motor	Precision flow control and predictability
Dry torque motor design	Eliminates potential contamination issues in the air gaps of the torque motor that could cause machine downtime
Hardened 440C Bushing and Spool	Provides for high life, wear resistance when used in the harsh environments; provides for low sliding friction during use
Emergency failsafe positioning	Most valves are set up to return to a failsafe position when the command signal is interrupted or eliminated
Field replaceable pilot stage filter	Enables preventive maintenance in the field, saving precious machine downtime and service costs
External null bias adjustment	Enables technicians to manually adjust the null bias of the valve to adapt to the conditions of the machine (see section on null flow adjustment – Page 11). This feature provides a simple adjustment to machine performance without the need to adjust a controller.

DESCRIPTION OF OPERATION

The 631 Series Flow Control Servo Valve consists of a polarized electrical torque motor and two stages of hydraulic power amplification. The motor armature extends into the air gaps of the magnetic flux circuit and is supported in this position by a flexure tube member. The flexure tube acts as a seal between the electromagnetic and hydraulic sections of the valve. The 2 motor coils surround the armature, one on each side of the flexure tube.

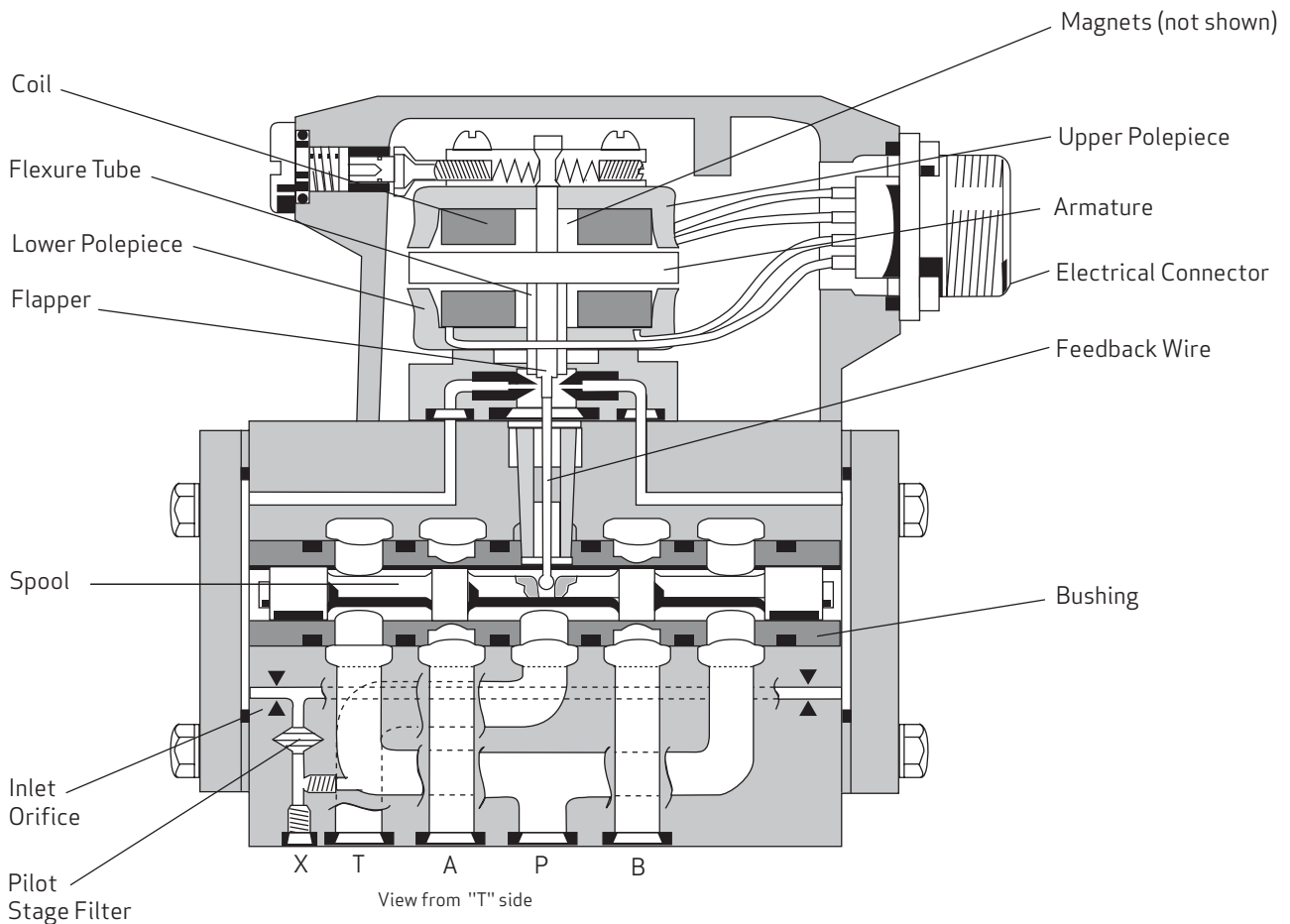
The flapper of the first stage hydraulic amplifier is rigidly attached to the armature. The flapper extends through the flexure tube and passes between 2 nozzles, creating two variable orifices between the nozzle tips and the flapper. The pressure controlled by the flapper and nozzle variable orifice is fed to the end areas of the second stage spool.

