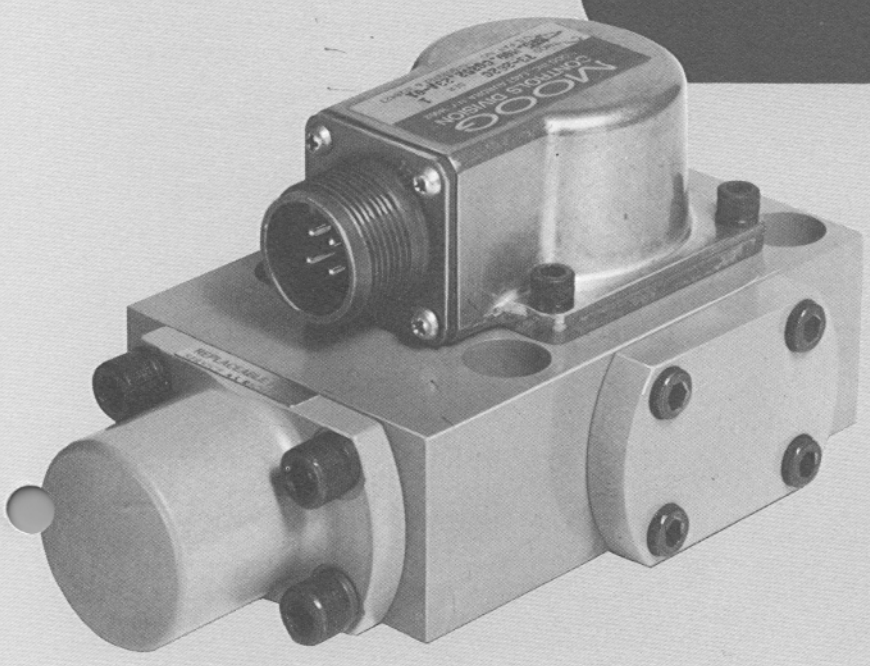
CATALOG 731 480

MOOG® SERIES 73

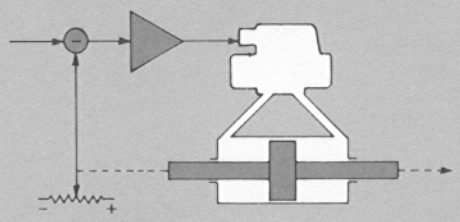


TWO-STAGE FLOW CONTROL SERVOVALVE

MOOG SERIES 73 SERVOVALVE

The 73 Series is a high performance, two-stage design that covers the range of rated flows from 1 to 15 gpm at 1000 psi. These valves have a large field replaceable filter for first stage flow that insures long, trouble-free operation.

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 simple cantilever spring. The valve design is simple and rugged for dependable, long life operation.



In a conventional closed loop position control system, valve flow is applied to a hydraulic piston which drives the load. Load position is measured electrically and fed back for comparison with a signal representing the desired position. The resulting error signal is amplified, providing current input to the valve to control flow.

frictionless, flexure tube supported armature flapper

balanced, double coil, double air gap torque motor

motor coils protected during thermal and vibration extremes by resilient potting

mechanical feedback with simple cantilever spring

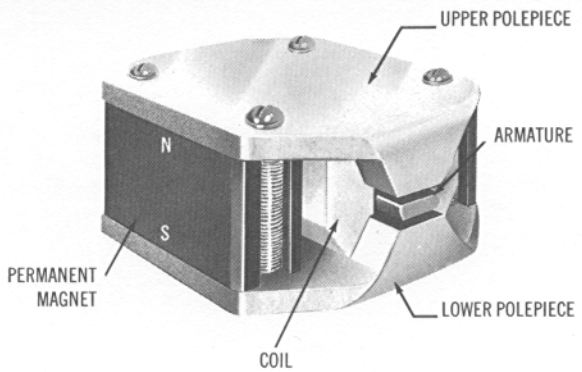
o-ring floated, center pinned bushing with convenient null adjust

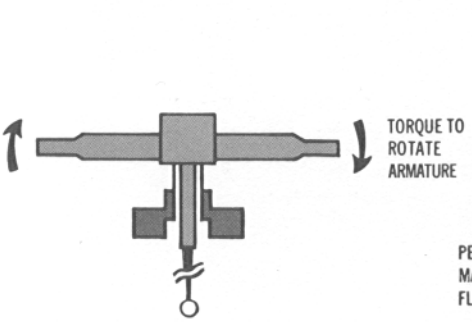
optional fifth port for separate pilot supply

