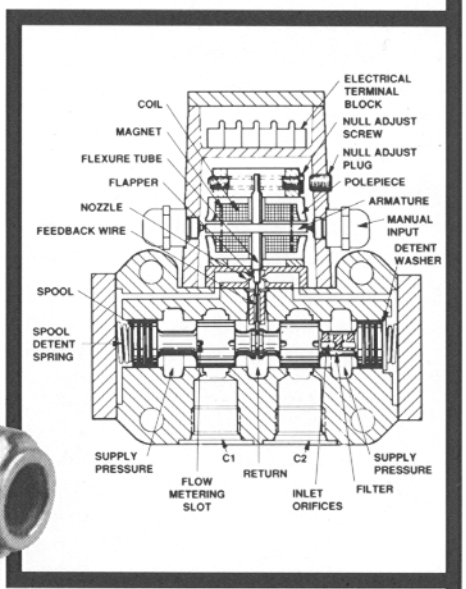
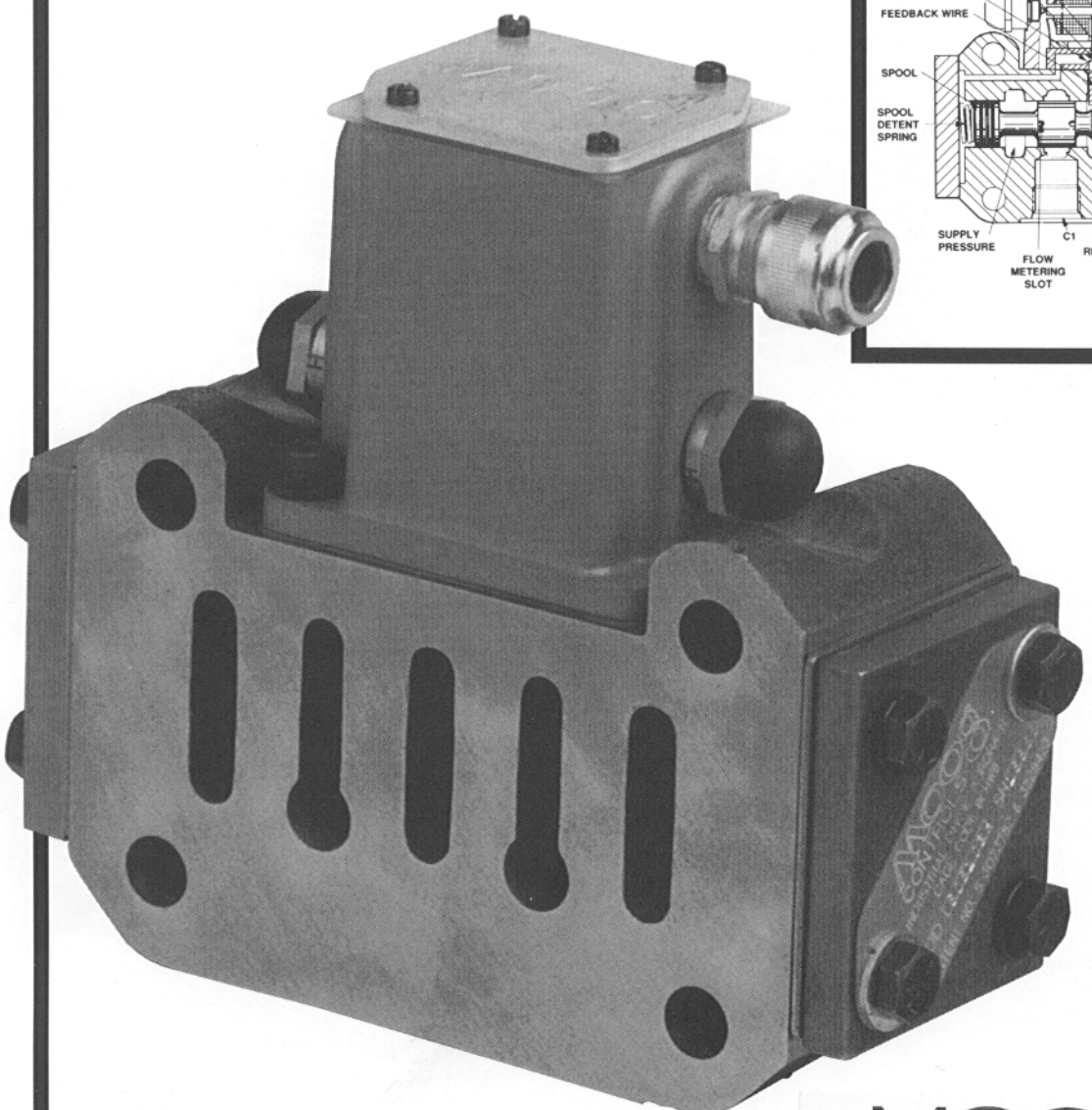
60 Series Product Manual

PROPORTIONAL ELECTROHYDRAULIC CONTROL VALVES





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Series 60 Proportional Electrohydraulic Control Valves

Series 60 valves are electrically controlled, proportional metering valves suitable for a variety of mobile vehicles and industrial control applications, such as earth moving vehicles, articulated arm devices, cargo handling cranes, lift trucks, logging equipment, farm machinery, steel mill controls, utility construction and servicing vehicles, firetrucks, etc.

Proportional electrohydraulic controls can be used in place of manually operated directional valves. This new control approach offers conveniences and flexibility not possible with manual valves.

SERIES 60 VALVES

Series 60 valves are "closed-center" for operation with a constant pressure hydraulic supply. The valves contain a four-way sliding spool having two load control ports. These load ports connect to a cylinder/piston or rotary hydraulic motor. Electrical input to the Series 60 Valve controls the flow to the load in a proportional manner throughout the range from zero to full flow in either direction.

ELECTRICAL CONTROLLERS

Electrical control for Series 60 valves can come from several different types of manual control stations. Stackable single lever controllers, two-axis joy stick controllers, multi-axis hand held controllers, and multi-channel radio controllers are available.

CONTROL CHARACTERISTICS

Series 60 valves provide smooth and repeatable flow control within a fraction of a second after the electrical command. Electrical controllers provide operator convenience with negligible effort and optimum controls arrangement and location. The result is a mobile equipment hydraulic control system that is smooth and fast, and easy to operate and maintain.

