Type 30
Nozzle-Flapper
Flow Control Servovalves
TYPE 30
NOZZLE-FLAPPERSERVOVALVES

■ Flow Control
■ Two Stage
■ Double Nozzle
■ Mechanical Feedback

Five Basic Sizes

<table>
<thead>
<tr>
<th>PORT CIRCLE DIAMETER</th>
<th>MAX RATED FLOW</th>
<th>VALVE WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in</td>
<td>mm</td>
</tr>
<tr>
<td>Series 30</td>
<td>0.480</td>
<td>12.19</td>
</tr>
<tr>
<td>Series 31</td>
<td>0.625</td>
<td>15.88</td>
</tr>
<tr>
<td>Series 32</td>
<td>0.780</td>
<td>19.81</td>
</tr>
<tr>
<td>Series 34</td>
<td>0.780</td>
<td>19.81</td>
</tr>
<tr>
<td>Series 35</td>
<td>1.000</td>
<td>25.40</td>
</tr>
</tbody>
</table>

This Catalog Contains
• General information on Type 30 servovalves
• Information on standard valve designs

Standard Designs
• Are assembled from standard parts
• Offer choice of
  – rated flow
  – rated pressure
  – rated current (coil resistance)
  – internal coil connection
  – electrical connector or cable
  – connector or cable location
  – seal compound
• give standard performance (per Moog specification)
• eliminate non-recurring start-up costs
• minimize lead-time; certain models carried in stock

Position Servo –
The Usual Application of Flow Control Servovalves

• Servovalve supplied with constant pressure $P_s$ (e.g., 3000 psi or 210 bars)
• Servovalve controls flow to and from piston end chambers in response to electrical signal
• Piston drives load
• Position feedback signal obtained from pot, LVDT, DCDT, etc.
• Difference between position command signal and position feedback signal is error signal
• Error signal is amplified to drive servovalve
• Load moves to reduce error to near zero
DESIGN FEATURES

Quality
- System conforms to MIL-Q-9858
- Valves typically assembled and tested in Class 100,000 clean room (per FED STD 209)

Environmental Capability of Standard Designs*
- Meet or exceed MIL-V-27162 and SAE ARP 490
- Meet or exceed the following as tested per MIL-STD-810
  - high temperature – normal performance at +275°F fluid and ambient with MIL-H-5606 fluid
  - low temperature – normal performance at 0°F fluid and ambient with MIL-H-5606 fluid
  - extreme low temperature – valves will respond to input commands at –65°F fluid and ambient on MIL-H-5606 fluid
  - altitude – normal performance to 100,000 feet altitude
  - random vibration – will withstand 25 g rms (5 to 2000 Hz) 30 minutes per axis
  - sinusoidal vibration – will withstand sweep from 16 g at 25 Hz, to 35 g at 2000 Hz, 30 minutes per axis
  - acceleration – will withstand 50 g any axis
  - shock – will withstand 6 msec sawtooth, 100 g peak, any axis
  - salt spray, fungus, humidity, sand and dust – will withstand all exposures per MIL-STD-810
- useful life – >10 years with normal overhaul
- cyclic life – > 10⁷ cycles with normal wear

* Type 30 Servovalves are not necessarily limited by the environments listed. Special designs are available that considerably extend these capabilities.

Materials used in Standard Type 30 Servovalves

<table>
<thead>
<tr>
<th>Part</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body*</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>End caps</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Spool and bushing*</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Filter (35 micron absolute)</td>
<td>Sintered stainless steel wire mesh</td>
</tr>
<tr>
<td>Flexure sleeve</td>
<td>Beryllium copper</td>
</tr>
<tr>
<td>Polepieces and armature</td>
<td>Nickel-iron steel</td>
</tr>
<tr>
<td>Magnets</td>
<td>Alnico alloy</td>
</tr>
<tr>
<td>Feedback spring</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Torque motor cover</td>
<td>Anodized aluminum alloy</td>
</tr>
</tbody>
</table>

*The Series 30 has an integral bushing and body made from stainless steel.

- Rugged, stainless steel body
- One-piece bushing with EDM flow slots*
- Bushing slip-fit in body bore
  - eliminates bushing land O-rings
  - bushing easily removed for cleaning or replacement
- O-ring sealed spool stops
  - eliminates pressure loading of ends of bushing
- Spool bushing tolerances for diametral clearance held within 20 microinches (¼ µm)
- 20 µm nominal filter (35 µm absolute) for pilot flow
- Symmetrical, double nozzle hydraulic amplifier
  - provides consistent performance over wide temperature range
- Hydraulic amplifier integrated into main valve body
  - eliminates several O-rings
- Torque motor in environmentally sealed compartment
- Frictionless, flexure sleeve supported armature/flapper
  - isolates hydraulic fluid from torque motor
- Balanced, double coil, double air gap torque motor
  - reduces temperature centershift
  - minimizes external magnetic fields
  - reduces sensitivity to external magnetic materials or fields
- Motor coils have resilient potting
  - cushions coils during thermal and vibration extremes
- Mechanical feedback with simple cantilever spring
  - rolling ball contact with spool minimizes wear
  - feedback removable without damage to valve

* EDM = electric discharge machined
Series 30 does not have a bushing (slots are EDM’d in valve body).
**TERMINOLOGY**