The second stage is a conventional four-way spool design in which output flow from the valve, at a fixed valve pressure drop, is proportional to spool displacement from the null position. A cantilevered feedback spring is fixed to the flapper and engages a slot at the center of the spool. Displacement of the spool deflects the feedback spring which creates a force on the armature/flapper assembly.

Input signals induce a magnetic charge in the armature and causes a deflection of the armature and flapper. This assembly pivots about the flexure tube and increases the size of one nozzle orifice and decreases the size of the other.

The differential pressure created by this action causes spool motion. The resulting spool displacement induces a linear force in the feedback wire which opposes the original input signal torque. Spool movement continues until the feedback wire force equals the input signal force.

Electro-hydraulic Servo Valve Cut-away



631 SERIES SERVO VALVES

General Technical Data

Valve design	2-stage, with spool and busing and dry torque motor
Pilot stage	Nozzle Flapper
Mounting pattern	ISO 4401-05-05-0-94
Installation position	Any orientation, fixed or movable
Weight	2.2 kg (4.9 lb)
Storage temperature range	-40 to +60 °C (-40 to +140 °F)
Ambient temperature range	-40 to +135 °C (-40 to +275 °F)
Vibration resistance	30 g, 3 axis, 10 Hz to 2 kHz
Shock resistance	30 g, 3 axis
Seal material	Fluorocarbon (FKM) 85 Shore A Others upon request

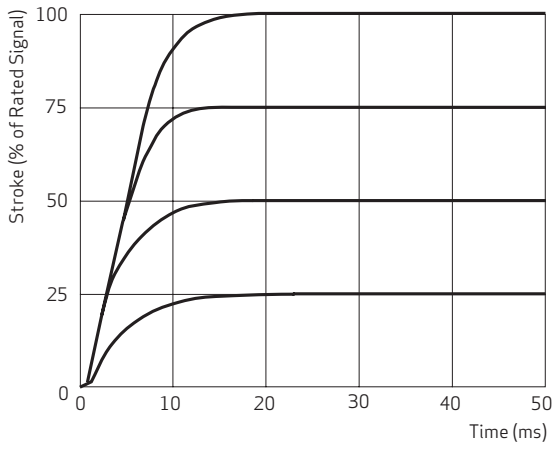
Hydraulic Data

Maximum operating pressure to ports P, A, B, X	315 bar (4,500 psi)
Maximum operating pressure to port T	20% of pilot pressure, max 100 bar (1,450 psi)
Rated flow at p_N 35 bar/spool land (500 psi/spool land)	5, 10, 20, 40, 60, 75
Null adjust authority	Greater than 10% of rated flow
Hydraulic fluid	Hydraulic oil as per DIN 51524 parts 1 to 3 and ISO 11158 Other fluids on request.
Temperature range	-40 to +135 °C (-40 to +275 °F)
Recommended viscosity range	10 to 85 mm ² /s (cSt)
Maximum permissible viscosity range	5 to 1,250 mm ² /s (cSt)
Recommended cleanliness class as per ISO 4406	
For functional safety	19/16/13
For longer life	17/14/11
Recommended filter rating	
For functional safety	$\beta_{10} \leq 75$ (10 μ m absolute)
For longer life	$\beta_5 \leq 75$ (5 μ m absolute)

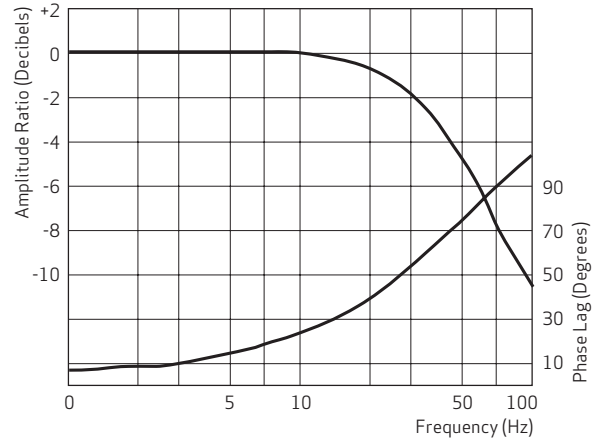
Static and Dynamic Data

Deviation of rated flow	$\pm 10\%$ of rated flow
Step response time for 0 to 100% stroke	18 ms
Threshold	1.0% of rated signal
Hysteresis	< 3% of rated signal
Null shift at $\Delta T = 38$ °C (100 °F)	< 4% of rated signal