PROPORTIONAL ELECTROHYDRAULICS OFFER:

- Ease of operation
  Dramatically low control lever force all but eliminates operator fatigue

- Simplified hydraulic plumbing
  Valves can be located near actuators;
  eliminates need to plumb hydraulics into control cab

- Flexibility of controls
  Location and orientation of controllers can be "human engineered" for operator convenience
  Convenient two-axis joy stick without cumbersome mechanical linkages
  Simple electrical interlocks can improve safety of equipment

- Extremely smooth feathering
  Very low friction of control levers and Series 60 valves gives precise operator control with no sacrifice in maximum speed

- Long reliable life with easy maintenance
  Moog Controls system filters will ensure fluid cleanliness for trouble-free operation
  Detailed service manual available for field repair of Series 60 valves

Series 60 Operation

Moog Controls Series 60 valves use an electrical torque motor, a nozzle-flapper pilot stage and a sliding spool main stage. *

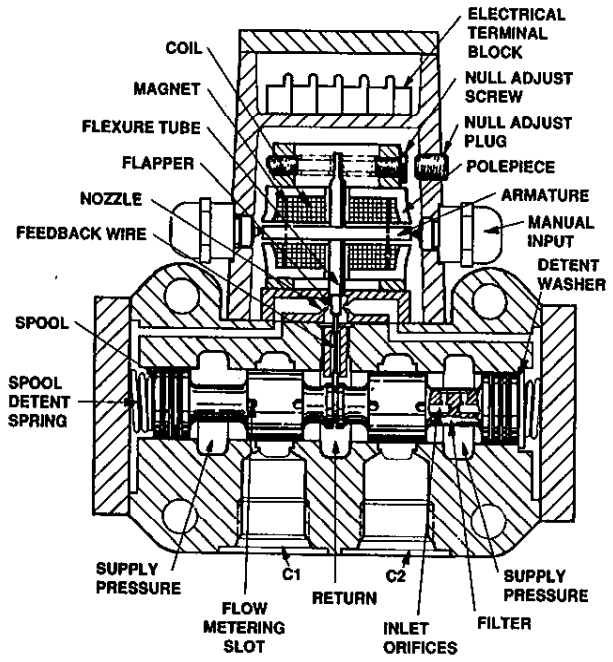
TORQUE MOTOR

The torque motor includes coils, polepieces, magnets and an armature. The armature is supported for limited movement by a flexure tube. The flexure tube also provides a fluid seal between the hydraulic and electromagnetic portions of the valve.

PILOT STAGE

The flapper attaches to the center of the armature and extends down, inside the flexure tube. A nozzle is located on each side of the flapper so that flapper motion varies the nozzle openings. Pressurized hydraulic fluid is supplied to each nozzle through an inlet orifice located in the end of the spool. This pilot stage flow is filtered by a 40μ screen that is wrapped around the shank of the spool. Differential pressure between the ends of the spool is varied by flapper motion between the nozzles.

*U.S. Patent Nos. 3,023,782 and 3,228,423



VALVE SPOOL

The four-way valve spool directs flow from supply to either control port C1 or C2 in an amount proportional to spool displacement. The spool contains flow metering slots in the control lands that are uncovered by spool motion. Spool movement deflects a feedback wire that applies a torque to the armature/flapper. Spool detent springs are provided to center the spool whenever hydraulic driving pressures are absent.

OPERATION

Electrical current in the torque motor coils causes either clockwise or counter-clockwise torque on the armature. This torque displaces the flapper between the two nozzles. The differential nozzle flow moves the spool to either the right or left. The spool continues to move until the feedback torque counteracts the electromagnetic torque. At this point, the armature/flapper is returned to center so the spool stops and remains displaced until the electrical input changes to a new level. Therefore, valve spool position is proportional to the electrical signal. The actual flow from the valve to the load will depend upon the load pressure as described under Rated Flow (page 4).

APPLICATION REQUIREMENTS

Supply pressure	3000 psi maximum 300 psi minimum
Maximum return pressure	300 psi below supply but not above 1500 psi
Operating temperature (fluid and/or ambient)	200°F maximum —30°F minimum
Fluid	Petroleum base hydraulic fluids 60 to 450 SSU at 100°F
Filtration required	Moog Controls Type HP non-bypass 10μ full flow supply line filter recommended
Rated electrical power	0.135 watts
Mounting	Any position, fixed or movable

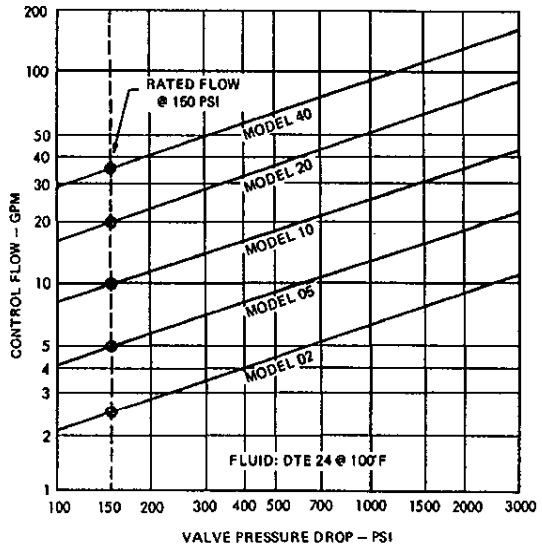
RATED FLOW

Five Series 60 Models are available having the following nominal rated flows:

Nominal Rated Flow

Model	@ 150 psi valve pressure drop	@ 1000 psi valve pressure drop
02	2-1/2 gpm	6-1/2 gpm
05	5 gpm	13 gpm
10	10 gpm	26 gpm
20	20 gpm	52 gpm
40	36 gpm	93 gpm

Rated flow is achieved with either plus or minus 100% electrical signal. The amount of rated flow will depend upon valve pressure drop. Valve pressure drop is the difference between net supply pressure (supply pressure minus return pressure) and the load pressure. For example, if the supply pressure is 1500 psi, the return pressure 100 psi, and the differential pressure across the load is 800 psi, then the valve pressure drop is 600 psi. Nominal valve flow with ±100% electrical input for various valve pressure drop conditions is plotted below.



VALVE SIZING

Standard valve ratings are given for 150 psi valve pressure drop. Most systems operate at 1500 psi or 2500 psi. When the load does not require much pressure drop across the cylinder, the valve has the total supply pressure drop.

$$\Delta P_V + \Delta P_C = P_S$$

$$\text{so } \Delta P_V = P_S - \Delta P_C$$

where ΔP_V = valve pressure drop

ΔP_C = total pressure drop across cylinder, lines, filters, and accessories at full flow

P_S = supply pressure

Flow through the valve increases with the valve pressure drop according to the following:

$$Q_V = Q_r \sqrt{\frac{\Delta P_V}{150}}$$

where Q_V = flow with actual valve pressure drop

Q_r = rated valve flow at 150 psi valve pressure drop

ΔP_V = actual valve pressure drop (psi)

For example, with a 2500 psi system, a 20 gpm Series 60 valve will pass at no load:

$$Q_V = 20 \sqrt{\frac{2500}{150}} = 82 \text{ gpm}$$

If the pump can support this flow, then the load will move over four times faster than the velocity calculated for rated valve flow.