*Per SAE ARP 490*

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 of either polarity to produce rated flow, expressed in milliamperes (ma). Rated current is specified for a particular coil configuration (differential, series, individual 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 net 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 (R ohms) and the apparent coil inductance (L 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** $Q_v$ - The flow through the valve control ports to the load expressed in in³/sec (cis), gal/min (gpm), liters/min (lpm) or for fuel applications lbs/hr (pph).
- **Rated Flow** $Q_{r}$ - 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, gpm, lpm or pph.
- **Flow Gain** - The nominal relationship of control flow to input current, expressed as cis/ma, gpm/ma, lpm/ma or pph/ma.
- **No Load Flow** - The control flow with zero load pressure drop, expressed in cis, gpm, lpm or pph.
- **Internal Leakage** - The total internal valve flow from pressure to return with zero control flow (usually measured with control ports blocked), expressed in cis, gpm, lpm or pph. Leakage flow will vary with input current, generally being a maximum at the valve null (called null leakage).
- **Load Pressure Drop** $\Delta P_L$ - The differential pressure between the control ports (that is, across the load actuator), expressed in lbs/in² (psi), or bars.

**Valve Pressure Drop** $\Delta P_\nu$ - The sum of the differential pressures across the control orifices of the servovalve spool, expressed in psi or bars. Valve pressure drop will equal the supply pressure, minus the return pressure, minus the load pressure drop, $[\Delta P_\nu = (P_S - R) - \Delta P_L]$.

**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 nominal psi/ma or bars/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), and phase angle (in degrees), over a specific frequency range.

**Units**

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

<table>
<thead>
<tr>
<th>Units</th>
<th>English</th>
<th>Metric</th>
<th>Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluid Flow</td>
<td>in³/sec (cis)</td>
<td>Liters/min (lpm)</td>
<td>0.98 lpm/cis</td>
</tr>
<tr>
<td></td>
<td>gal/min (gpm)</td>
<td>bars</td>
<td>101.0 pph/lpm*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.78 lpm/gpm</td>
</tr>
<tr>
<td>Fluid Pressure</td>
<td>lb/in² (psi)</td>
<td>bars</td>
<td>0.069 bars/psi</td>
</tr>
<tr>
<td>Dimensions</td>
<td>inches (in)</td>
<td>millimeters (mm)</td>
<td>25.4 mm/in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>micrometers (µm)</td>
<td>25,400 µm/in</td>
</tr>
<tr>
<td>Weight</td>
<td>pounds (lb)</td>
<td>kilograms (kg)</td>
<td>0.454 kg/lb</td>
</tr>
<tr>
<td>Force</td>
<td>pounds (lb)</td>
<td>Newtons (N)</td>
<td>4.45 N/lb</td>
</tr>
<tr>
<td>Torque</td>
<td>in-lb</td>
<td>Newton meters (N-m)</td>
<td>0.113 N-m/in-lb</td>
</tr>
<tr>
<td>Temperature</td>
<td>degrees Fahrenheit</td>
<td>degrees Celsius</td>
<td>°C=5/9 (°F–32)</td>
</tr>
</tbody>
</table>

\*JP-4 and JP-5 jet fuel
SPECIAL DESIGNS

Specific applications and major programs may warrant a special servovalve design.

- Special Type 30 valves are designed to satisfy customer specification
  - provides optimum servovalve configuration
  - allows customer configuration control
- May be special
  - performance
  - environments
  - testing
  - bias
  - quality control
  - mounting
  - porting
  - connector
  - materials
  - handling
- Any change from standard is a special
- Special designs carry a unique part number, parts list, test procedures, etc.
- Special Type 30 designs that require a non-standard manifold pattern will be assigned a Series 33 part number

Unusual Environments

- High Temperature – to 400°F (200°C) fluid and ambient with Viton seals (limited life)
  - to 650°F (350°C) fluid and ambient with metallic seals, ceramic insulated magnetic wire, and special magnetic materials
- High Accelerations – to 400 g with special mass balanced armature/flapper and stainless steel flexure sleeve
- High Vibration – to 100 g rms (20-2000 Hz) with damping fluid and armature motion restraint
- High Shock – to 5000 g with damping fluid and stainless steel flexure sleeve
- Nuclear Radiation – to $2 \times 10^5$ rads with standard motor coils or $10^7$ rads with hardened motor coils; higher radiation levels with ceramic insulation and metallic seals
- External Pressurization - to hundreds of psi with special motor cap or with motor cavity vented to pressure equalized return

Special Fluids

- Most fuels, propellants, and oxidizers
- Other hydraulic fluids including water
- Pneumatics

Special Spool Designs

- Three-way spools having single control port
- Spool stops for limiting maximum flow
  - flow limit usually held to ±10%
- Special spool null cuts
  - prescribed amounts of underlap or overlap, symmetrical or unsymmetrical
- Non-linear slot width
  - different flow gain for each valve polarity as used with some three-way actuators
  - stepped width slots for dual flow gain

Special Configurations

- Spool position transducer
- Plug-in electrical connector for flush mount with manifold surface
- Fiber optic input
- Pressure feedback for increased load damping and softer pressure gain
**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 sleeve
- Fluid continuously flows from 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)

**Valve Spool**
- Spool slides in bushing (sleeve), or directly in body bore for Series 30
- 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 sleeve 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
**ELECTRICAL CHARACTERISTICS**