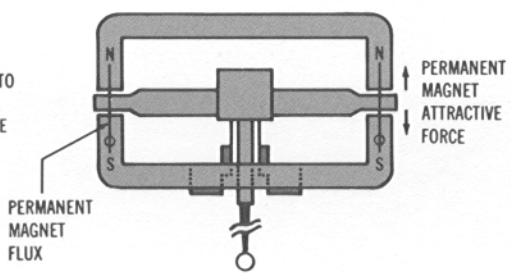
OPERATION

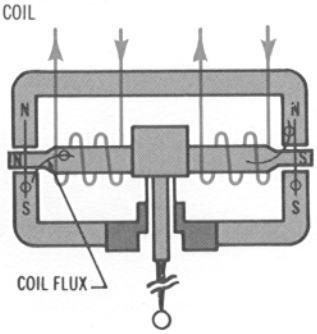
TORQUE MOTOR

- charged permanent magnets polarize polepieces
- dc current in coils causes increased force in diagonally opposite air gaps
- magnetic charge level sets magnitude of decentering force gradient on armature



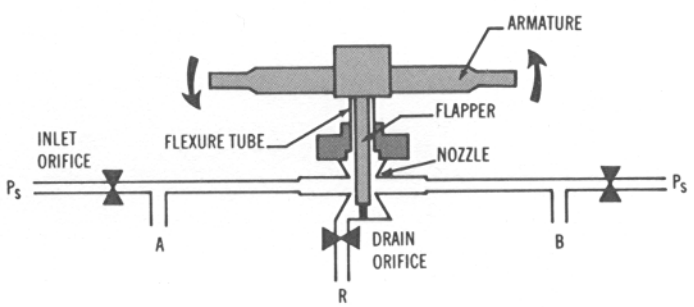


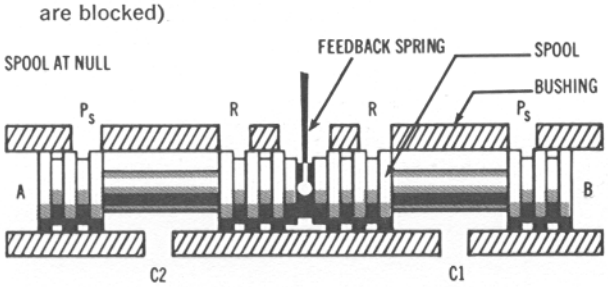


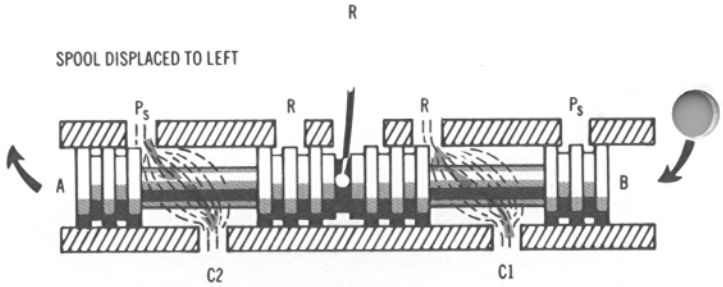


HYDRAULIC AMPLIFIER

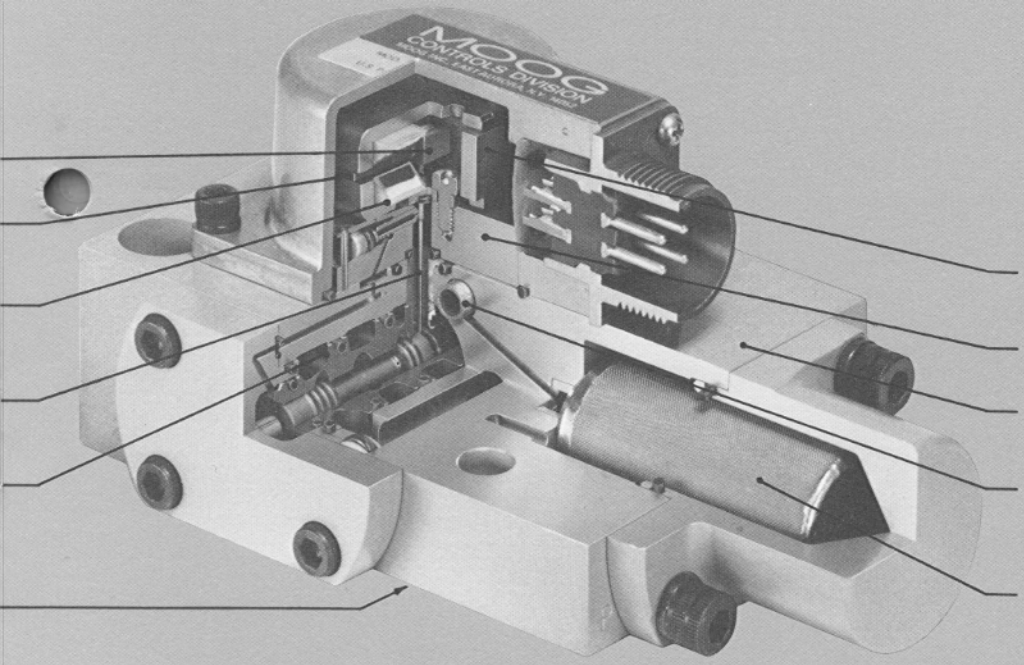
- armature and flapper rigidly joined and supported by thin-wall flexure tube
- fluid continuously flows from supply pressure P_S, through both inlet orifices, past nozzles into flapper chamber, through drain orifice to return R
- rocking motion of armature/flapper throttles flow through one nozzle or the other
- this diverts flow to A or B (or builds up pressure if A and B are blocked)