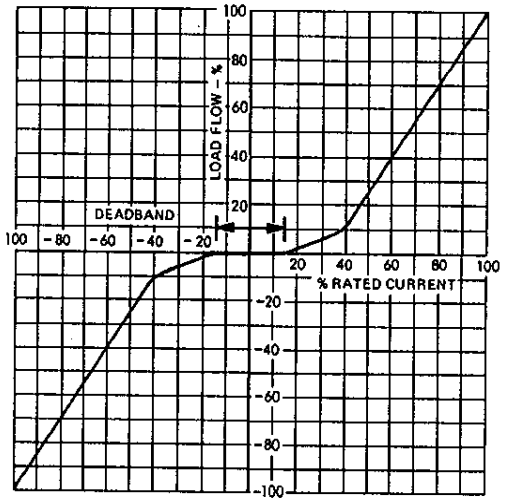
Initially in a system it is *better to undersize* the valve flow capacity than it is to oversize. Spools in Series 60 valves are easily altered to change their flow capacity.

Spool Configurations

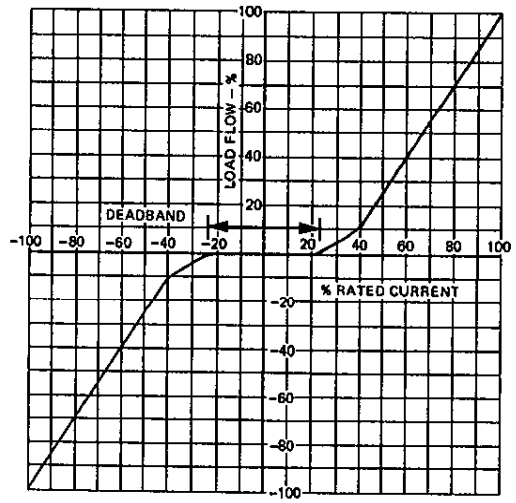
The flow capacity and flow control characteristic of Series 60 valves is determined by the valve spool. The spool contains the flow-metering slots, hence the flow characteristic can be changed by changing valve spools. Several rated flows, flow control shapes, and valve null configurations are available.

CURVILINEAR FLOW

This spool configuration gives reduced flow just outside the null deadband region (to 40% of rated current). The reduced flow provides vernier control at slow speed for improved load feathering. Standard curvilinear flow spools are provided with cylinder ports open to return at null.



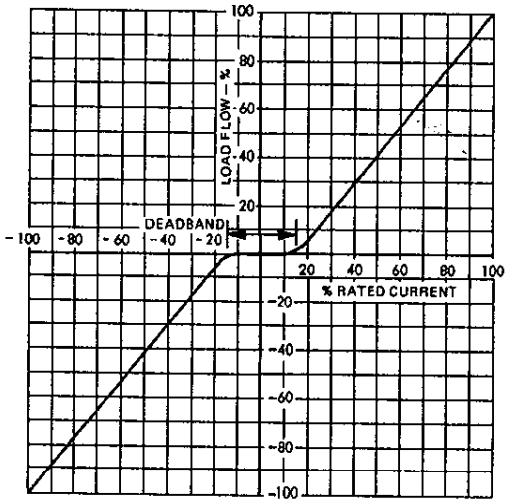
Curvilinear Flow Characteristic for Models 02, 05 and 10.



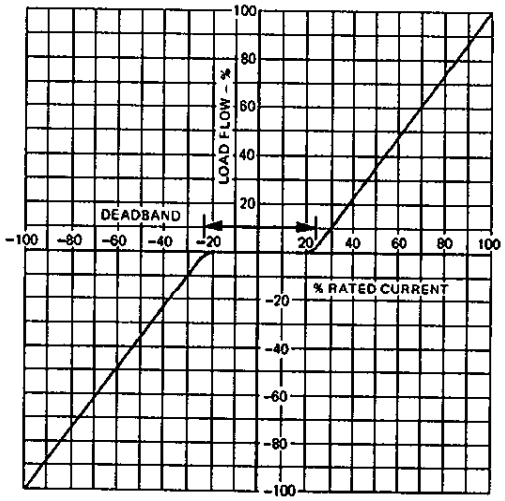
Curvilinear Flow Characteristic for Models 20 and 40.

LINEAR FLOW

This spool choice provides linear flow control outside the null deadband region. Low flow spools (Models 02, 05, and 10) have about ±15% deadband. High flow spools (Models 20 and 40) have additional null deadband for improved closed-center control. All linear flow valves are supplied with closed-cylinder ports.



Linear Flow Characteristic for Models 02, 05 and 10.



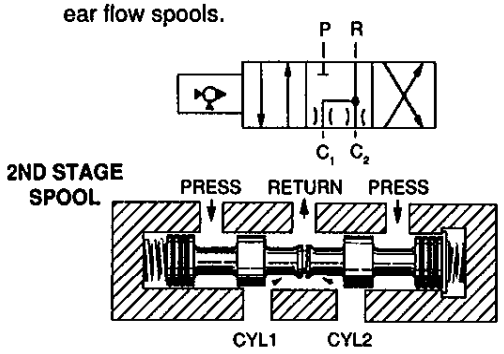
Linear Flow Characteristic for Models 20 and 40.

Performance

OPEN-CYLINDER PORTS

Valves with open-cylinder ports dump the cylinder lines to tank when the valve is off. This allows use of pilot operated load holding valves.

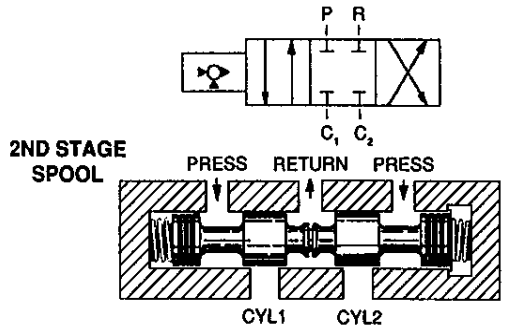
Open-cylinder-ports can only be provided with curvilinear flow spools.



NOTE: The Series 60 is basically a "closed-center" valve that operates with a constant pressure supply. This open-cylinder port spool configuration is not suitable for an "open center" hydraulic circuit.

CLOSED-CYLINDER PORTS

With this spool configuration, the cylinder ports are blocked at center (null) and the supply and return ports are closed off. Deadband about null is provided so that the load actuator will be stopped and blocked with zero electrical signal. This spool configuration is generally supplied for automatic feedback control systems.