*Standard Coil Configurations*

<table>
<thead>
<tr>
<th>CODE FOR PART NUMBER OF STANDARD VALVE</th>
<th>P</th>
<th>S</th>
<th>D</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTERNAL COIL CONFIGURATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parallels Coils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Series Coils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differential Coils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Coils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PINS (IF CONNECTOR)</strong></td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td><strong>COLORS (IF CABLE)</strong></td>
<td>grn</td>
<td>red</td>
<td>grn</td>
<td>red</td>
</tr>
<tr>
<td><strong>SERIES COILS</strong></td>
<td>Not possible</td>
<td>B+</td>
<td>A–</td>
<td>B+</td>
</tr>
<tr>
<td><strong>PARALLEL COILS</strong></td>
<td>B+</td>
<td>A–</td>
<td>Not possible</td>
<td>Not possible</td>
</tr>
<tr>
<td><strong>DIFFERENTIAL COILS</strong></td>
<td>Not possible</td>
<td>Not possible</td>
<td>for A+ when current A to B to A to C for A– when current B to A to C to A</td>
<td>Tie A,D when current A to B to D to C for A,D– when current A to B to C to D</td>
</tr>
<tr>
<td><strong>SINGLE COIL</strong></td>
<td>Not possible</td>
<td>Not possible</td>
<td>B+</td>
<td>A– or A+</td>
</tr>
</tbody>
</table>

---

**Electrical Connector**

- Standard configurations (see table below)
- Bendix pygmy connector
- 18 inch long cable
- Special Type 30 connectors
  - connector type and location per customer specification
  - flush manifold plug-in connector available

**Dither**

- Servovalve performance normally measured without dither
- Dither current may be applied to Type 30 Servovalves
- Usually will decrease servovalve and actuator threshold
- Will increase spool null leakage

**Dither Characteristics**

- Frequency selected to suit system
- Peak-to-peak dither amplitude may be as high as ±20% servovalve rated current without degradation of valve life

---

**External Connections to Give Flow Out C2**

<table>
<thead>
<tr>
<th>COIL CONFIGURATION AVAILABLE</th>
<th>CONNECTOR TYPE</th>
<th>CODE FOR PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>P, S, D, I</td>
<td>*PC-02E-8-4P 4 pin screw</td>
<td>4 PC</td>
</tr>
<tr>
<td>P, S, D</td>
<td>*PC-02E-8-3P 3 pin screw</td>
<td>3 PC</td>
</tr>
<tr>
<td>P, S, D, I</td>
<td>*PT-02E-8-4P 4 pin bayonet</td>
<td>4 PT</td>
</tr>
<tr>
<td>P, S, D</td>
<td>*PT-02E-8-3P 3 pin bayonet</td>
<td>3 PT</td>
</tr>
<tr>
<td>I</td>
<td>4 wire cable, 18&quot; long</td>
<td><strong>4 CA</strong></td>
</tr>
<tr>
<td>D</td>
<td>3 wire cable, 18&quot; long</td>
<td><strong>3 CA</strong></td>
</tr>
<tr>
<td>P, S</td>
<td>2 wire cable, 18&quot; long</td>
<td><strong>2 CA</strong></td>
</tr>
</tbody>
</table>

* Bendix part number
** Only choice for Series 30
**Rated Current**
- Choice of coil resistance and coil connections determine valve rated current (see table below)
- Other coil resistance and rated current combinations can be supplied for special valves
- Lower rated current can be specified for standard coils, but with corresponding degradation of valve performance
- Triple rated current can be supplied indefinitely with no damage to servovalve

**Coil Impedance**
- Composed of
  - dc coil resistance
  - ac coil resistance
  - coil apparent inductance
- DC coil resistance
  - nominally equal for both coils, but may vary ±10% as coils are wound for desired number of turns
  - will vary with temperature (approximately 0.002 ohms/ohm °F)
- AC coil resistance
  - represents work done in moving armature
  - becomes significant above 200 Hz
- Coil apparent inductance
  - includes coil self inductance plus mutual inductance of other coil
    - mutual coupling of coils is approximately 50%
  - will vary considerably with motion of armature (due to back emf)
    - affected by valve supply pressure, signal amplitude, and signal frequency
    - may become capacitive at higher frequencies
    - usually specified at 50 Hz with normal operating conditions

**Quiescent Current**
- May be present with push-pull operation of three and four wire coil configurations
  - signal input current \( i = i_1 - i_2 \)
  - quiescent current \( i_Q = \frac{i_1 + i_2}{2} \)
    - when \( i_1 = i_2 \)
  - quiescent current \( i_Q \) should be \( i_R > i_Q > i_R \)
  - small null shift and gain change may occur with changes in quiescent current amplitude and polarity

**Servoamplifier**
- Provides dc current into torque motor coils
  - regardless of coil inductance and resistance
  - requires current feedback amplifier
  - large shunt capacitance at output of amplifier may produce undesirable resonance with servovalve coil impedance
- Current feedback amplifier
  - eliminates apparent servovalve gain change due to changes in coil impedance
  - minimizes phase lag due to coil inductance
- Standard servovalve drive amplifiers available from Moog
  - table top units
  - low cost industrial units
  - aerospace units on special order

