MOOG

Proportional Control Valves
D631 Series
ISO 4401 Size 05

Operating Instructions

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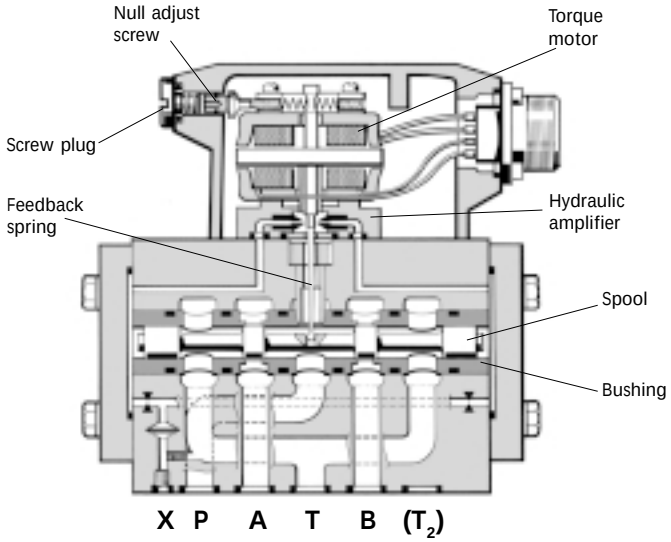


1. Safety Instructions

1.1 Warnings and symbols

ATTENTION — refers to special orders and prohibitions to prevent damage

DANGER — refers to special orders and prohibitions to prevent injury or extensive damage

1.2 Correct application

1.2.1 The valves D631 Series are proportional valves suited for electrohydraulic position, velocity, pressure and force control.
The valves are designed for flow rate control in hydraulic systems that operate with mineral oil based fluids.

DANGER Using the valves for purposes other than those mentioned above is considered contrary to the intended use. The user bears entirely the risk of such misuse.

Correct application involves also observing the operating instruction and complying with the inspection and maintenance directives.

1.3 Organizational measures

1.3.1 We recommend to include this operating instruction into the maintenance plan of the machine / plant.

1.3.2 In addition to the operating instruction, observe also all other generally applicable legal and other mandatory regulations relevant to accident prevention and environmental protection. Instruct the operator accordingly.

1.3.3 All safety and danger prevention instructions of the machine/plant must meet the requirements of EN 982.

1.4 Selection and qualification of personnel

1.4.1 Only well-trained and instructed personnel are allowed to work with MOOG proportional valves.

1.4.2 Work with electrohydraulic valves must be carried out only by personnel having special knowledge and experience in plants running with electrohydraulic controls.

1.5 Safety instructions for specific operational phases

1.5.1 Take the necessary precautions to ensure that the machine / plant is used only when in a safe and reliable state.

1.5.2 Check the machine / plant at least once per working shift for obvious damage and defects (e.g. leakage). Report any changes to the responsible group / individual immediately. If necessary, stop the machine immediately and secure it.

1.5.3 In the event of malfunctions, stop the machine / plant immediately and secure it. Have any defects corrected immediately.

1.5.4 DANGER If the machine / plant is completely shut down for maintenance and repair work at the valve, it must be secured against inadvertent start up by:

- Locking the principal control elements and removing the key or
- attaching a warning sign to the main switch.

1.6 Safety instructions for the operation of hydraulic plants

1.6.1 Work on electrohydraulic equipment must be carried out only by personnel having special knowledge and experience in electrohydraulic controls.

1.6.2 DANGER Check all lines, hoses and fittings of the plant regularly for leaks and obvious damage. Repair damage immediately. Splashed oil may cause injury and fire.

1.6.3 DANGER Before removing the valve depressurize all system sections to be opened, pressure lines and accumulators of the hydraulic system in accordance with the specific instructions for the plant.