NOTE: The closed-cylinder port Series 60 valve with linear flow characteristic is generally used for automatic closed loop control. These systems include an electrical transducer to sense load position, or force, or velocity, and an electronic servoamplifier to close the loop.

Other spool configurations (such as curvilinear flow with closed-cylinder ports) can be supplied on special order.

- Threshold

  The maximum change in electrical command to produce corresponding change from the valve.

  < 2% rated current

- Hysteresis

  The maximum non-repeatability of valve output due to cycling the electrical command.

  < 4% rated current

- Frequency Response

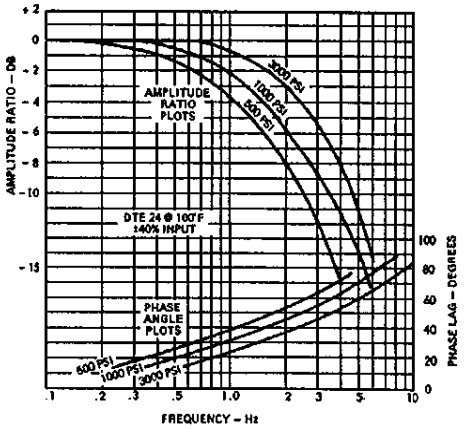
  Typical sinusoidal frequency response for valve operation at various supply pressures is shown below.

- Internal Leakage

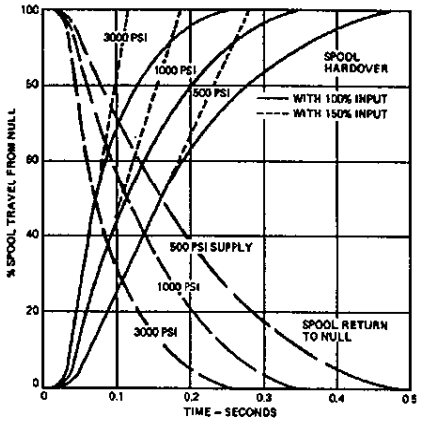
  The total valve leakage with zero electrical input and 1000 psi supply. < 0.4 gpm

- Transient Response

  Typical valve transient response for step inputs of electrical current are shown below.



TYPICAL FREQUENCY RESPONSE

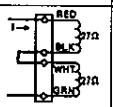
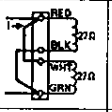
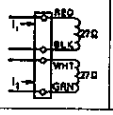


TYPICAL STEP RESPONSE

Electrical

Series 60 Valves have two 27 ohm coils that may be connected at the terminal strip for series, parallel or differential (push-pull) operation. The coils can also be used separately (single coils) to give valve operation from two different controllers. This allows both local and remote control locations. A fixed resistor can be wired in series with one valve coil to reduce the authority of the corresponding control station.

Coil inductance with two coils in series is 0.4 henry.

	Coil Connection	Voltage for rated current @70 °F	Rated Current	Flow Out C1
SERIES		± 2.7 vdc	I = ± 0.05 amp	Red (+) Green(-)
PARALLEL		± 1.35 vdc	I = ± 0.1 amp	Red (+) Green (-)
SINGLE COILS		± 2.7 vdc either	± 0.1 amp either	Red (+) & Black (-) or White (+) & Green (-)

CABLES

Electrical cable entrance into a Series 60 Valve should utilize the compressed rubber grommet cable clamp that is supplied with each valve. This type of clamp seals the torque motor cavity and also provides mechanical strain relief. Alternatively, the wires may be carried in a wire conduit that is threaded to screw into the torque motor housing.

Stacking

Hydraulic connection and mounting of Series 60 Valves is accomplished with seal plates and hydraulic manifolds. Both low flow and high flow (>15 gpm) manifolds are available.

SINGLE VALVE STACK

Series 60 Valves can be supplied with or without the three thru-flow ports for supply and return fluid. Single valve stacks are simplified by omitting the thru-flow ports. Just a single manifold and seal plate are then required. Installation drawings for single ended valves with both high flow and low flow manifolds are shown below.

VALVE STACKING

Stacking of valves is recommended to minimize space requirements and to simplify plumbing. Stacking kits are available to handle up to six valves. Each kit contains the appropriate manifolds, end plate, seal plates, and hardware. End plates are used to provide mounting feet for both ends of the valve stack.

In each installation the higher flow valves should be positioned closest to the manifold. Certain stacking kits contain two hydraulic manifolds so that both ends of the stack can be plumbed to supply and return.

TORQUING

Bolts for all stacking kits should be torqued to 55 ± 5 ft. lbs.

STACKING KITS

Number of Valves to be Stacked	Total Combined Flow at any one time	Manifold Provided	Stacking Kit Part Number
Single Valve	up to 15 gpm	1 low flow	A01177N1
	above 15 gpm	1 high flow	A01177N2
2	up to 15 gpm	1 low flow	59656N3
	above 15 gpm	1 high flow	59656N4
3	up to 15 gpm	1 low flow	59656N5
	above 15 gpm	1 high flow	59656N6
4	up to 15 gpm	1 low flow	59656N7
	15 to 30 gpm	2 low flow	59656N8
	30 to 60 gpm	1 high flow	59656N16
	above 60 gpm	2 high flow	59656N9
5	up to 15 gpm	1 low flow	59656N10
	15 to 30 gpm	2 low flow	59656N11
	30 to 60 gpm	1 high flow	59656N17
	above 60 gpm	2 high flow	59656N12
6	up to 15 gpm	1 low flow	59656N13
	15 to 30 gpm	2 low flow	59656N14
	30 to 60 gpm	1 high flow	59656N18
	above 60 gpm	2 high flow	59656N15

Closed-Center Hydraulic Supply

Perhaps the most unusual requirement for use of Moog Controls Series 60 valves in a mobile vehicle is a closed-center hydraulic circuit. The majority of vehicles now in use have an open-center, or constant flow, hydraulic circuit.