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**Table: Coils**

<table>
<thead>
<tr>
<th>Code for Part Number of Standard Valve</th>
<th>P Parallel Coils</th>
<th>S Series Coils</th>
<th>D Differential Coils</th>
<th>I Individual Coils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( R ) Ohms</td>
<td>( L ) Henrys</td>
<td>( i_R ) Ma</td>
<td>( R ) Ohms</td>
</tr>
<tr>
<td>0040</td>
<td>20</td>
<td>0.10</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>0080</td>
<td>40</td>
<td>0.18</td>
<td>40</td>
<td>160</td>
</tr>
<tr>
<td>0130</td>
<td>65</td>
<td>0.30</td>
<td>30</td>
<td>260</td>
</tr>
<tr>
<td>0200</td>
<td>100</td>
<td>0.59</td>
<td>20</td>
<td>400</td>
</tr>
<tr>
<td>0500</td>
<td>250</td>
<td>1.1</td>
<td>15</td>
<td>1000</td>
</tr>
<tr>
<td>1000</td>
<td>500</td>
<td>2.6</td>
<td>10</td>
<td>2000</td>
</tr>
<tr>
<td>1500</td>
<td>750</td>
<td>3.4</td>
<td>8</td>
<td>3000</td>
</tr>
</tbody>
</table>

**Note:** Resistance values at 68°F (20°C) ± 10% tolerance
Inductance values are typical for 50 Hz, servovalve pressurized. Inductance is not normally measured on individual servovalves.
*Inductance values per coil with differential operation (Class A push-pull).
HYDRAULIC CHARACTERISTICS

Supply Pressure

- 500 psi to 4000 psi for standard designs
- valves are set up and tested at supply pressure specified
- valves can be used at other supply pressures, but some null shift may occur
- lower and higher pressures available on special order
- Valves supplied for pressures below 500 psi should be specially designed
- Type 30 Servovalves can function with supply pressures as low as 50 psid
- servovalve performance, especially threshold and dynamic response, is degraded with low supply pressure

Proof and Burst Pressures

- Proof pressure capability
  - at supply and control ports = 1.5 P_s
  - at return port = 1.0 P_s
- Burst pressure capability
  - at supply and control ports = 2.5 P_s
  - at return port = 1.5 P_s or 5000 psi maximum

Return Pressure

- May vary widely with minimal valve null shift
- Should never exceed supply pressure to avoid back flowing hydraulic amplifier

Rated Flow

- Each valve Series covers a range of no-load rated flow to the maximum shown (for MIL-H-5606)

<table>
<thead>
<tr>
<th>O-RING ELASTOMER</th>
<th>COMPATIBLE FLUIDS</th>
<th>TEMP RANGE*</th>
<th>TEST FLUID</th>
<th>CODE FOR PART NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buna N</td>
<td>MIL-H-83282 (synthetic hydrocarbon) Petroleum Base Fluids such as MIL-H-5606, MIL-H-6083, DTE, Regal, Brayco Silicone Fluids</td>
<td>-65°F to +275°F</td>
<td>MIL-H-83282 or MIL-H-5606</td>
<td>BUN</td>
</tr>
<tr>
<td>Fluorocarbon Rubber (Viton)</td>
<td>Petroleum Base Fluids such as Type A Transmission Fluid, JP-4, JP-5 Superrefined Mineral Oils Silicone Fluids Silicate Ester Fluids such as MIL-H-8446, MLO-8200, OS-45, M2V Industrial Phosphate Ester Fluids such as Cellulube, Pydraul, Pyroguard Di-Ester Base Fluids such as MIL-L-7808, Houghton Safe Tri-Ester Base Fluids such as Trichloroethylene</td>
<td>-20°F to +400°F</td>
<td>MIL-H-83282 or MIL-H-5606</td>
<td>VIT</td>
</tr>
<tr>
<td>Ethylene Propylene Rubber</td>
<td>Aircraft Phosphate Ester Fluids such as Skydrol, Hyjel, Aerofase Hydrazine** UDMH Water, steam, air</td>
<td>-65°F to +300°F</td>
<td>Hyjel IV A</td>
<td>EPR</td>
</tr>
</tbody>
</table>

*Operating temperature range may be further restricted by fluid.
** Standard Type 30 Servovalves are suitable for short term use with this fluid. Special designs with all stainless steel wetted parts are recommended for long term use.
Flow-Load Characteristics

\[ Q_v = K_i \sqrt{\Delta P_v} \]

where 
- \( Q_v \) = valve flow to load
- \( K \) = servovalve sizing factor
- \( i \) = input current
- \( \Delta P_v \) = valve pressure drop
- \( \Delta P_v = (P_s - R) - \Delta P_L \)

where 
- \( P_s \) = supply pressure
- \( R \) = return pressure
- \( \Delta P_L \) = load pressure drop

- Nominal flow to load

Some flow saturation will occur with servovalves having maximum flow capacity
- Saturation causes droop at the high end of the flow curve

Spool Lap
- Standard servovalves have zero lap within limits of flow linearity shown on page 12
- Prescribed amounts of underlap or overlap can be specified on special order
- Underlap (or open center)
  - Increases flow gain at null
  - Reduces valve pressure gain at null
  - Increases valve null leakage
- Overlap
  - Reduces flow gain at null
  - Reduces null leakage flow
  - Reduces pressure gain (into a load)