1.6.4 When handling oil, grease and other chemical substances, observe safety regulations valid for each product.

2. Description

2.1 Operation

2.1.1 General

The D631 Series proportional flow control valves are throttle valves for 3- and preferably 4-way applications. They consist of an electromechanical transformer (torque motor), a hydraulic amplifier (nozzle/flapper principle), a spool in a bushing and a cantilever feedback spring. The torque motor contains coils, pole pieces, permanent magnets and an armature. The armature is connected to a flexible tube which allows a limited rotation of the armature and at the same time seals the electromagnetic components against the hydraulic fluid.
The hydraulic amplifier is a full bridge arrangement with two upstream fixed orifices and two downstream variable orifices created by two nozzles and a flapper between them. The flapper is connected at its upper end to the centre of the armature and extends downward through the flexure tube to the nozzles. A deflection of the flapper between the nozzles changes the size of the variable orifices in opposite sense.

The 4-way spool controls fluid flow from pressure port to one of the load ports and also from the other load port to return.
Deflection of the feedback spring due to spool displacement produces a torque which is fed back to the torquemotor.

2.1.2 Operating principle

An electric current (command or input signal) is applied to the coils of the torquemotor and produces depending on the current polarity a clockwise or counterclockwise torque to the armature. The thereby deflected nozzle flapper system creates a pressure difference across the drive areas of the spool and effects its movement. The feedback spring connected to the armature engages with its lower end into a bore of the spool and is thus deflected by spool displacement. The motion of the spool stops when feedback torque and electromagnetic torque are in equilibrium. Then the flapper is again in hydraulic centre position (approximately). Thus the position of the spool is proportional to the electric command signal.

2.2 Technical Data

Series			**D631- .....P.....**	**D631- .....H.....**
Mounting pattern			ISO 4401 - 05 - 05 - 0 - 94	ISO 4401 - 05 - 05 - 0 - 94
Pilot connection			optional, internal or external	optional, internal or external
Mounting direction			any, fixed or moveable	any, fixed or moveable
Vibration			15 g, 3 axis	15 g, 3 axis
Mass		[kg]	2,2	2,2
Rated flow Q_N at Dp_N = 35 bar per land, tolerance ±10 %		[l/min]	see nameplate of the valve	see nameplate of the valve
Max. valve flow Q_{max}		[l/min]	160	160
Null leakage flow [2]) max.		[l/min]	< 2,5 to 4,2	< 2,5 to 4,2
Pilot leakage flow [2])		[l/min]	1,7	1,4
Pilot flow [2]) max., for 100% step input		[l/min]	0,8	0,55
Max. operating pressure p_{max}				
Main stage:	Ports P, A, B	[bar]	315	315
	Port T	[bar]	20% of pilot pressure, max. 100 bar	20% of pilot pressure, max. 100 bar
Pilot stage:	Port X (regular version)	[bar]	15 to 210	15 to 210
	Port X (with dropping orifice)	[bar]	25 to 315	25 to 315
Temperature range	Ambient	[°C]	– 20 to + 60	– 20 to + 60
	Fluid	[°C]	– 20 to + 80	– 20 to + 80
Operating fluid			mineral oil based hydraulic fluid according to DIN 51524, part 1 to 3, others upon request	
Viscosity	recommended	[mm²/s]	15 to 100	15 to 100
System filtration			High pressure filter, mounted in the main flow without bypass, but with dirt alarm	
Class of cleanliness according to				
NAS 1638			6 or better [1])	6 or better [1])
ISO 4406			15 / 12 or better [1])	15 / 12 or better [1])
Filter rating	for normal operation		$\beta_{15} \geq 75$ (15 µm absolute)	$\beta_{15} \geq 75$ (15 µm absolute)
	for longer life		$\beta_{10} \geq 75$ (10 µm absolute)	$\beta_{10} \geq 75$ (10 µm absolute)

[1]) For long life wear protection of metering lands
[2]) Measured at 210 bar pilot or operating pressure, fluid viscositiy of 32 mm²/s and fluid temperature of 40°C

For additional technical information, such as dimensions, ordering information etc. see catalogue D631 Series.