631 SERIES SERVO VALVES



Step Response



Standard Frequency Response
 3,000PSI DTE -24 at 38° C (100° F)
 ±25% Input Amplitude

ELECTRICAL DATA

Rated current and coil resistance

A variety of coils are available for 631 Series Servo Valves, which offer a wide choice of rated currents.

Coil impedance

The resistance and inductance of standard coils are given below. The 2 coils in each Servo Valve are wound with equal turns giving a normal production tolerance on coil resistance of $\pm 12\%$. Copper magnet wire is used, so the coil resistance will vary significantly with temperature. The effects of coil resistance changes can be essentially eliminated through use of a current feedback servoamplifier having high output impedance.

Inductance is determined under pressurized operating conditions and is greatly influenced by back electromagnetic forces of the torque motor. These effects vary with most operating conditions, and vary greatly with signal frequencies above 100 Hz. The apparent coil inductance values given are determined at 50 Hz.

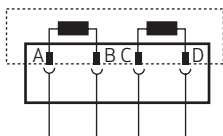
Ordering code	Command signal [mA]			Coil resistance [Ohms/coil at 25°C (77°F)]	Power consumption [W]			Coil inductance [H] measured at 50 Hz		
	Single coil	Series coil	Parallel coil		Single coil	Series coil	Parallel coil	Single coil	Series coil	Parallel coil
Q	± 30	± 15	± 30	300	0.27	0.14	0.14	2.0	7.0	2.0
R	± 100	± 50	± 100	28	0.28	0.14	0.14	0.2	0.8	0.2

Coil connections

A 4-pin electrical connector that mates with an MS3106F14S-2S is standard. All 4 torque motor leads are available at the connector so that external connections can be made for series, parallel, or differential operation. 631 Series Servo Valves can be supplied on special order with other connectors or pigtail.

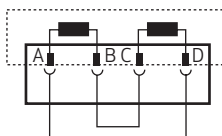
Configuration for valve opening P → B, A → T

Single



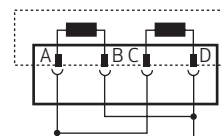
A (+), B (-) or C (+), D (-)