DESIGN FEATURES*



dry torque motor in sealed compartment

modular torque motor and pilot stage assembly

rugged aluminum alloy body

sintered stainlesss steel, woven wire, 35 μ m absolute filter for pilot stage

field replaceable 35 μ m absolute filter for pilot flow

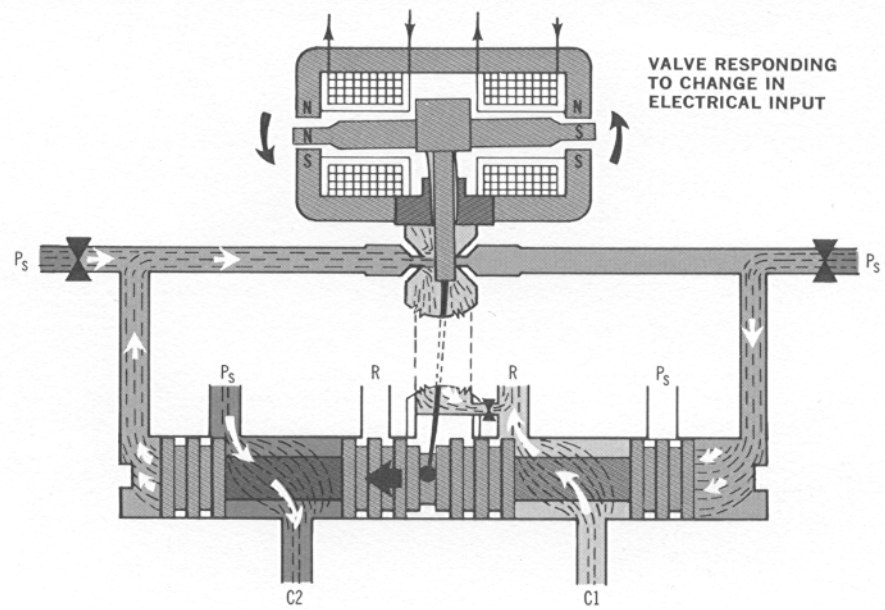
*Design features of 73 Series Servovalves are covered by U.S. Patents 3,023,782 and 3,228,423 together with corresponding patents in several foreign countries.

VALVE SPOOL

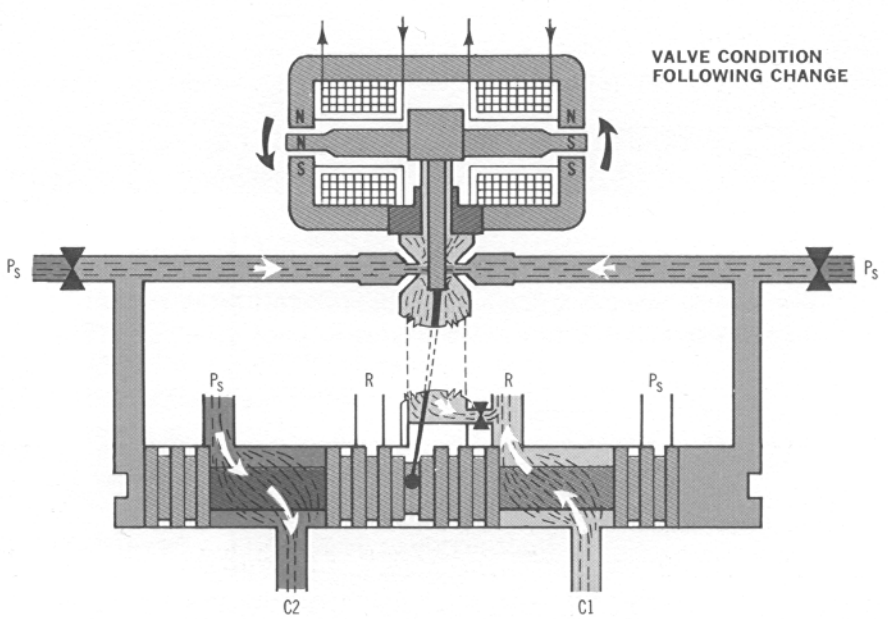
- 4-way spool slides in bushing (sleeve)
- bushing contains rectangular holes (slots) or annular grooves that connect to supply pressure P_S and return R
- at "null", spool is centered in bushing; spool lobes (lands) just cover P_S and R openings
- spool motion to either side of null allows fluid to flow from P_S to one control port, and from other control port to R

OPERATION

- electrical current in torque motor coils creates magnetic forces on ends of armature
- armature and flapper assembly rotates about flexure tube support
- flapper closes-off one nozzle and diverts flow to that end of spool
- spool moves and opens P_S to one control port; opens other control port to R
- spool pushes ball end of feedback spring, creating restoring torque on armature/flapper
- as feedback torque becomes equal to torque from magnetic forces, armature/flapper moves back to centered position
- spool stops at a position where feedback spring torque equals torque due to input current
- therefore, spool position is proportional to input current
- with constant pressures, flow to load is proportional to spool position



VALVE RESPONDING TO CHANGE IN ELECTRICAL INPUT



VALVE CONDITION FOLLOWING CHANGE

TERMINOLOGY

See Moog Technical Bulletin No. 117 for a complete discussion of servovalve terminology and test techniques.