3. Installation

3.1 General Information

3.1.1 Compare model number and valve type with information from the hydraulic schematic or bill of material.
3.1.2 The valve can be mounted in all directions, fixed or moveable.
3.1.3 Check mounting surface on planeness (0,02 mm for 100 mm) and surface roughness (Ra <1 µm)
3.1.4 Pay attention to cleanliness of mounting surface and surroundings when installing the valve.
3.1.5 Use lint-free tissue to clean!
3.1.6 Before installation, remove protection plate from the valve and keep it for later repair.
3.1.7 Use socket head bolts according to DIN 912 for mounting, strength class 10.9, and tighten them diagonally changing according to table 1 (tolerance +/- 10 %)

Mounting pattern ISO 4401	Bolts to DIN 912-10.9	Qty. reqrd.	Torque [Nm]
05-05-0-94	M6 x 70	4	7,5

Table 1

3.1.8 Pay attention to correct position of ports and location of o-rings during installation.

3.2 Conversion internal/external

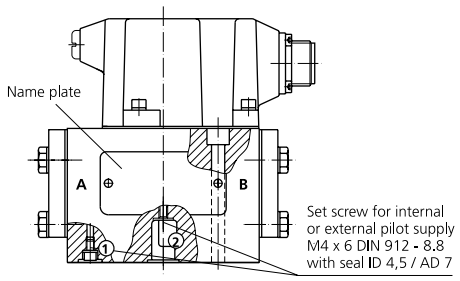
3.2.1 The pilot connection mode is indicated on the nameplate (see type designation)
3.2.2 For the location of the code letter see example of type designation: **P40FOFM4NBRM**. The meaning of this code letter is as follows:

Designation	new	former	
Pressure range	to 315 bar	to 210 bar	to 315 bar
Internal	4	A	E
External	5	C	G

With older valve models this code letter is located at the end of the type designation **P040FO500NE**. The meaning in this case is:

I = Internal pilot connection
E = External pilot connection

3.2.3 Conversion instruction
For operation with internal or external pilot supply connection convert valve according to the following drawing and instruction.



Pilot flow supply	Set screw (M 4 x 6 DIN 912) bore 1	bore 2
internal P	closed	open
external X	open	closed

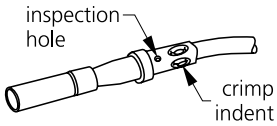
3.3 Electric connection

The specified mating connector is designed for **crimp contacts of size 16**. Former connectors had solder contacts.

3.3.1 Instruction for Crimping
If you order the connector the necessary socket contacts are enclosed in the delivery bag of the mating connector supplied with the valve.
Special tools are required for preparing cables and connectors. (These tools are listed in chapter 8.1 "Tools"). Pay attention to the wiring instructions, which are to be found in this assembly instruction. The complete instructions can be received from MOOG together with the tools set.

3.3.1.1 Baring wires
Bare cables professionally to a length of 6,5 mm. Don't damage conductor or squeeze insulation.

3.3.1.2 Wiring contacts
Connect contacts only with prescribed tools (see 8.1 and assembly instructions)
After crimping check whether
- wire can be seen through the inspection hole in the contact
- none of the contacts is bent or damaged
- no strand is outside the termination hole
- a proper crimp termination with eight crimp indents has been performed.



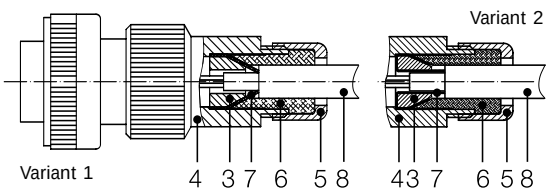
3.3.1.3 Assembling contacts
After wiring the contacts, the leads have to be pulled through all accessories used, such as grommet, ferrule, endbell and cable clamp. Make sure that leads are inserted through the appropriate cavity of grommet. In order to ease insertion of leads, the contacts have to be dipped in Isopropyl.