Internal Leakage
- Includes first stage hydraulic amplifier flow, spool null leakage flow, and bushing laminar leakage flow
- Spool null leakage flow is essentially zero when spool is off-null
- Servovalve internal leakage excluding spool null leakage is called tare flow
- Hydraulic amplifier flow largely determines servovalve frequency response
- Lower flow degrades response
- Spool null leakage flow is related to maximum valve flow (slot width) and null cut
- Special low leakage versions of Series 30 Servovalve are available with <0.25 cis at 3000 psi
- Table gives internal leakage of standard Type 30 Servovalves (with MIL-H-5606 at 100°F)

Maximum Leakage of Standard Type 30 Servovalves

<table>
<thead>
<tr>
<th>VALVE SERIES</th>
<th>TARE LEAKAGE FLOW CIS at 1000 psi</th>
<th>SPOOL NULL LEAKAGE FLOW (% rated flow at rated pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>&lt; 0.20</td>
<td>&lt; 4</td>
</tr>
<tr>
<td>31</td>
<td>&lt; 0.25</td>
<td>&lt; 4</td>
</tr>
<tr>
<td>32</td>
<td>&lt; 0.28</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>34</td>
<td>&lt; 0.35</td>
<td>&lt; 3</td>
</tr>
<tr>
<td>35</td>
<td>&lt; 0.45</td>
<td>&lt; 3</td>
</tr>
</tbody>
</table>
**STATIC PERFORMANCE**

**Control Flow**
- Servovalve control flow to the load is nominally proportional to electrical input current
- standard production acceptance test limits for no-load flow shown below
- limits do not include servovalve hysteresis or null bias
- limits at ±100% input for maximum flow designs may be +10%, –20% due to non-linearities caused by flow saturation

- Control flow non-linearity is greatest in null region
  - may be from 50% to 200% nominal gain within range of ± 3% electrical input for standard null cut
  - can be held to closer limits on special order
- Maximum valve flow to 140% rated flow with oversignal
  - spool stops to limit maximum flow can be provided
- Control flow characteristic may change with fluid temperature
  - a +100°F temperature rise may cause control flow to increase as much as 3% due to fluid viscosity effects
  - at very high temperatures (over 400°F) a +100°F temperature rise may cause control flow to decrease by 3% due to magnetic effects

**Pressure Gain**
- Blocked load $\Delta P_l$ changes rapidly from $-P_s$ to $+P_s$ in null region
  - minimum pressure gain will be $0.4 P_s/1.2 i_R$ for standard servovalves
  - maximum pressure gain may be three times higher
  - pressure gain will decrease with spool null edge wear
  - Special pressure gain requirements may interact with desired flow gain at null, spool null leakage, and nominal control port pressures at null

**Hysteresis**
- Maximum hysteresis for standard Type 30 Servovalves with normal operation conditions is < 3%
  - hysteresis may increase to 4% at –30°F
  - hysteresis limit for special high temperature servovalves (>400°F) is <4%

**Threshold**
- Maximum threshold for standard Type 30 Servovalves with normal operating conditions is <1/2 % (without dither and with supply pressure greater than 1000 psi)
  - with $P_s$ below 1000 psi threshold limit is <1%
  - threshold limit should be doubled at –30°F
  - with dither, threshold approaches 0%
**Null Bias**

- Electrical input current to obtain valve null includes both temporary null shifts and permanent changes in null bias
- Null bias is measured under standard valve operating conditions (pressures, temperatures, environments)
- Null bias measurements exclude valve hysteresis
- Initial servovalve null bias on standard valves (as shipped) is less than 2% rated input
- Long-term null bias after exposure to environments and use can be expected to be <5%

**Null Shift**

- Change in null bias with environment and operating conditions will vary from unit to unit, but is generally:

<table>
<thead>
<tr>
<th>NULL SHIFT</th>
<th>SERIES</th>
<th>TYPICAL MAX. SPOOL FORCE (POUNDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMP</td>
<td>30</td>
<td>55</td>
</tr>
<tr>
<td>50°F to 150°F</td>
<td>31</td>
<td>55</td>
</tr>
<tr>
<td>0°F to 200°F</td>
<td>32</td>
<td>110</td>
</tr>
<tr>
<td>ACCELERATION</td>
<td>34</td>
<td>140</td>
</tr>
<tr>
<td>TO 40 G SPOOL AXIS</td>
<td>35</td>
<td>160</td>
</tr>
</tbody>
</table>

- Special mass balanced torque motor design available for <0.06%/g to 400 g
- Null shifts are not normally tested during production acceptance testing
- Tighter null shift specifications can be imposed by providing 100% valve testing under critical environment