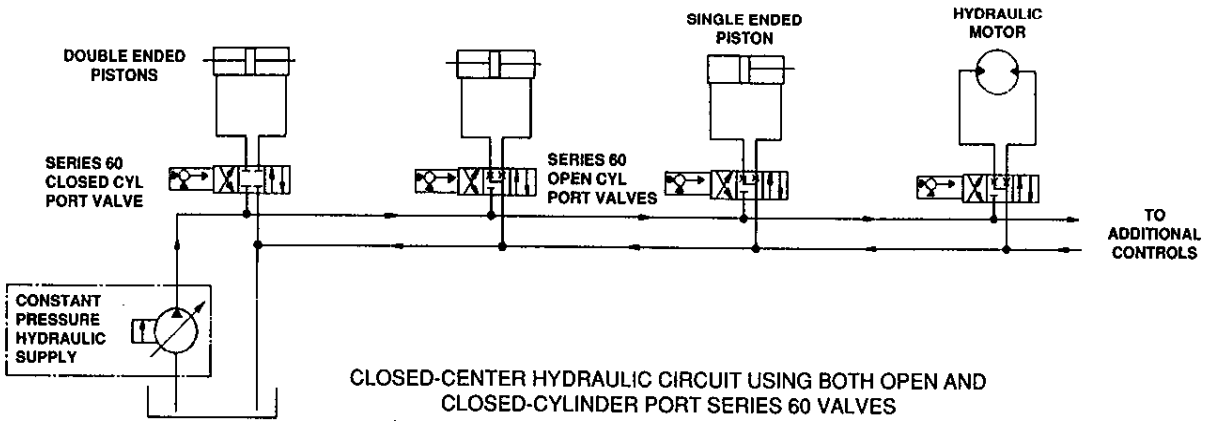
A closed-center circuit offers the ultimate in vehicle control. Various control functions are non-interactive, and the response is immediate and positive. Controls in open-center circuits suffer from the sluggishness of building-up pressure to move a load, and from the loss of response that occurs when other controls are exercised.

Plumbing is usually simplified in a closed-center circuit as the number and size of hydraulic lines are reduced. This saves installation and assembly costs.

A closed-center circuit also provides the pilot pressure necessary to actuate Moog Controls Series 60 valves directly from the main supply pump. This avoids the need for a priority valve or an additional pump, either of which are required to provide pilot pressure in an open-center hydraulic circuit.

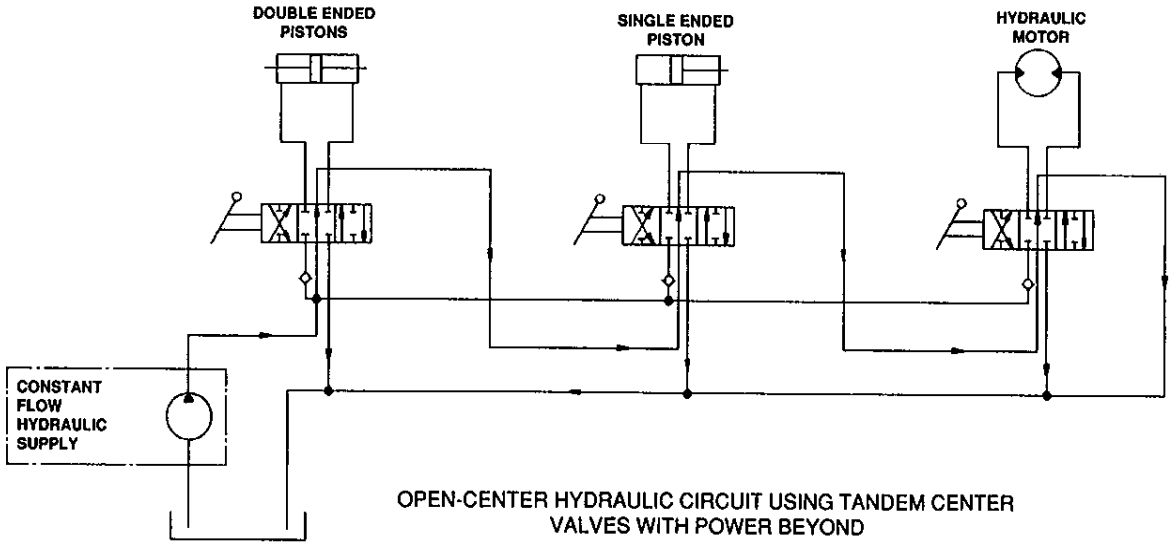
Closed-Center Hydraulic Circuit	Open-Center Hydraulic Circuit
Constant pressure supply • with controls not actuated system has full pressure and nearly zero flow	Constant flow supply • with controls not actuated system has full flow and nearly zero pressure
Pump builds-up flow to move load	Pump builds-up pressure to move load
Variable displacement pump, • or pump unloading circuit, • or load demand pump circuit	Constant displacement pump
Control valves divide available flow	Control valves divide available pressure
Valves may have open- or closed-cylinder ports	Valves may have open- or closed-cylinder ports
Various valve stacks connected in parallel • optimum size plumbing to each valve stack	Tandem center valve stacks with or without power beyond • full flow hydraulic plumbing to all valve stacks

Closed-Center Circuit



CLOSED-CENTER HYDRAULIC CIRCUIT USING BOTH OPEN AND CLOSED-CYLINDER PORT SERIES 60 VALVES

Open-Center Circuit



OPEN-CENTER HYDRAULIC CIRCUIT USING TANDEM CENTER VALVES WITH POWER BEYOND

Pumping Circuit and Fluid Cleanliness

The hydraulic supply for Series 60 valves can be provided by several different pumping circuits. A variable displacement pump is, perhaps, the best. This circuit provides full pressure at all times. A small accumulator may be used to provide transient flow during the time the pump stroke picks up a load demand. Standby power is small. A variety of compensator designs are available to tailor the pump pressure/flow (power output) characteristic. A solenoid operated blocking valve is recommended for added safety.

An accumulator unloading circuit is often used with a closed-center system. The pump is brought "on-line" periodically to recharge the supply accumulator.

When changing over from an open to a closed-center system, a fixed displacement pump with solenoid actuated bypass valve is often the simplest circuit.

The solenoid is energized whenever an electrical command is given to a Series 60 valve. Manual open-center valves can be used in the same hydraulic circuit with Series 60 valves if a closed-center plug is installed.

The cylinder demand circuit for unloading a fixed displacement pump is a very effective hydraulic supply for a closed-center system. The pilot operated unloading valve maintains supply pressure a nominal amount (about 300 psi) above that needed to move any one piston. The pilot lines and check valves (which connect to the valve stack or to the cylinders) can be sized very small. The nominal standby pressure is sufficient for operating the Series 60 valves.

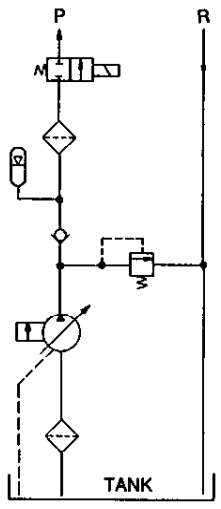
FILTRATION

The most important requirement for successful use of Series 60 valves is adequate fluid cleanliness. If the hydraulic system is initially flushed for clean-up, and if proper filtration (rated at $\beta_3 > 200$) is provided, reduced component wear will be obtained and the Series 60 valves will give long, trouble-free operation.