3.3.1.4 Inserting contacts
Dip contacts in Isopropyl and insert them with prescribed tool (see 8.1 and assembly instructions) through the grommet with constant pressure (into the insulator) until it snaps into its position. Insert contacts according to marking on the insulator.
Also insert unwired contacts in order to guarantee proper sealing.

3.3.1.5 Removing contacts
All accessories are removed in reverse direction as described in chapter 3.3.1.3 Remove contacts with prescribed tool according to assembly instructions.

3.3.1.6 Shielding
When fixing a shielding braid to connector with DZ-adaptor
- Loosen lock nut (5). Slide heat shrink component (6) and lock nut (5) over cable(8).

Variant 1
- Push shielding braid (7) onto endbell (3).
- Remove protruding braid wires.



Variant 2
- Push endbell (3) over cable and place shielding braid (7) externally over endbell (3).
- Mount locknut (5) on shell (4).

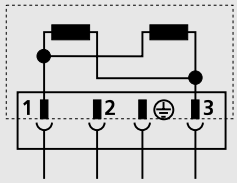
3.3.2 Connector wiring

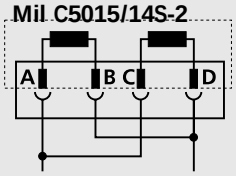
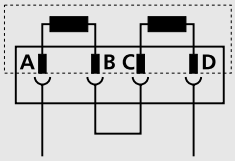
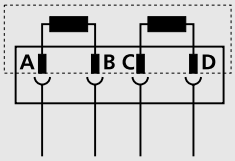
Electric connection with 4-pole connector to Mil C5015/14S-2

The torque motor has 2 coils. The leads of the coils are single connected to the pins. For operation in parallel, series or single coil mode the corresponding wiring must be done in the mating connector.
Optional two types of coils are available:
Coil 1 with 28 Ω
Coil 2 with 300 Ω

Electric connection with connector to DIN 43650

The torque motor has 2 coils. The coils are connected in parallel inside the valve.
Two types of coils are available:
Coil 1 with 28 Ω
Coil 2 with 300 Ω

Connector DIN 43650			
Coil type		1	2
Input resistance	[Ω]	14	150
Rated current	[mA]	± 100	± 30
Inductance (at 60 Hz)	[Henry]	0,2	1,8
Electrical power	[W]	0,14	0,14
Connections for valve opening P ç B, A ç T		1 (+) and 3 (–)	

Connector		**Parallel wiring Mil C5015/14S-2** 		**Series wiring** 		**Single coils** 	
Coil type		1	2	1	2	1	2
Input resistance (25°C)	[Ω]	14	150	56	600	28	300
Rated current	[mA]	± 100	± 30	± 50	± 15	± 100	± 30
Inductance (at 60 Hz)	[Henry]	0,2	1,8	0,8	7,0	0,25	2,0
Electrical power	[W]	0,14	0,14	0,14	0,14	0,28	0,27
Connections for valve opening P ç B, A ç T		A and C (+) B and D (–)		A (+), D (–) B and C connected		A (+), B (–) or C (+), D (–)	

4. Setting up

This information is valid for new installations to be put into operation as well as for repair cases.

4.1 Filling the hydraulic system

ATTENTION

New oil is never clean. Therefore the system should generally be filled by using a filling filter.This fine mesh filter should at least comply with the following requirement: $ß_{10} \geq 75$ (10 µm absolute).

4.2 Flushing the hydraulic system

ATTENTION

Before the hydraulic system is put into operation for the first time (also after modifications) it has to be flushed carefully according to the instructions of the manufacturer of the machine / plant.

4.2.1 Before flushing suitable flushing elements have to be inserted in the pressure filters instead of the high pressure elements.