Series



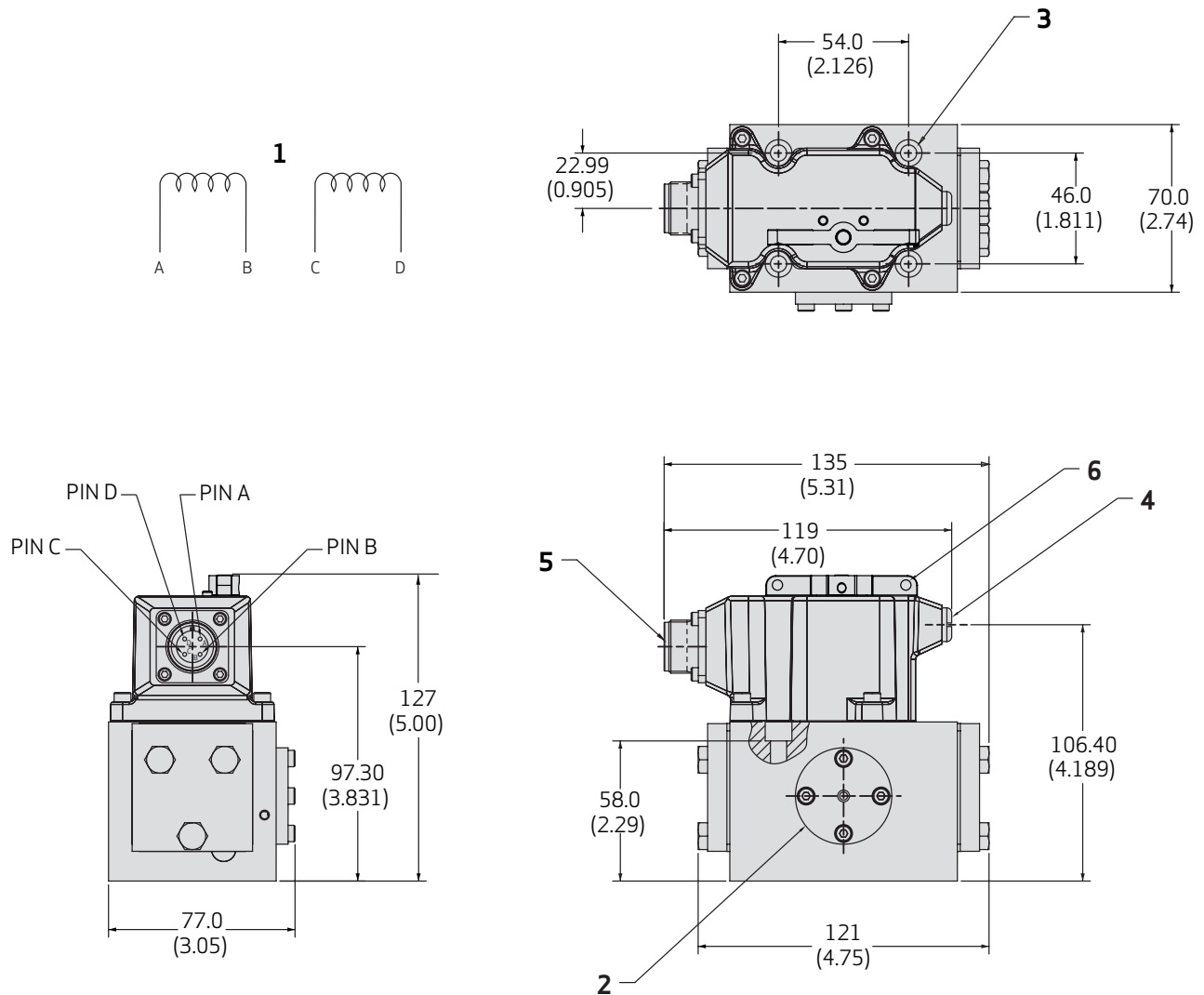
A (+), D (-), B and C connected

Parallel



A and C (+), B and D (-)

INSTALLATION DRAWINGS AND NULL ADJUST INSTRUCTIONS



- 1 Typical wiring schematic
- 2 Filter location
- 3 4X Ø 6.76 (0.266) thru Ø 11.10 (0.437) to depth shown Mounting Holes
- 4 Null adjust cover. Remove for screw access (requires 1/8" hex key)
- 5 Connector mates with MS3106F14S-2S
- 6 Optional Manual Override

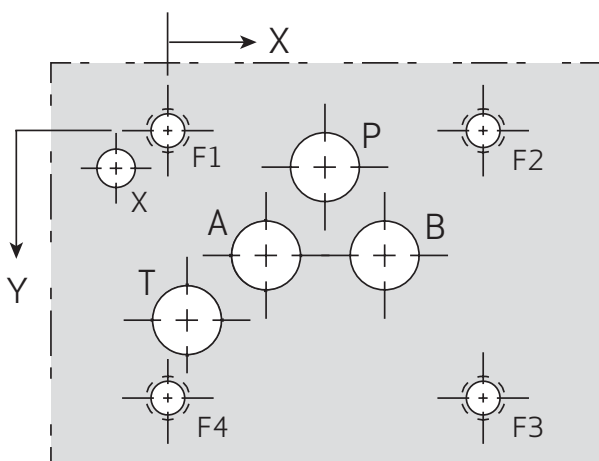
Fluid:
 Industrial hydraulic fluid per DIN 51524 parts 1 to 3 and ISO 11158, maintained to ISO 4406 Code 19/16/13 recommended. Viscosity 10 to 85 mm²/s (cSt) at 38 °C (60 to 300 SUS at 100 °F)

Operating Temperature Range:
 Fluid: -40 to +60 °C (-40 to +140 °F)
 Ambient: -40 to +135 °C (-40 to +275 °F)

Valve Phasing:
 Flow out port B results when:
 Series coils: B & C connected, A+, D-
 Parallel coils: A & C connected, B & D connected, A & C+, B and D-
 Single coils: A+ /B- or C+/D-

Null Adjust:
 Flow out port A results with the clockwise rotation of the null adjust screw.