ELECTRICAL

INPUT CURRENT The electrical current to the valve which commands control flow, expressed in milliamperes (ma).

RATED CURRENT The specified input current of either polarity to produce rated flow, expressed in milliamperes (ma). Rated current is specified for a particular coil connection (differential, series or parallel coils) and does not include null bias current.

QUIESCENT CURRENT A dc current that is present in each valve coil when using a differential coil connection. The polarity of the current in the two coils is reversed so that no signal input exists.

COIL IMPEDANCE The complex ratio of coil voltage to coil current. Coil impedance will vary with signal frequency, amplitude, and other operating conditions, but can be approximated by the dc coil resistance (ohms) and the apparent coil inductance (henrys) measured at a signal frequency.

DITHER An ac signal sometimes superimposed on the servovalve input to improve system resolution. Dither is expressed by the dither frequency (Hz) and the peak-to-peak dither current amplitude (ma).

HYDRAULIC

CONTROL FLOW The flow through the valve control ports to the load expressed in in^3/sec (cis), or gal/min (gpm), or lit/min (lpm).

RATED FLOW The specified control flow corresponding to rated current and given supply and load pressure conditions. Rated flow is normally specified as the no-load flow and is expressed in cis, or gpm, or lpm.

FLOW GAIN The nominal relationship of control flow to input current, expressed as cis/ma, or gpm/ma, or lpm/ma.

NO-LOAD FLOW The control flow with zero load pressure drop, expressed in cis, or gpm, or lpm.

INTERNAL LEAKAGE The total internal valve flow from pressure to return with zero control flow (usually measured with control ports blocked), expressed in cis, or gpm, or lpm. Leakage flow will vary with input current, generally being a maximum at the valve null (called NULL LEAKAGE).

LOAD PRESSURE DROP The differential pressure between the control ports (that is, across the load actuator), expressed in lbs/in^2 (psi), or bar.

VALVE PRESSURE DROP The sum of the differential pressures across the control orifices of the servovalve spool, expressed in psi or bar. Valve pressure drop will equal the supply pressure, minus the return pressure, minus the load pressure drop $[P_V = (P_S - P_R) - P_L]$.

PERFORMANCE

LINEARITY The maximum deviation of control flow from the best straight line of flow gain. Expressed as percent of rated current.

SYMMETRY The degree of equality between the flow gain of one polarity and that of reversed polarity, measured as the difference in flow gain for each polarity and expressed as percent of the greater.

HYSTERESIS The difference in valve input currents required to produce the same valve output as the valve is slowly cycled between plus and minus rated current. Expressed as percent of rated current.

THRESHOLD The increment of input current required to produce a change in valve output. Valve threshold is usually measured as the current increment required to change from an increasing output to a decreasing output. Expressed as percent of rated current.

LAP In a sliding spool valve, the relative axial position relationship between the fixed and movable flow-metering edges with the spool at null. Lap is measured as the total separation at zero flow of straight line extensions of the nearly straight portions of the flow curve, drawn separately for each polarity. Expressed as percent of rated current.

PRESSURE GAIN The change of load pressure drop with input current and zero control flow (control ports blocked). Expressed as the nominal psi/ma or bar/ma throughout the range of load pressure between ±40% supply pressure.

NULL The condition where the valve supplies zero control flow at zero load pressure drop.

NULL BIAS The input current required to bring the valve to null, excluding the effects of valve hysteresis. Expressed as percent of rated current.

NULL SHIFT The change in null bias resulting from changes in operating conditions or environment. Expressed as percent of rated current.

FREQUENCY RESPONSE The relationship of no-load control flow to input current when the current is made to vary sinusoidally at constant amplitude over a range of frequencies. Frequency response is expressed by the amplitude ratio (in decibels, or db), and phase angle (in degrees), over a specific frequency range.

UNITS

Recommended English and Metric (SI) units for expressing servovalve performance include the following:

	English	Metric	Conversion
fluid flow	in^3sec (cis) gal/min (gpm)	liter/min (lpm)	0.98 lpm/cis 3.78 lpm/gpm
fluid pressure	lbs/in^2 (psi)	bar	0.069 bar/psi
dimensions	inch (in)	millimeters (mm) micrometers (μm)	25.4 mm/in 25400 μm/in
mass	pounds (lb)	kilogram	0.454 kg/lb
force	pounds (lb)	Newtons (N)	4.45 N/lb
torque	lb-in	Newton-meters (N-m)	0.113 N-m/lb-in
temperature	degrees Fahrenheit (°F)	degrees Celsius (°C)	°C = 5/9 (°F − 32)

HYDRAULIC CHARACTERISTICS

Unless specified otherwise, all performance parameters are given for valve operation on Mobil DTE-24 fluid at 100°F (38°C).