**Summary**

**STATIC PERFORMANCE (AT 100°F)**

<table>
<thead>
<tr>
<th>Static Performance</th>
<th>Series 30 +10% –15%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated flow tolerance</td>
<td>±10%</td>
</tr>
<tr>
<td>Linearity</td>
<td>±7%</td>
</tr>
<tr>
<td>Symmetry</td>
<td>±5%</td>
</tr>
<tr>
<td>Null region</td>
<td>±3%</td>
</tr>
<tr>
<td>Null bias</td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>≤±2%</td>
</tr>
<tr>
<td>Long-term</td>
<td>≤±5%</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>≤3%</td>
</tr>
<tr>
<td>Threshold</td>
<td></td>
</tr>
<tr>
<td>Supply pressures 1000 psi and above</td>
<td>&lt;0.5%</td>
</tr>
<tr>
<td>Supply pressures below 1000 psi</td>
<td>&lt;1.0%</td>
</tr>
<tr>
<td>Pressure gain</td>
<td></td>
</tr>
<tr>
<td>40% supply pressure at</td>
<td>&lt;1.2%</td>
</tr>
<tr>
<td>Coil resistance tolerance</td>
<td>±10%</td>
</tr>
<tr>
<td>Supply proof pressure</td>
<td>1.5 Pₗ or 6000 psi max</td>
</tr>
<tr>
<td>Supply burst pressure (not tested)</td>
<td>2.5 Pₗ or 10,000 psi max</td>
</tr>
<tr>
<td>Return proof pressure</td>
<td>Pₗ or 4000 psi max</td>
</tr>
<tr>
<td>Return burst pressure (not tested)</td>
<td>1.5 Pₗ or 5000 psi max</td>
</tr>
<tr>
<td>External leakage</td>
<td>None</td>
</tr>
</tbody>
</table>

*Max flow Series 30 +10% –15%*
DYNAMIC PERFORMANCE

Frequency Response
• Will depend upon signal amplitude, supply pressure, and internal design configuration
• Plot below shows typical responses for standard Type 30 Servovalves

Internal Dynamics of Type 30 Servovalves
See Technical Bulletin 103 for a discussion of servovalve dynamic characteristics and response measuring techniques.

Typical Parameters for Series 31*
i = torque motor current...................................................... ± 10 ma
x_s = spool displacement................................................... ± 0.015 in max
Q_v = servovalve control flow.............................................. ± 4 gpm
K_1 = torque motor gain.................................................. 0.025 in-lbs/ma
K_2 = hydraulic amplifier flow gain .................................. 150 in³/sec
K_3 = flow gain of spool/bushing...................................... 1030 in³/sec
A = spool end area .......................................................... 0.026 in²
k_f = net stiffness on armature/flapper............................ 115 in-lbs/in
k_w = feedback wire stiffness ......................................... 16.7 in-lbs/in
b_f = net damping on armature/flapper.......................... 0.016 in-lbs/sec
l_f = rotational mass of armature/flapper......................... 4.4 × 10⁻⁶ in-lbs/sec^2

\[ \zeta = \frac{1}{2} \frac{b_f}{k_f} \]  damping ratio of first stage...................................... 0.4

\[ \omega_n = \sqrt{\frac{k_f}{l_f}} \]  natural frequency of first stage................................. 814 Hz

\[ K_v = \frac{K_2 k_w}{k_1 A} \]  servovalve loop gain........................................... 840 sec⁻¹

*Consult Moog Sales for parameters of other series valves.

Step Response
• Time response to step input current depends on valve design parameters
• Approximate transient response of standard Type 30 Servovalves operating at 3000 psi is

<table>
<thead>
<tr>
<th>VALVE SERIES</th>
<th>Equivalent First Order Time Constant sec.</th>
<th>Equivalent Second Order Natural Frequency Hz</th>
<th>Damping Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0015</td>
<td>200</td>
<td>0.5</td>
</tr>
<tr>
<td>31</td>
<td>0.0015</td>
<td>200</td>
<td>0.5</td>
</tr>
<tr>
<td>32</td>
<td>0.0020</td>
<td>160</td>
<td>0.55</td>
</tr>
<tr>
<td>34</td>
<td>0.0029</td>
<td>110</td>
<td>0.6</td>
</tr>
<tr>
<td>35</td>
<td>0.0035</td>
<td>90</td>
<td>0.9</td>
</tr>
</tbody>
</table>

• Frequency response of specially designed valves can be improved by
  • increased hydraulic amplifier flow
  • shorter spool stroke (larger slot width)
  • use of stub shafts on spool ends
  • higher rated current (stiffer feedback spring)
STANDARD SERIES 30 NOZZLE-FLAPPER SERVOVALVES

Installation Details

30S020

NOTE: CABLE SHOWN OVER RETURN PORT (CODE R)
DIRECTION CAN BE OVER PRESSURE PORT (CODE P)

CABLE, 18 INCH (45 CM)
MINIMUM LENGTH

1.54 (39.1) MAX

0.125 (3.18)

0.88 (22.4)

0.88 (22.4)

0.80 (20.3)

0.80 (20.3)

RETURN PORT

CONTROL PORT C1

0.87 (22.1) MAX RAD

0.152 (3.86) DIA 4 MOUNTING HOLES

PRESSURE PORT

0.469 (11.91)

0.398 (10.05)

0.398 (10.05)

0.240 (6.10)

0.240 (6.10)

0.240 (6.10)

0.240 (6.10)

0.06 (1.6)

0.06 (1.6)

0.06 (1.6)

0.06 (1.6)

PORTS 0.160 (4.06) MAX DIA.
C: BORED 0.100 x 0.310 D: x 0.030 DEEP
(5.08 x 7.87 x 0.76)
Dimensions in parentheses are in millimeters

Typical frequency response for Standard Series 30 Servovalves shown below

Standard design valves may be ordered by completing part number (see page 20)

• Specify rated control flow in cis within limits of table
• Use two digits and decimal point as indicated
• Specified flow will be provided for test fluid used (see page 10)
• Lower rated flows available on special order
• Specify supply pressure from 500 to 4000 psi to nearest 50 psi
• Lower and higher pressures available on special order