631 SERIES HOLE PATTERN FOR MOUNTING SURFACE



Designation		P	A	B	T	X	F1	F2	F3	F4
Size Ø	mm	11.13	11.13	11.13	11.13	3.18	M6	M6	M6	M6
	in	0.438	0.438	0.438	0.438	0.125	1/4-20	1/4-20	1/4-20	1/4-20
Position X	mm	27.0	16.69	37.31	3.20	-9.00	0	54.0	54.0	0
	in	1.063	0.657	1.469	0.126	-0.354	0	2.126	2.126	0
Position Y	mm	6.32	21.41	21.41	32.51	6.32	0	0	46.02	46.02
	in	0.249	0.843	0.843	1.280	0.249	0	0	1.812	1.812

Surface

Surface to which the valve is mounted requires:

- Flatness of 0.03 mm (0.001 in) over 100 mm (3.94 in)
- Average finish R_a better than 0.8 μm (0.000032 in)

Ports

For maximum flow ports must be designed as follows:

- P and T with 10 mm (0.390 in) diameter, counter-bored 15.75 mm (0.620 in) by 1.5 mm (0.061 in) deep
- A and B with 9 mm (0.344 in) diameter, counter-bored 15.75 mm (0.620 in) by 1.5 mm (0.061 in) deep
- X with 7.5 mm (0.295 in) diameter, counter-bored 11.75 mm (0.463 in) by 1.5 mm (0.061 in) deep

Conversion Instruction

For operation with internal or external pilot connection.

Pilot flow supply Screw and seal washer location (M4 X 6 DIN EN ISO 4762)

	X	P
Internal P	closed	open
External X	open	closed

Recommended Mounting Seals

Material dependant on application

- 2 mm cross-section x 12 mm inside diameter, 90 durometer for P, A, B, and T ports
- 2 mm cross-section x 8 mm inside diameter, 90 durometer for X port

Recommended Mounting Screws

Material dependant on application

- SHCS 5/16 x 1.75 long. Grade 8 minimum
- SHCS M8 x 45 long. Grade 10.9 minimum

NULL FLOW ADJUSTMENT

It is often desirable to adjust the null flow of a servo valve independently of other system parameters. The mechanical null adjustment permits convenient control function set-ups. Valves with mechanical null adjustment allow for at least $\pm 10\%$ adjustment of null flow. Mechanical feedback elements position the spool relative to the valve body for a given input signal.

Mechanical Adjustment Procedure

The mechanical null adjuster is a hex socket adaptor located behind the pan head screw in the motor cap (see illustration below) which, when adjusted, provides control of the spool position to obtain the desired flow null.

Normal adjustment should require less than \pm one turn. Limit null screw adjustment to less than \pm two turns.

Adjustment Procedure

- a. Using a blade screwdriver, remove the null access screw to permit adjustment of the hex socket setscrew.
- b. Using a 1/8 inch Allen Wrench, adjust the setscrew to obtain the desired flow null.

Note: Clockwise rotation of the null adjuster produces flow out port A.

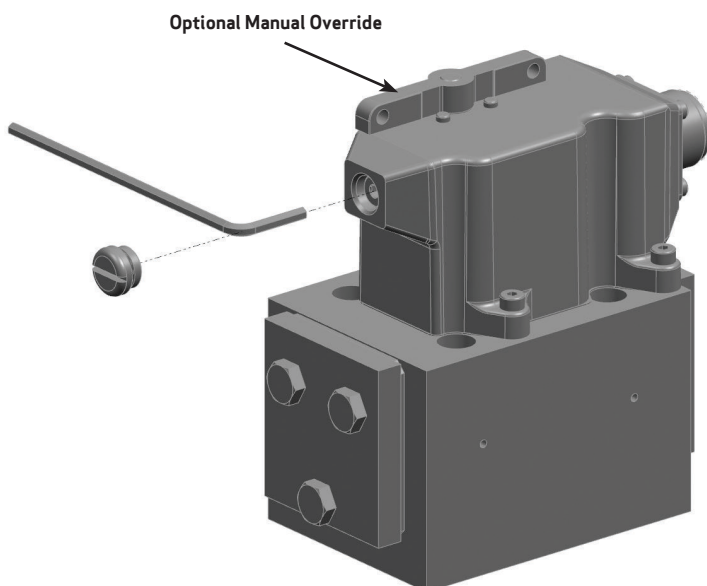
- c. After the desired flow null has been obtained, replace the null access screw.

Tools and Equipment

- a. Blade screwdriver
- b. Allen wrench set (1/8 inch)

Optional Manual Override Operation

At times it may be convenient to activate the servo valve manually rather than with an electrical control signal. This can be done on the 631 series with the optional manual override. With supply pressure applied, rotating the manual override handle on the motor cap fully counterclockwise will result in the right port pressure increasing. Rotating the manual override handle on the motor cap fully clockwise will result in the left port pressure increasing.