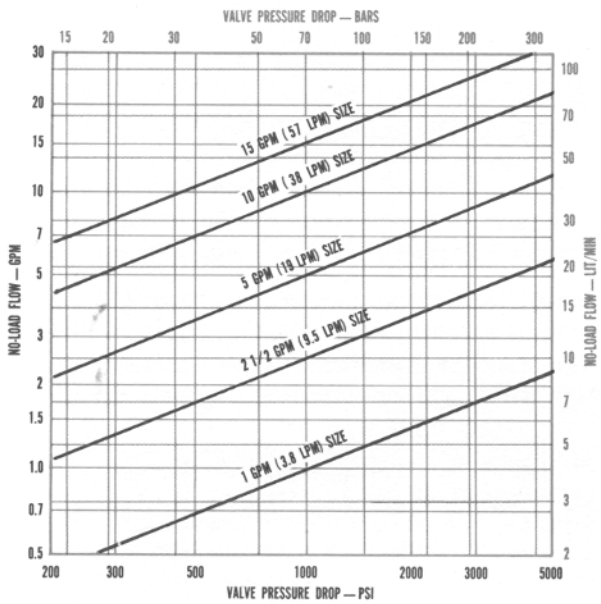


FIGURE 1 CHANGE IN RATED FLOW WITH PRESSURE

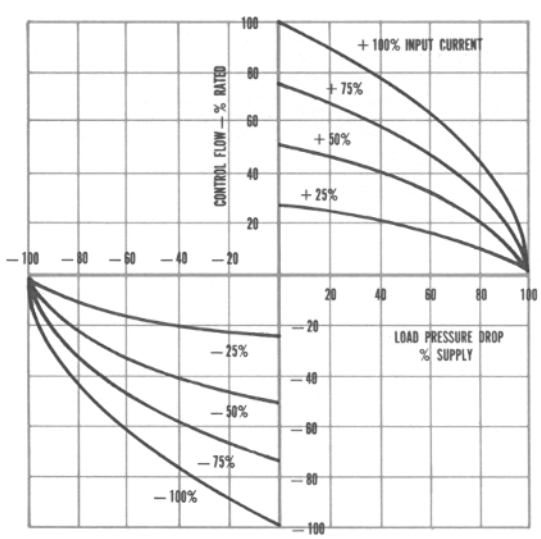


FIGURE 2 — CHANGE IN CONTROL FLOW WITH CURRENT AND LOAD PRESSURE

FLUID SUPPLY Series 73 Servovalves are intended to operate with constant supply pressure.

Supply Pressure

minimum	200 psi (14 bars)
maximum standard	3000 psi (210 bars)
maximum special order	5000 psi (350 bars)

Proof Pressure

at pressure port	150% supply
at return port	100% supply

Fluid — petroleum base hydraulic fluids 60-450 SUS @ 100° F (10-97 cSt @ 38° C)

Buna N seals are standard;
Viton A available on special order.

Supply filtration required — 10μm nominal (25μm absolute) or finer recommended

Operating temperature,

minimum — −40° F (−40° C)
(unless limited by fluid viscosity $\leq$ 6000 SUS or 1300 cSt) ($\leq$ 1300 cSt)

maximum — + 275° F (+ 135° C)
(unless limited by fluid temperature rating)

RATED FLOW Flow specified below is the full valve control flow with either ± 100% electrical input when operating with supply and load pressure conditions that give 1000 psi (70 bars) valve drop. Control flow will saturate in higher flow models due to pressure drop in internal passages.

Five valve models are available from stock:

Valve Model	Flow with 1000 psi (70 bars) Supply — Rated Flow GPM	Rated Flow Lit/Min	Internal Leakage GPM	Internal Leakage Lit/Min
73-100	1	3.8	< 0.17	< 0.66
73-101	2.5	9.5	< 0.22	< 0.83
73-102	5	19	< 0.35	< 1.32
73-103	10	38	< 0.35	< 1.32
73-104	15	57	< 0.35	< 1.32

Rated flow for other valve pressure drop conditions is given in Figure 1. Flow with various combinations of supply pressure and load pressure drop can be determined by calculating the valve pressure drop.

$$P_V = (P_S - P_R) - P_L$$

P_V = valve pressure drop
P_S = supply pressure
P_R = return pressure
P_L = load pressure drop

FLOW-LOAD CHARACTERISTICS Control flow to the load will change with load pressure drop and electrical input as shown in Figure 2. These characteristics follow closely the theoretical square-root relationship for sharp-edged orifices, which is

$$Q_L = K\, i \sqrt{P_V}$$

Q_L = control flow
K = valve sizing constant
i = input current
P_V = valve pressure drop