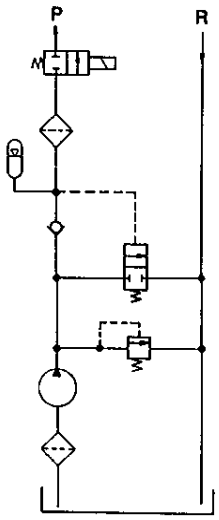
It should not be inferred that Series 60 valves are particularly dirt sensitive. The nozzles and orifices will pass 150 micron particles. However, large amounts of smaller contaminant can cause silting at the spool and sleeve, or load up the protective filter.

Each stack of Series 60 valves should be protected by a non-bypass, 10 micron (or finer) filter with an element that can withstand full supply pressure drop without collapse. The Moog Controls HP Filter with optional dirt alarm (available in several flow sizes from 10 gpm to 100 gpm) is specifically designed for these applications.

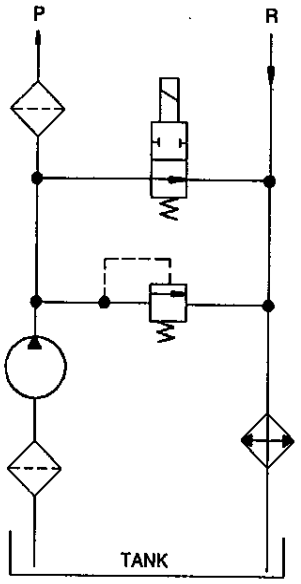
Lower cost filter elements that cannot withstand full supply pressure drop ***should not*** be used. These elements will collapse when loaded and dump large amounts of contaminant into the system. Filters that have bypass valves ***should not*** be used. They cease to work when the element needs replacement and this leads to system contamination rather than a filter change.



VARIABLE DISPLACEMENT PUMP AND ACCUMULATOR



FIXED DISPLACEMENT PUMP AND ACCUMULATOR/ UNLOADING



FIXED DISPLACEMENT PUMP WITH SOLENOID BY-PASS VALVE

FLUSHING

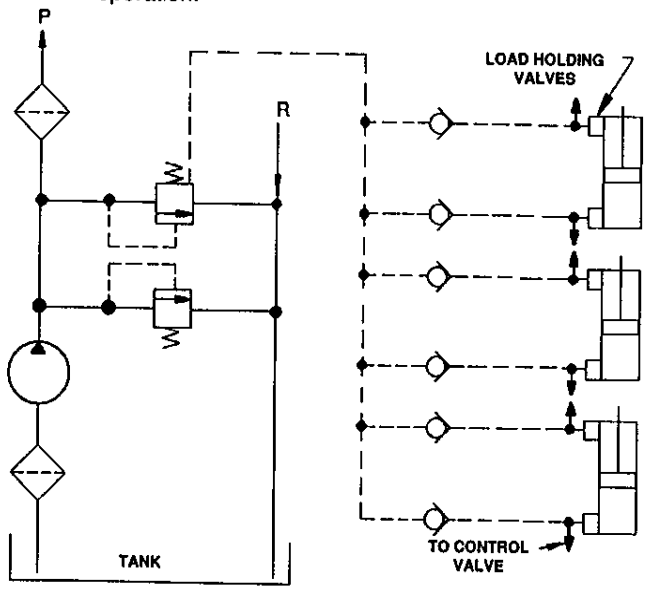
A closed-center system requires a different flushing technique from an open-center system since no open path exists from pressure to return. A new hydraulic system must be flushed for clean-up before connecting Series 60 valve stacks.

The recommended procedure is to pre-clean the reservoir and all tubing, then make up and install all hydraulic lines, fittings, and components. Pipe dope should not be used on threaded fittings. Instead, use a wrap of teflon tape applied 2 or 3 threads back from the end of the male fitting. Where possible, pre-flush and clean up cylinders, actuators and connecting hydraulic lines before installation.

When installation is complete, disconnect the pressure and return lines at each valve stack. Use an adaptor fitting to connect the pressure and return lines together. Sometimes a low micron clean-up filter is inserted in this connection.

Now start the pump and flush the hydraulic system, replacing filter elements as necessary, until clean. A low pressure filter element may be used in the system filter housing during clean-up. Usually this flushing procedure takes two hours or more.

After flushing, replace all filter elements and flush for an additional ten minutes. Then re-connect the pressure and return lines to the valve stacks. The hydraulic system should now be ready for long and trouble-free operation.