4.2.2 Before flushing the operational temperature of the hydraulic system should be achieved. Observe temperature!

4.2.3 A flushing plate or, if the system allows, a directional valve should be mounted in place of the MOOG porportional valve. The P- and T-connections are flushed through the flushing plate. The user A- and B- connections can also be flushed by the directional valve. Attention, the directional valve can lead to unpermissable movements in the load (i.e. with parallel drives), which may result in damage of the machine/ plant. Instructions of the manufacturer have to be strictly observed.

ATTENTION

Minimum flushing time **t** can be calculated as follows:

$$t \approx \frac{V}{Q} \cdot 5 \quad [h]$$

V = content of reservoir [liter]
Q = flow rate of the pump [l/min]

4.2.4 The flushing process can be considered successful when a system cleanliness of 15/12 according ISO 4406 or class 6 according NAS 1638 or better is achieved. A long life of the metering lands of the proportional valve can be expected for this cleanliness class.

4.2.5 Replace flushing elements in the pressure filters by suitable high pressure elements after flushing. Install MOOG proportional valve instead of flushing plate or directional valve.

DANGER

4.3 Setting up

4.3.1 Set up machine / plant according to the operation instructions of the manufacturer after the valves have been installed. Vent hydraulic system!

4.3.2 The safety instructions of the machine / plant manufacturer must be observed. Especially the safety requirements for machines like injection moulding machines (EN 201), blow moulding machines (EN 422) and die casting machines (EN 869), to name a few, are important.

4.3.2 Observe oil temperature.

4.3.3 Check hydraulic system for external leakage!

4.4 Nulladjustment

The hydraulic null of the valve is preset at the factory with a tolerance of +/- 2% of rated signal. If necessary this null can be readjusted by the user of the valve.

4.4.1 **Procedure**: Clean the valve externally. Remove the mating connector. Remove cover screw to access the adjustor. Use an internal hex wrench (size SW 3) to turn the adjustor either clockwise or anti-clockwise. Clockwise rotation of the adjustor will increase flow out of port A.

ATTENTION Do not turn the adjustor more than one quarter turn in either direction (+/- 20 degrees is equivalent to +/- 10% null shift).

4.4.2 While adjusting watch the actuator (motor) motion to find

ATTENTION the null position. With overlapped valves turn the adjustor carefully in both directions to just start motion and then back into deadzone midposition between those two wrench positions.

4.4.3 After proper null adjustment apply protective cover screw again and mount the mating connector.

5. Maintenance

Besides regular visual inspection for external leakage and filter replacement, valve maintenance work is not required.

All repairs of MOOG valves can only be performed at facilities listed in MOOG World Wide Service Network (see back cover).

5.1 Filter replacement

The built-in filter disk protects orifices and nozzles against coarse contaminants. With severe contamination the valve response will be slowed down.

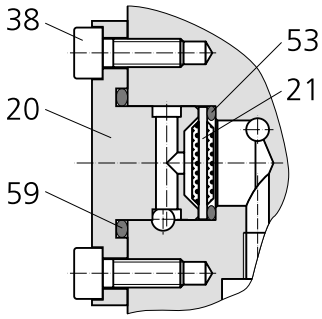
ATTENTION **Replace filter!** Cleaning is useless!

Before starting to work on the valve clean the external surface around the filter cover!

ATTENTION **Attention:** The filter disk (21) is flown from inside to the outside. After removal of the cover (20) any contamination particles are at the inside of the disk (21) and therefore can not be seen from outside.

ATTENTION

5.1.1 Remove 4 internal hex bolts (38) using Allan wrench (SW3). Remove cover (20). Remove the filter disk (21) now accessible by using a scriber or a fine screwdriver as extraction tool.



5.1.2 Check o-rings (59) and (53) for damage. Replace if necessary.

5.1.3 Insert o-ring (53) first. Then insert the new filter disk (21) such that the side with the notch at the rim points outward. Mount o-ring (59) on the cover (20) using clean grease and mount cover to the valve body. Torque the 4 bolts (38) to **3 Nm**.