### SUPPLY PRESSURE

(No load valve pressure drop)

<table>
<thead>
<tr>
<th>PSI</th>
<th>MINIMUM VALUE</th>
<th>MAXIMUM VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CIS</td>
<td>GPM</td>
</tr>
<tr>
<td>500</td>
<td>.51</td>
<td>.13</td>
</tr>
<tr>
<td>1000</td>
<td>.69</td>
<td>.18</td>
</tr>
<tr>
<td>1500</td>
<td>.84</td>
<td>.22</td>
</tr>
<tr>
<td>2000</td>
<td>.96</td>
<td>.25</td>
</tr>
<tr>
<td>2500</td>
<td>1.1</td>
<td>.29</td>
</tr>
<tr>
<td>3000</td>
<td>1.2</td>
<td>.31</td>
</tr>
<tr>
<td>3500</td>
<td>1.3</td>
<td>.34</td>
</tr>
<tr>
<td>4000</td>
<td>1.4</td>
<td>.36</td>
</tr>
</tbody>
</table>

• Specify coil resistance per Table page 9
• Specify 4CA for 4 lead cable with individual coil connection (see page 8)
• Cable location over R or P only choice for Series 30
• Specify O-ring seal material per Table page 10

Performance of Standard Series 30 Servovalves
(Tested on non-magnetic manifold)

Static ...........................................................see table page 13
Dynamic ............................................response limits at ±25% input per table

<table>
<thead>
<tr>
<th>Nominal Supply Pressure (psi)</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum amplitude ratio</td>
<td>&lt;2db</td>
<td>&lt;2db</td>
<td>&lt;2db</td>
<td>&lt;2db</td>
</tr>
<tr>
<td>Frequency of 90° phase point</td>
<td>&gt;120 Hz</td>
<td>&gt;150 Hz</td>
<td>&gt;170 Hz</td>
<td>&gt;200 Hz</td>
</tr>
</tbody>
</table>

Stock Series 30 Servovalve
Part number 30 12. 3000 11000 4 CA R BUN

Supply pressure...........................................................3000 psi
Rated flow..............................................................12 cis (3.1 gpm) no-load
O-rings.........................................................................Buna N
Test fluid.................................................................MIL-H-5606
Rated current...........................................................10 ma parallel
Coil resistance .........................................................1000 ohms/coil
Coil connection .........................................................individual coils
Connector......................................................................4 wire cable
Cable location ............................................................over return port

Dimensions in parentheses are in millimeters

NOTE: CABLE SHOWN OVER RETURN PORT (CODE R)
DIRECTION CAN BE OVER PRESSURE PORT (CODE P)
STAND ARD SERIES 31
NOZZLE-FLAPPER SER VOVALVES

Installation Details
31S020

NOTE: MOTOR CAP ENVELOPE WILL CHANGE FOR ALTERNATE CONNECTOR LOCATIONS

Typical frequency response for Standard Series 31 Servovalves shown below

Standard design valves may be ordered by completing part number (see page 20)

- Specify rated control flow in cis within limits of table
- use two digits and decimal point as indicated
- specified flow will be provided for test fluid used (see page 10)
- lower rated flows available on special order
- Specify supply pressure from 500 to 4000 psi to nearest 50 psi
- lower and higher pressures available on special order

<table>
<thead>
<tr>
<th>SUPPLY PRESSURE (no load valve pressure drop)</th>
<th>Range of No-Load Rated Flow with MIL-H-5606</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI</td>
<td>MINIMUM VALUE</td>
</tr>
<tr>
<td></td>
<td>CIS</td>
</tr>
<tr>
<td>500</td>
<td>2.7</td>
</tr>
<tr>
<td>1000</td>
<td>3.8</td>
</tr>
<tr>
<td>1500</td>
<td>4.7</td>
</tr>
<tr>
<td>2000</td>
<td>5.4</td>
</tr>
<tr>
<td>2500</td>
<td>6.1</td>
</tr>
<tr>
<td>3000</td>
<td>6.7</td>
</tr>
<tr>
<td>3500</td>
<td>7.2</td>
</tr>
<tr>
<td>4000</td>
<td>8.3</td>
</tr>
</tbody>
</table>

- Specify coil connection and coil resistance per Table page 9
- Specify connector or cable per page 8
- Specify location of connector or cable
- Specify O-ring seal material per Table page 10

Performance of Standard Series 31 Servovalves
(Tested on non-magnetic manifold)

Static ..............................................see table page 13
Dynamic ...................response limits at ±25% input per table

Nominal Supply Pressure (psi)

<table>
<thead>
<tr>
<th>Nominal Supply Pressure (psi)</th>
<th>Maximum amplitude ratio</th>
<th>Frequency of 90° phase point</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>&lt; 2 db</td>
<td>&gt; 120 Hz</td>
</tr>
<tr>
<td>1000</td>
<td>&lt; 2 db</td>
<td>&gt; 150 Hz</td>
</tr>
<tr>
<td>2000</td>
<td>&lt; 2 db</td>
<td>&gt; 170 Hz</td>
</tr>
<tr>
<td>3000</td>
<td>&lt; 2 db</td>
<td>&gt; 200 Hz</td>
</tr>
</tbody>
</table>