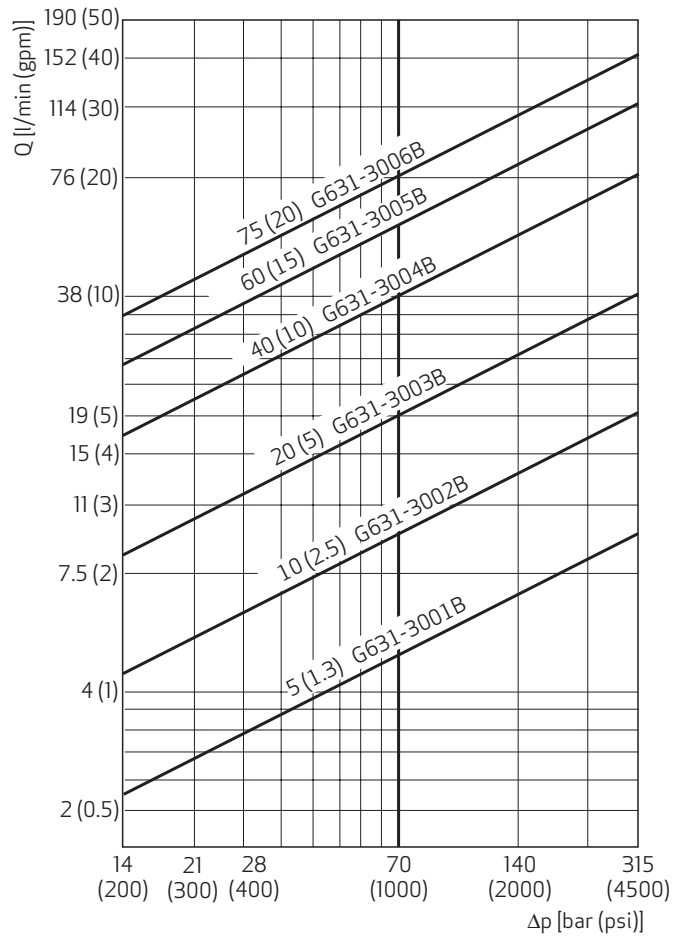
FLOW CALCULATION

The actual flow is dependent upon electrical command signal and valve pressure drop. The flow for a given valve pressure drop can be calculated using the square root function for sharp edge orifices.

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

- Q actual flow
- Q_N rated flow
- Δp actual pressure drop per spool land
- Δp_N rated pressure drop per spool land

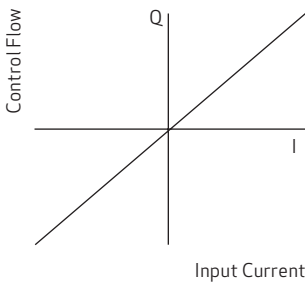
Flow Diagram



NULL CUT OPTIONS

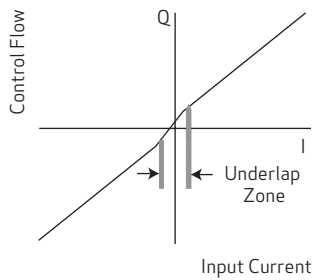
See Ordering Code for reference

Standard Axis Cut



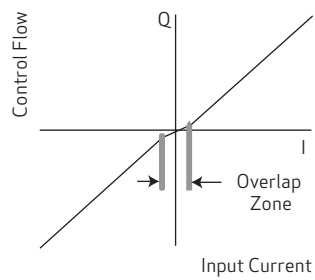
Default, without request for optional cuts

Open Center Spool Valves



Normally used in hydraulic motor applications

Closed Center Spool Valves

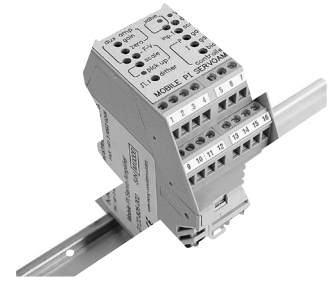


Normally used in failsafe applications

RELATED PRODUCTS

Din Rail Modules - Analog Control Cards

Moog's DIN rail mounted module analog control cards are ideal for use in enclosures where space is limited. Modules include servoamplifiers, transducer conditioning electronics, command and auxiliary function modules, valve drive amplifiers, and power supplies. All of these modules are CE marked and require a 24V DC supply. The modules mount to standard 35mm DIN rail mount for easy installation and removal.



Din Rail Module

Portable Valve Testers - Evaluates Valves in the Field

Valve testers are a cost effective method for evaluating valves in the field. They provide a quick and easy means of differentiating between hydraulic and electronic problems. There are five models to choose from, each with different levels of capability and flexibility to meet your specific requirements. All valve testers have a compact, easily portable design.