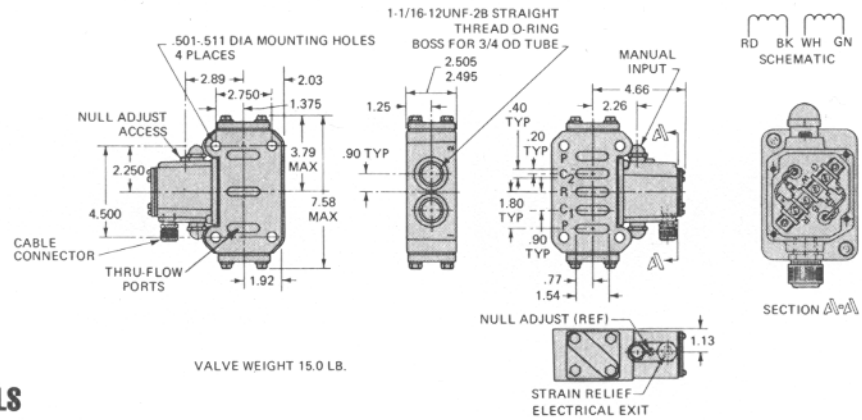


FIXED DISPLACEMENT PUMP WITH CYLINDER DEMAND PUMP UNLOADING VALVE

Design Features

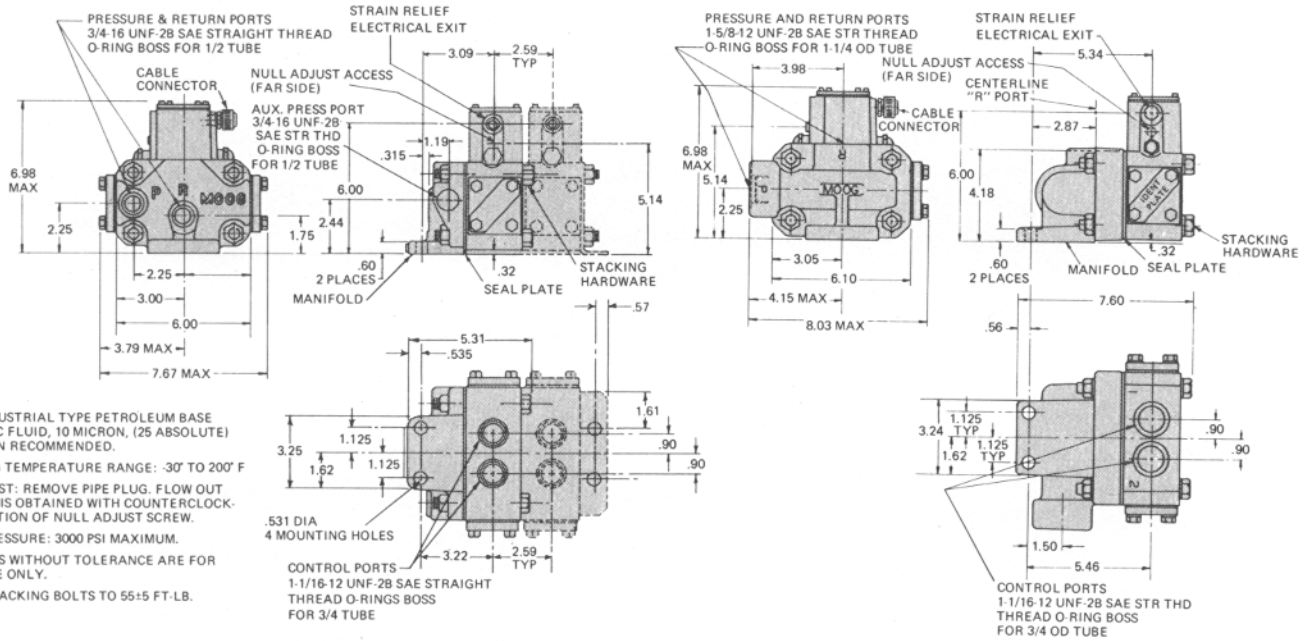
Design features of Moog Controls Series 60 Valves are covered by U.S. Patents 3,023,782 and 3,228,423

- **Rugged construction** - with heavy-duty cast iron body
- **High spool driving forces** - for positive spool positioning
- **Completely symmetrical design** - has minimum null shift with pressure and temperature changes
- **Reliable double-nozzle pilot stage** - has 150 micron dirt passing capability
- **Dry electrical torque motor** - eliminates pick-up of magnetic particles from the fluid
- **Low electrical power** - (0.135 watts maximum) gives greater reliability and life for electrical controllers
- **Built-in pilot stage filter** - (40 micron nominal) for dependable, long-term operation
- **Simple spool feedback** - eliminates complex linkage and mechanical feedback mechanisms
- **Interchageable spools** - provides convenient choice of flow capacity or flow metering configuration, even in the field
- **Field serviceable** - easily removable pilot valve for spool cleaning
- **Mechanical null adjustment** - for convenient set-up of control function
- **Spool detent springs** - ensure centered valve for pressure off conditions
- **Flat manifold stacking** - eliminates the need for transfer tubes, bushings, spacers, etc.
- **Manual input** - provides direct control of pilot stage in event of electrical failure



VALVE WEIGHT 15.0 LB.

SERIES 60 INSTALLATION DETAILS



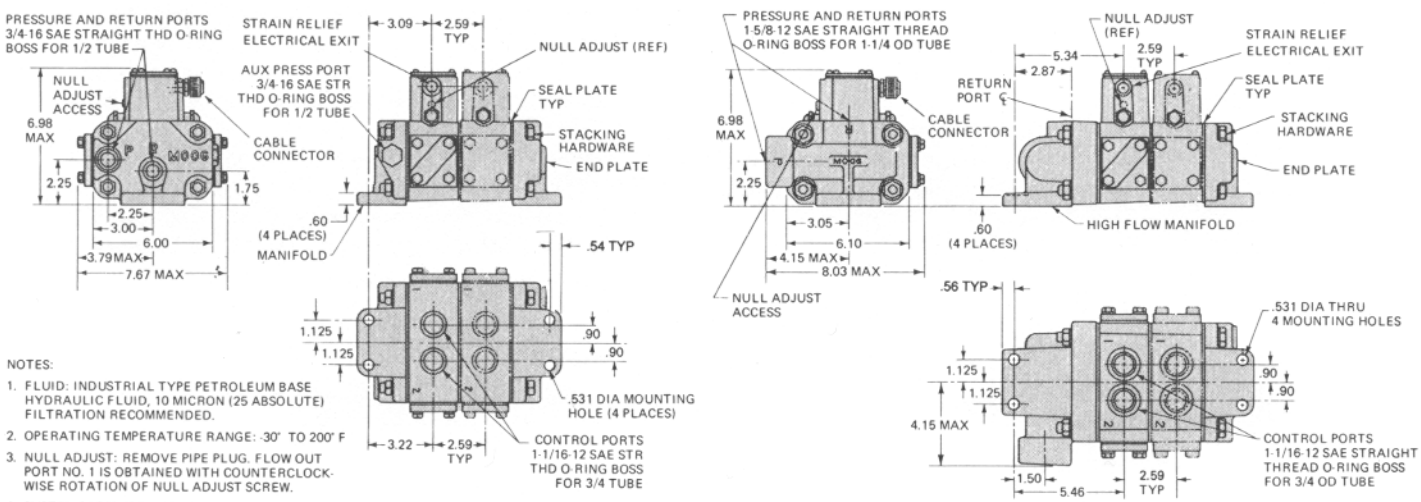
NOTES

1. FLUID: INDUSTRIAL TYPE PETROLEUM BASE HYDRAULIC FLUID, 10 MICRON, (25 ABSOLUTE) FILTRATION RECOMMENDED.
2. OPERATING TEMPERATURE RANGE: -30° TO 200° F
3. NULL ADJUST: REMOVE PIPE PLUG. FLOW OUT PORT NO. 1 IS OBTAINED WITH COUNTERCLOCK-WISE ROTATION OF NULL ADJUST SCREW.
4. SYSTEM PRESSURE: 3000 PSI MAXIMUM.
5. DIMENSIONS WITHOUT TOLERANCE ARE FOR REFERENCE ONLY.
6. TORQUE STACKING BOLTS TO 55±5 FT-LB.

WITH LOW FLOW MANIFOLD

WITH HIGH FLOW MANIFOLD

SINGLE MANIFOLD INSTALLATIONS



NOTES:

1. FLUID: INDUSTRIAL TYPE PETROLEUM BASE HYDRAULIC FLUID, 10 MICRON (25 ABSOLUTE) FILTRATION RECOMMENDED.
2. OPERATING TEMPERATURE RANGE: -30° TO 200° F
3. NULL ADJUST: REMOVE PIPE PLUG. FLOW OUT PORT NO. 1 IS OBTAINED WITH COUNTERCLOCK-WISE ROTATION OF NULL ADJUST SCREW.
4. SYSTEM PRESSURE: 3000 PSI MAX.
5. DIMENSIONS WITHOUT TOLERANCE ARE FOR REFERENCE ONLY.
6. TORQUE STACKING BOLTS TO 55 ± 5 FT-LB.