PERFORMANCE CHARACTERISTICS

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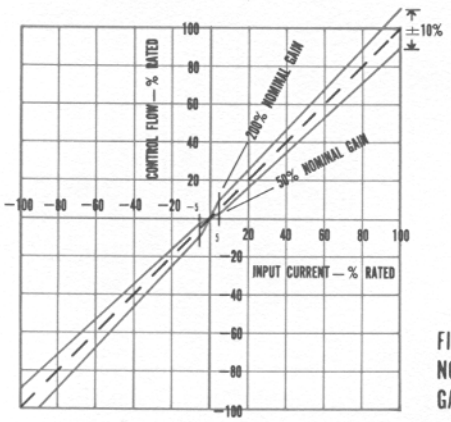


FIGURE 3
NO-LOAD FLOW
GAIN TOLERANCES

FLOW GAIN The no-load flow characteristics of a Series 73 servovalve can be plotted to show flow gain, symmetry, and linearity. Typical limits (excluding hysteresis effects) are shown in Figure 3.

LINEARITY The nonlinearity of control flow to input current will be most severe in the null region due to variations in the spool null cut. With standard production tolerances valve flow gain about null (within ±5% of rated current input) may range from 50 to 200% of the normal flow gain.

RATED FLOW TOLERANCE	± 10%
SYMMETRY	< 10%
HYSTERESIS	< 3%
THRESHOLD	< ½%

SPOOL DRIVING FORCES

The maximum hydraulic force available to drive the second-stage spool will depend upon the supply pressure, and the hydraulic amplifier pressure gradient. The normal first-stage configuration for a Series 73 Servovalve will produce a spool driving force gradient which exceeds 1 lb/% (0.4 daN/%) input current with a 3000 psi (210 bars) supply. This gradient will be reduced about 30% when operating on a 1000 psi (70 bars) supply. The maximum spool driving force with 3000 psi (210 bars) supply is 150 pounds (67 daN).

PRESSURE GAIN The blocked load differential pressure will change rapidly from one limit to the other as input current causes the valve spool to traverse the null region. Normally the pressure gain at null for Series 73 Servovalves exceeds 30% of supply pressure for 1% of rated current and can be as high as 80%.

NULL externally adjustable

NULL SHIFT

With Temperature	100°F variation (56°C)	<± 2%
With Acceleration	to 10 g	<± 2%
With Supply Pressure	80% to 110% nominal	<± 2%
With Quiescent Current	50% to 100% rated current	<± 2%
With Back Pressure	0% to 20% of supply	<± 2%

FREQUENCY RESPONSE Typical response characteristics for Series 73 servovalves are shown in Figures 4 and 5. Servovalve frequency response will vary with signal amplitude, supply pressure, temperature, and internal valve design parameters. The variation in response with supply pressure, as expressed by the change in frequency of the 90° phase point, is given in Figure 6.

STEP RESPONSE Typical transient response of 73 Series servovalves is given in Figure 7. The straight-line portion of the response represents saturation flow from the pilot stage which will increase with higher supply pressures.