Valve Tester

Filtration - Oil Filtration Requirements for Industrial Servo Systems

The most effective way to reduce life cycle costs of an oil hydraulic system, regardless of the types of valve used, is through close attention to contamination control. For industrial servo systems the ideal system filter arrangement is summarized as follows:

- Use a 10 micron (Beta 10 \geq 75) high pressure filter without by-pass just before the valve or critical parts of the valve (e.g. pilot)
- Use a 3 micron (Beta 3 \geq 75) low pressure filter in the return or bypass line.
- Use a filter in the tank breather that is at least the same filtration level as the finest filter in the system.

This recommendation is based on the fact that most servo and proportional valves can accept the odd particle up to 25 microns so the pressure filter will protect the valve from catastrophic failure. The real work is done by the low pressure filter reducing the small particle contamination which is the prime contributor to component wear and silting.

Assuming that the filters are properly dimensioned and care is taken during initial installation and maintenance, the aim should be to limit oil contamination to 16/13 (under ISO 4406:1987) or 19/16/13 (under ISO 4406:1999).

For long life, the maximum levels per ISO 4406: 1987 and 1999 are 14/11 and 17/14/11, respectively. It is important to note that these are maximum contamination levels and with proper care and regular filter change, significantly lower levels can and should be achieved. Attention must also be paid to a number of other factors that contribute to oil condition problems such as elevated temperatures, high tank humidity, "dirty" new oil, etc.



Hydraulic Filters

ROUTINE MAINTENANCE GUIDELINES

Every six months or 4,000 operating hours, check for proper operation of the control valve assembly by performing the preventative maintenance steps outlined below. These checks do not require removal of the valve from the process line. If a problem is suspected, repair the valve assembly prior to returning the unit to service.

- Replace the hydraulic filter element
- Stroke the valve and check for smooth, full-stroke operation; unsteady motion could indicate a servo valve, actuator or process valve problem

GENERAL INFORMATION

Effects when Storing Valves

The following effects may occur when storing valves for a long time:

- Sealing materials become brittle, possibly resulting in leaks
- Hydraulic fluid becomes gummy, possibly resulting in friction

Storage Time

The storage time starts at stock receipt and ends at mounting of the valve.

Preservatives

If preservation is carried out, use only preservatives which are compatible with the sealing materials and do not affect the valve, spare parts and accessories.

BEFORE STORAGE

Note: If the valves are exposed to aggressive environmental influences during storage, vacuum packaging may be necessary. We recommend the following preparatory measures for storage:

Mount the shipping plate on the valve.

This is the only way of adequately protecting the valves against the ingress of dirt and moisture and protecting the seals against the effects of ozone and UV.

Put the valve, spare parts and accessories into the original packaging.

Package each valve separately.

Enclose anti-tarnish paper or package the valve, spare parts and accessories with corrosion inhibiting film.

(Only for storage time > 1 year.)

Multipacks of single valves in their individual packages are allowed.

Seal the original packaging properly.

This is the only way of adequately protecting the valves, spare parts and accessories against damage.

STORAGE CONDITIONS

We recommend the following ambient conditions for storage:

- Dust-free, moderately ventilated
- As vibration-free and shock-free as possible

Shock resistance (as per EN 60068-2-27):
50 g, 6 directions, half-sine 3 ms

Vibration resistance (as per EN 60068-2-6):
30 g, 3 axes, frequency 10 to 2,000 Hz

Temperature

Recommended: +15 to +25 °C (+59 to +77 °F)

Permissible: -40 to +60 °C (-40 to +140 °F)

Temperature fluctuations >10 °C (50 °F) must be avoided.

Distance to shielded radiators: > 1 m (3 ft)

No direct exposure to sunlight

No sources of light with a high UV content

UV rays generate ozone, which damage sealing materials.

Relative air humidity: < 65 %, non condensing

AFTER STORAGE

We recommend to check the original packaging, valve, spare parts and accessories for possible damage or alterations due to storage, that is, before use.

Damaged or not functional valves, spare parts and accessories must not be started up.

Sealing materials with the following characteristics must not be used:

- Contamination
- Cracking
- Hardening/softening
- Stickiness
- Discoloration

Storage Time > 5 Years

We recommend that the valve be checked by us or one of our authorized service centers after a storage time of more than 5 years.

Storage Time > 10 Years

After a storage time of more than 10 years the valves have to be checked by us or one of our authorized service centers.

ABOUT MOOG

Moog Inc. is a worldwide designer, manufacturer and integrator of precision control components and systems. Moog's Industrial Group designs and manufactures high performance motion control solutions combining electric, hydraulic, and hybrid technologies with expert consultative support in a range of applications including energy production and generation machinery, industrial production machinery and simulation and test equipment. We help performance-driven companies design and develop their next-generation machines.

Moog maintains facilities in 26 countries around the globe. This vast scope ensures that our engineers remain close to the needs of machine builders and provide flexible design solutions and technical expertise tailored to our customers' toughest challenges.