ATTENTION

5.1.4 Check valve for external leakage after pressurizing it.

6. Malfunctions, Causes and Elimination

6.1 Leakage at the mounting surface of the valve

- Have all seals been installed at ports A, B, P, T, (T_2) and X ok?
- Have the mounting bolts been tightened correctly?

ATTENTION Pay attention to the required torque!
Tighten bolts diagonally changing!

6.2 No hydraulic response of the valve

- Check coil resistance using an Ohmmeter (see pages 4 and 5 for values).
- Check for electric input signal.
- Check the mating connector for corrosion!
- Is hydraulic pressure present?
- Check pilot supply. Do you need internal or external?
- Is pilot pressure present?
- Is the filter disk contaminated?

6.3 Instability of the system, plant oscillates

- Check whether input signal is stable.
- Check filter disk for contamination.

6.4 With hydraulics ON valve goes hardover

DANGER Orifice contaminated (plugged).
Send valve to MOOG service center.

7. Declaration of Manufacturer

A Declaration of Manufacturer according to EC machine directive 89/392/EWG, Annex II B, is avialable for proportional valves D631 Series and will supplied upon the request.

8. Tools, spare parts and accessories

8.1 Tools

Tools are only required for for installation, nulladjustement and filter replacement.

8.1.1 Installation of the valve

8.1.1.1 Mounting of the valve requires
Allan wrench SW 6

8.1.2 Nulladjustment

8.1.2.1 Screwdriver for the plug and Allan wrench SW 3 for nulladjust are required.

8.1.3 Filter replacement

8.1.3.1 For removal and mounting of the cover
Allan wrench SW 3

8.1.3.2 For extraction of the filter disk use of a scriber or small screw driver is suggested.

8.1.3.3 For mounting the o-ring on the cover and for inserting o-rings into the valve base clean grease is required.

8.1.4 Assembly of crimp contacts of the connector as per descripton section 3.3.1 on page 5

Item	Qty.	Description	MOOG Part No.
1	1	Crimp pliers	C21162 001
2	1	Positioner, tool insert for contact sizes 16 und 20	C21163 001
3	1	Installation tool for contact size 16	C21164 001
4	1	Replacement tool for contact size 16	C21165 001

The complete tool set for crimping can be obtained from MOOG by ordering part no. **C21166 001.**

8.2 Spare parts

MOOG Part No.	Description	Pos.[1])	Dimensions	Material	Qty.
A25163 012 020	O-ring, ports P, T, A, B, (T_2)		ID 12 x Ø 2	FPM Sh 85	5 pcs.
A25163 008 020	O-ring, port X		ID 8 x Ø 2	FPM Sh 85	1 pc.
A67999 100	Replaceable filter disk	21	100 µm nominal		1 pc.
A25163 013 015	O-ring, behind filter disk	53	ID 13 x Ø 1,5	FPM Sh 85	1 pc.
A25163 017 020	O-ring, for filter cover	59	ID 17 x Ø 2	FPM Sh 85	1 pc.
66098 040 006	Screw plug, port X (internal/external)		M4 x 6 DIN 912-8.8		1 pc.
A25528 040	Seal, port X		ID 4,5 / AD 7		1 pc.

[1]) see sketch capter 5.1, Filter replacement, on page 6

8.3 **Accessories** (not including in delivery)

MOOG Part No.	Description	Dimensions/Notes	Oty.
B46744 004	Mating connector, 4-pole, Mil C5015/14S-2S (for cable dia min. Ø 6,5 mm, max. Ø 9,5 mm)	waterproof, protection IP65	
A03665 060 070	Mounting bolts	M6x70 DIN 912-10.9	4 pcs.
	Mounting manifolds	see special data sheet	
76046 001	Flushing plate	P - T	
76046 002	Flushing plate	P - T - X	
76046 006	Flushing plate	P - A - B - T - X	

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

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