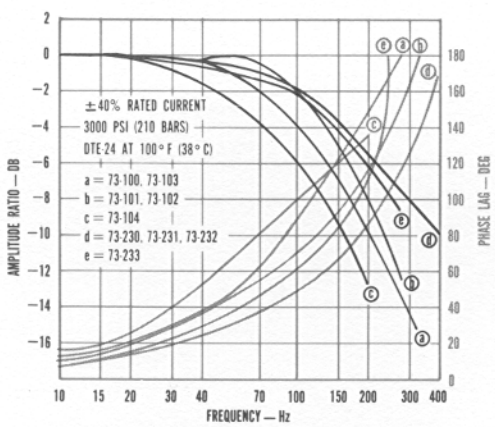


FIGURE 4 REDUCED AMPLITUDE FREQUENCY RESPONSE

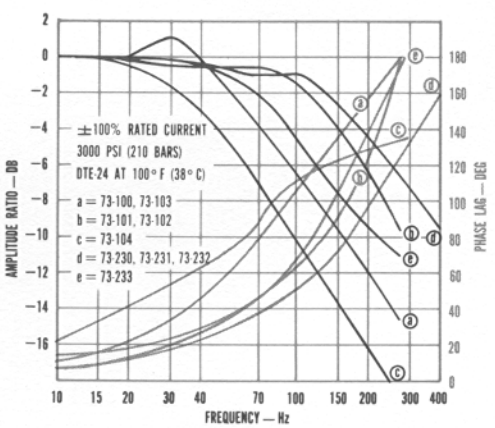


FIGURE 5 FULL AMPLITUDE FREQUENCY RESPONSE

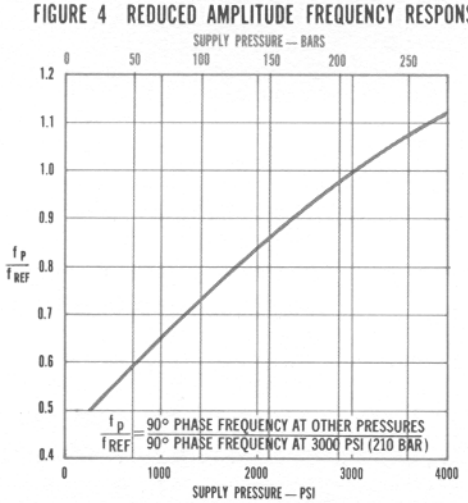


FIGURE 6 FREQUENCY RESPONSE CHANGE WITH PRESSURE

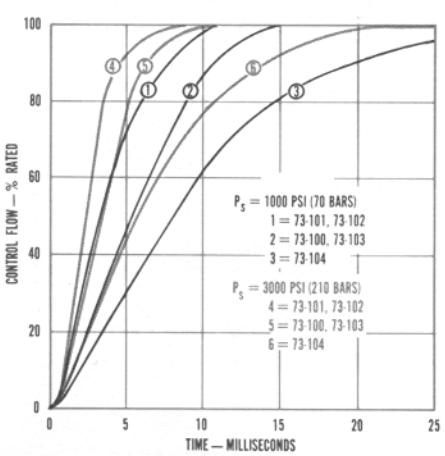


FIGURE 7 STEP RESPONSE

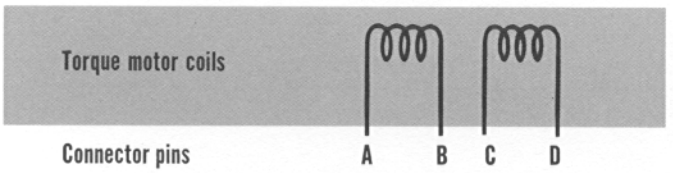
ELECTRICAL CHARACTERISTICS

RATED CURRENT & COIL RESISTANCE

A variety of coils are available for 73 Series Servovalves, so there is a wide choice of rated current. See Table I. It is possible to derate a coil to give a lower rated current than listed, thus rated current may be 8 ma differential for a 1000 ohm/coil valve.

Also, 73 Series valves can be supplied with internal resistors to give higher resistance for a given rated current. Thus 670 ohm resistors with 130 ohm coils will give 30 ma rated differential current with 800 ohm/coil.

STANDARD ELECTRICAL CONFIGURATION



External connections and electrical polarity for flow out C2 are

single coil: A+, B—; or C+, D—
series coils: tie B to C; A+, D—
parallel coils: tie A to C and B to D;
A & C+, B & D—

COIL CONNECTIONS A four-pin electrical connector (that mates with a MS3106-14S-2S) is standard. All four torque motor leads are available at the connector so external connections can be made for series, parallel, or differential operation.

73 Series Servovalves can be supplied on special order with other connectors. Also the coils can be wired internally for 2 or 3-wire operation.

SERVOAMPLIFIER The servovalve responds to input current, so a servoamplifier that has high internal impedance (as obtained with current feedback) should be used. This will reduce the effects of coil inductance and will minimize changes due to coil resistance variations.

DITHER A small amplitude dither signal may be used to improve system performance. If used it is recommended that dither frequency be 200 to 400 Hz and less than 20% rated current amplitude.

COIL IMPEDANCE The resistance and inductance of standard coils are given in the Table below. The two coils in each servovalve are wound for equal turns with a normal production tolerance on coil resistance of ± 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 emf's 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.

Table I. Available Coils for 73 Series Servovalves

NOMINAL RESISTANCE PER COIL AT 70° F (21° C) OHMS	RECOMMENDED RATED CURRENT — MA		APPROXIMATE COIL INDUCTANCE — HENRYS			
	Differential, Parallel or Single Coil Configuration	Series Coils	Single Coils	Differential* Coils	Series Coils	Parallel Coils
22	200	100	0.07	0.10	0.21	0.06
40	50	25	0.12	0.19	0.36	0.10
**80	40	20	0.22	0.34	0.66	0.18
130	30	15	0.37	0.58	1.1	0.30
200	20	10	0.72	1.1	2.2	0.59
500	15	7.5	1.3	2.1	4.1	1.1
1000	10	5	3.2	5.0	9.7	2.6
1500	8	4	4.1	6.4	12.5	3.4

*Inductance per coil with differential operation (class A push-pull).
**Coil supplied in standard models.

STANDARD MODELS

Moog maintains five different models of the 73 Series servovalve in stock. Characteristics of these stock models are controlled for optimum system performance in usual applications.

These stock valves are made in production quantities, so each user gains the cost and technical advantages of an established production design.