Moog experts work in close collaboration with machine builders and application engineers to design motion control systems for greater productivity, higher reliability, superior connectivity, less costly maintenance and more effective operations. Our regional presence, industry knowledge and design flexibility ensures Moog motion control solutions are tailored to their environment—from meeting operating regulations and performance standards, to taking machine performance to a higher level.

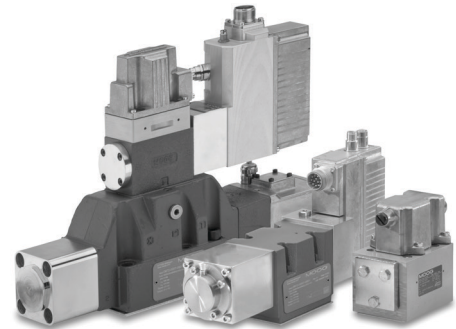
Products

At the heart of every Moog solution is an array of products engineered for precision, high performance and reliability. For more than six decades, Moog products have been specified for critical machine applications.

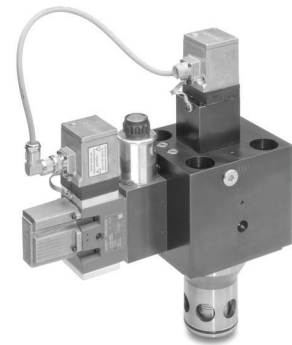
Some are developed specifically for unique operating environments. Others are standard equipment on machines across many industries. All are continuously improved to take advantage of the latest technology breakthroughs and advancements.

Moog products include:

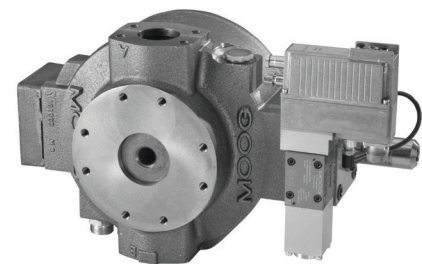
- Servo Valves and Proportional Valves
- Servo Motors and Servo Drives
- Servo Controllers and Software
- Radial Piston Pumps
- Actuators
- Integrated Hydraulic Manifold Systems and Cartridge Valves
- Slip Rings
- Motion Bases



Servo Valves



Active Cartridge Valves



Radial Piston Pumps



Servo Drives

ABOUT MOOG

Hydraulic solutions

Since Bill Moog invented the first commercially viable servo valve in 1951, Moog has set the standard for world-class hydraulic technology. Today, Moog products are used in a variety of applications - providing high power, enhanced productivity and ever better performance for some of the world's most demanding applications.

Electric solutions

Clean operation, low noise generation, less maintenance and reduced power consumption make Moog electric solutions ideal for applications worldwide. Moog is the ideal partner for applications where transitioning technologies requires special expertise.

Hybrid solutions

By incorporating the advantages of existing hydraulic and electric technologies - including modular flexibility, increased efficiency and cleanliness - into innovative hybrid solutions, Moog offers new performance potential in specialized applications.



Flight Simulation



Formula One Simulation Table

Moog Global Support

Moog Global Support is our promise to offer world-class Repair and Maintenance Services delivered expertly by our trained technicians. With the reliability only available from a leading manufacturer with facilities around the world, Moog offers you service and expertise you can count on to keep your equipment operating as it should.

This promise offers many benefits to our customers including:

- Reduce your downtime by keeping critical machines running in peak performance
- Protect your investment by ensuring reliability, versatility and long-life of products
- Better plan your maintenance activities and make systematic upgrades
- Leverage our flexible programs to meet the unique service requirements of your facility

Look to Moog for global support including:

- Repair services using OEM parts are performed by trained technicians to the latest specifications
- Stock management of spare parts and products to prevent unplanned downtime

- Flexible programs, tailored to your needs such as upgrades, preventative maintenance and annual/multi-year contracts
- On-site services bring the expertise to you, providing quicker commissioning, set-up and diagnostics
- Access to reliable services that are guaranteed to offer consistent quality anywhere in the world

For more information on Moog Global Support visit www.moog.com/industrial/service.



ACCESSORIES AND SPARE PARTS

Part name	Description	Material	Moog part number
Maintenance kit	Base o-rings	FKM per AMS7259	B52555RK200K001
	Additional o-rings required for filter access	Note that o-ring material is dependant on application	
	Filter disk		

Documents (not included in scope of delivery)

Part designation	Description	Remark	Part number
Catalog	631 series general information	To download document click here or scan below: 	CDL6641
Manual	631 standard series		CDS6672
	631K intrinsically safe (K) series		CDS6750

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

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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