WITH LOW FLOW MANIFOLD

WITH HIGH FLOW MANIFOLD

MANIFOLD AND END PLATE OR DUAL MANIFOLD INSTALLATIONS

Application Information

OSHA COMPATIBILITY

Moog Controls Series 60 valves meet the stringent requirements of today's Occupational Safety and Health Standards (OSHA). Pertinent requirements are the following:

- Bursting safety factor

  OSHA Chapter XVII paragraph 1910.67 requires that hydraulic system components operating in critical circuits be capable of withstanding four times the system operating pressure. Series 60 valves will withstand without rupture 12,000 psi on the supply port (3000 psi rating), or 6000 psi on the return port (1500 psi rating)

- Load holding

  OSHA requires compliance with ANSI (American National Standards Institute) Specification A92.2 for equipment having a movable work platform. This specification requires a hydraulic circuit that prevents free fall of the platform in the event of hydraulic line failure. This requirement is satisfied with a Series 60 valve having a curvilinear, open-cylinder port spool, and pilot operated load holding valves located at the cylinder.

- Dual station control

  ANSI Specification A92.2 also requires that equipment having a movable work platform have both upper (platform) and lower controls. The lower controls shall provide override of the upper controls.

  The two coils in a Series 60 valve permit control from two control stations (an upper and a lower). The override capability can be provided by a relay interlock.

INTRINSICALLY SAFE

Special versions of the Series 60 valve and control stations are available for mining and petrochemical applications. These components utilize a low voltage supply (4 volts) and incorporate diodes that prevent arc over in event of a wiring failure. The U.S. Bureau of Mines has performed tests in a methane atmosphere and found these components acceptable for intrinsic safety use.

VALVE SELECTION

The vast majority of Series 60 valve applications in mobile vehicles should use the curvilinear spool with open-cylinder ports. The curvilinear flow characteristic gives the smoothest feathering when the valve is properly sized.

VALVE SIZING

One of the most common mistakes in specifying Series 60 valves is oversizing valve flow. When this is done, system performance will be poor or even dangerous. The reason being that an oversized valve can move the load too fast, or can exceed the flow capacity of the pump. This drops the supply pressure to all valves.

MANUAL INPUT

Manual input buttons are provided on Series 60 valves to give direct control of the pilot stage. These convenient thumb and forefinger buttons provide approximately ±40% valve authority. Manual input control is helpful in case of electrical failure.

NULL ADJUST

Null of a Series 60 valve can be adjusted if necessary by first removing a cap screw contained in the motor cover. A 5/64 inch Allen wrench is inserted and turned slowly one way or the other to stop load motion. True null is midway between the positions that just cause load motion in each direction. Do not turn this adjustment more than ±1 turn as excessive movement can cause internal valve damage.

APPLICATIONS REVIEW SERVICE

Moog Controls will provide engineering assistance to OEM's who are planning to use Series 60 valves. This help includes recommendations on the selection and sizing of the valves, review of hydraulic and electrical system schematics, recommendations for filtration and flushing procedures, and other assistance in getting started with Moog Controls electrohydraulic controls.

LOAD HOLDING

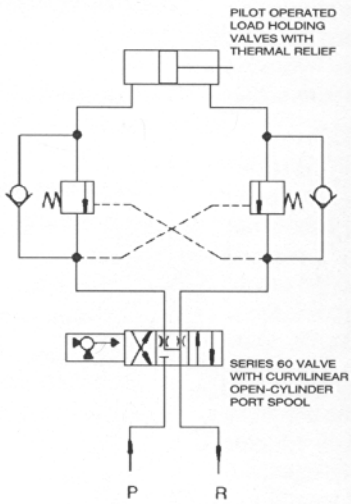
The closed-cylinder port Series 60 valve spool will not provide good load holding for standby or pressure-off conditions. Laminar leakage is always present across the spool lands and this leakage will allow the load to drift. A separate load holding valve or valves must be used. This may be a solenoid operated shut-off valve, or pilot pressure operated load holding valves, located between the Series 60 valve and the cylinder.

60 Series

PROPORTIONAL ELECTROHYDRAULIC CONTROL VALVES

Recommended Load Holding Circuit

OSHA requires load holding protection for movable work platforms to prevent free fall in case of hydraulic line failure. Load holding valves must be located at the cylinder to satisfy this requirement. A good combination is Series 60 valves having curvilinear, open-cylinder port spools and pilot operated load holding valves. The open-cylinder ports maintain tank pressure on the cylinder lines during all standby and pressure-off conditions. This prevents opening of the load holding valves. When the Series 60 valve is energized to move the load, it first builds up enough pressure in the cylinder line to drive the load (either up or down).



Ordering Information

60 — Series

A — Valve Body Configuration (see page 8)
A = single-ended valve
B = valve with thru-ports for stacking

10 — Rated Flow in gpm at 150 psi drop (see page 4)
02 = 2.5 gpm
05 = 5 gpm
10 = 10 gpm
20 = 20 gpm
40 = 36 gpm

I — Spool Configuration (see page 5)
1 = linear flow with closed cylinder ports
2 = (special) curvilinear flow w/ closed cylinder ports
3 = curvilinear flow with open cylinder ports

H — Factory Identification

Options

Stacking

Moog Controls will supply complete valve stacks to order. These complete assemblies of valves, seal plates, manifolds, bolts and washers reduce the chance for error or introduction of dirt during final installation.

Intrinsically Safe

Special Series 60 valves having back-to-back zener diodes built into the coil assemblies are available for use in hazardous atmospheres. This valve configuration has been tested and found acceptable by the U.S. Bureau of Mines for operation in a methane atmosphere.

Special Spool Configurations

A number of alternate spool designs are available for special systems. These include three-way spools, open-center spools, flow divider spools, and others. Consult a factory representative for details.

Seals

Buna N elastomeric seals are supplied with standard Series 60 valves. Buna N is recommended for most systems using petroleum base industrial fluids. Both Viton A and EPR seals are available for use with special fluids. Consult the factory for use of these alternate seal materials.

Separate Pilot Pressure

The Series 60 valve can be supplied with a separate supply connection for the pilot stage. This permits use of a low flow, constant pressure supply for the pilot stage(s). Special open-center spools are available for this valve configuration. Consult a factory representative for details.

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