STANDARD DESIGNS ARE AVAILABLE AS INDICATED BELOW

RATED FLOW		MODELS CARRIED IN STOCK		STANDARD DESIGN MODELS					
@ 1000 psi (70 bars) Supply		3000 psi (210 bars) Maximum Supply		3000 psi (210 bars) Maximum Supply				5000 psi (350 bars) Maximum Supply	
Gpm	Lit/Min	200 Ω/Coil 15 ma Diff.	80 Ω/Coil 40 ma Diff.	22 Ω/Coil 200 ma Diff.	1000 Ω/Coil 8 ma Diff.	1000 Ω/Coil 10 ma Diff.	High Response 80 Ω/Coil 40 ma Diff.	200 Ω/Coil 15 ma Diff.	80 Ω/Coil 40 ma Diff.
1	3.8	73-100		73-177	73-190		73-230	73-222	
2½	9.5	73-101		73-178	73-191		73-231	73-223	
5	19	73-102		73-161	73-192		73-232	73-224	
10	38	73-103		73-179	73-193		73-233	73-225	
15	57		73-104	73-180		73-194			73-234

ACCESSORIES

ORDER PART NUMBER

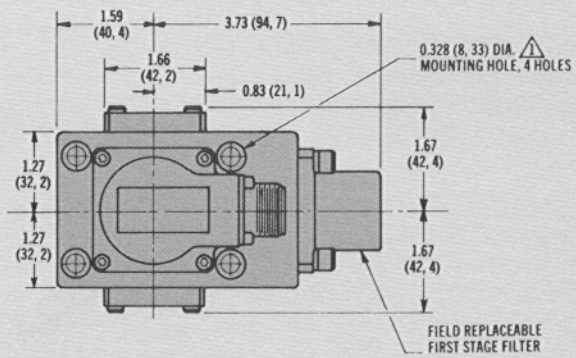
FLUSHING BLOCK..... 100-23718-1

ADAPTER MANIFOLD for ¾-inch tubing, 4 ports (SAE industrial straight threads).....100-43586-1

REPLACEMENT FILTER CARTRIDGE.... 071-22050

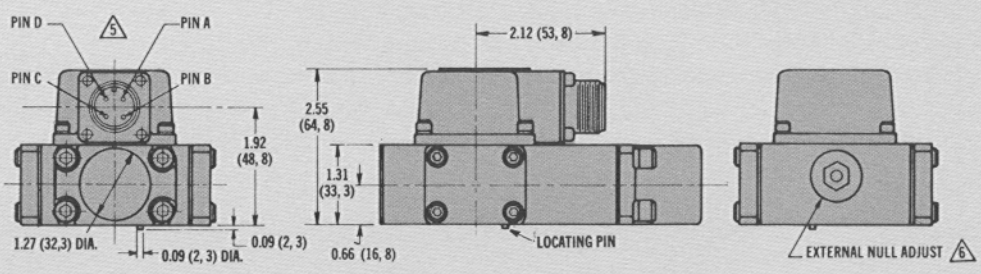
MATING ELECTRICAL CONNECTOR

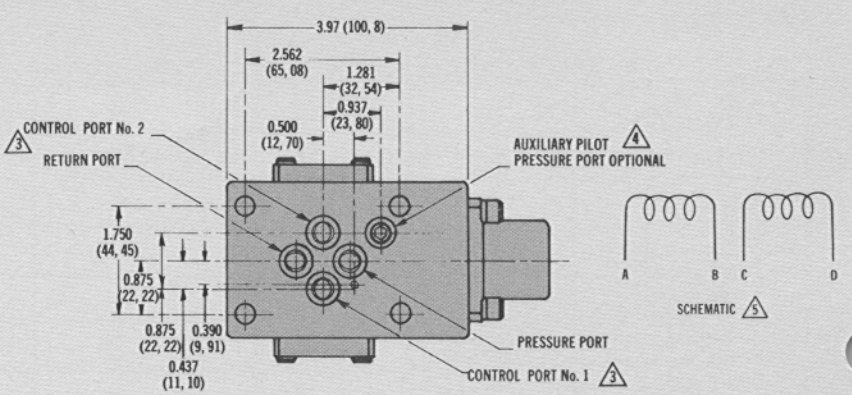
MS3106-14S-2S.....061-49054F14S-2S



INSTALLATION DETAILS

1. Suggested mounting screws: 5/16-18 x 1⅝" long, socket head cap screws (M8 x 40).
2. Surface to which valve is mounted requires 32/ finish, (▽▽▽) flat within 0.001 (0,02) TIR.
3. Ports P, R, 1, and 2: 0.312 (7,92) dia. port "O" rings: 0.070 (1,78) sect. x 0.426 (10,82) I.D.
4. Valves are supplied with provisions for either internal or external pressurization of first stage through aux. pressure port; aux. port dia.: 0.213 (5,41); aux. port "O" ring: 0.070 (1,78) sect. x 0.364 (9,25) I.D.
5. Electrical connector mates with MS3106-14S-2S, or equivalent.
6. Null adjust: flow out port 2 is obtained with clockwise rotation of null adjust screw.
7. Compressed oil volume for one piston port: 0.117 in.³ (2,97 cm³.)
8. Dimensions in parenthesis are in millimeters.





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