Stock Series 31 Servovalve
Part number 31 26 3000 1 1000 4 PC 2 BUN
normally carried in stock
Supply pressure........................................3000 psi
Rated flow..............................................26 cis (6.8 gpm) no-load
O-rings..................................................Buna N
Test fluid.............................................MIL-H-5606
Rated current ......................................10 ma parallel
Coil resistance .....................................1000 ohms/coil
Coil connection......................................individual coils
Connector .............................................Bendix PC-02E-8-4P
Connector location...............................over control port 2
STANDARD SERIES 32 NOZZLE-FLAPPER SERVOVALVES

Installation Details 32S020

-note motor cap envelope will change for alternate connector locations

ports (6.35) dia. C’ bored 0.122 (3.12) x 0.498 O.D. x 0.053 deep
(7.92 x 12.65 x 1.35)
dimensions in parentheses are in millimeters

Typical frequency response for standard series 32 servovalves shown below

-ampere ratio dB

0 20 40 60 80

-100% +100% +25%

-frequency Hz

-100% +25% +100%

-stock series 32 servovalve

-part number 32 54. 3000 11000 4 PC 2 BUN

-normally carried in stock

-supply pressure ..............................................................3000 psi

-rated flow ...............................................54 cis (14 gpm) no-load

-rated current .........................................................10 ma parallel

-test fluid ..........................................................MIL-H-5606

-rated current .........................................................10 ma parallel

-coil connection ......................................................individual coils

-connector ...................................................Bendix PC-02E-8-4P

-connector location ..........................................over control port 2

-std design valves may be ordered by completing part number (see page 20)

- specify rated control flow in cis within limits of table

- use two digits and decimal point as indicated

- specified flow will be provided for test fluid used (see page 10)

- lower rated flows available on special order

- specify supply pressure from 500 to 4000 psi to nearest 50 psi

- lower and higher pressures available on special order

-Supply Pressure (no load valve pressure drop)

<table>
<thead>
<tr>
<th>PSI</th>
<th>Range of No-Load Rated Flow with MIL-H-5606</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MINIMUM VALUE</td>
</tr>
<tr>
<td>500</td>
<td>11.28</td>
</tr>
<tr>
<td>1000</td>
<td>15.40</td>
</tr>
<tr>
<td>1500</td>
<td>19.49</td>
</tr>
<tr>
<td>2000</td>
<td>22.56</td>
</tr>
<tr>
<td>2500</td>
<td>24.63</td>
</tr>
<tr>
<td>3000</td>
<td>27.69</td>
</tr>
<tr>
<td>3500</td>
<td>29.75</td>
</tr>
<tr>
<td>4000</td>
<td>33.86</td>
</tr>
</tbody>
</table>

- specify coil connection and coil resistance per Table page 9

- specify connector or cable per code page 8

- specify location of connector or cable

- specify O-ring seal material per Table page 10

- Performance of standard series 32 servovalves

- (tested on non-magnetic manifold)

- static ...........................................................see table page 13

- dynamic .......................................response limits at ±25% input per table

- Nominal Supply Pressure (psi)

<table>
<thead>
<tr>
<th>PSI</th>
<th>Maximum amplitude ratio</th>
<th>Frequency of 90° phase point</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>&lt;2db</td>
<td>&gt;70Hz</td>
</tr>
<tr>
<td>1000</td>
<td>&lt;2db</td>
<td>&gt;110Hz</td>
</tr>
<tr>
<td>2000</td>
<td>&lt;2db</td>
<td>&gt;140Hz</td>
</tr>
<tr>
<td>3000</td>
<td>&lt;2db</td>
<td>&gt;160Hz</td>
</tr>
</tbody>
</table>

- stock series 32 servovalve

- part number 32 54. 3000 11000 4 PC 2 BUN

- normally carried in stock

- supply pressure ..............................................................3000 psi

- rated flow ......................................................54 cis (14 gpm) no-load

- rated current .........................................................10 ma parallel

- coil resistance ..........................................................1000 ohms/coil

- coil connection ......................................................individual coils

- connector ...................................................Bendix PC-02E-8-4P

- connector location ..........................................over control port 2
STANDARD SERIES 34 NOZZLE-FLAPPER SERVOVALVES

Supply Pressure

<table>
<thead>
<tr>
<th>PSI</th>
<th>Range of No-Load Rated Flow with MIL-H-5606</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>MINIMUM VALUE</td>
</tr>
<tr>
<td>22.5</td>
<td>30.</td>
</tr>
<tr>
<td>5.7</td>
<td>7.8</td>
</tr>
<tr>
<td>1000</td>
<td>37.5</td>
</tr>
<tr>
<td>30.</td>
<td>7.8</td>
</tr>
<tr>
<td>11.</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>42.0</td>
</tr>
<tr>
<td>37.5</td>
<td>9.6</td>
</tr>
<tr>
<td>14.</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>45.0</td>
</tr>
<tr>
<td>42.0</td>
<td>11.0</td>
</tr>
<tr>
<td>16.</td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td>49.0</td>
</tr>
<tr>
<td>45.0</td>
<td>12.0</td>
</tr>
<tr>
<td>17.</td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>52.0</td>
</tr>
<tr>
<td>49.0</td>
<td>13.0</td>
</tr>
<tr>
<td>19.</td>
<td></td>
</tr>
<tr>
<td>3500</td>
<td>56.0</td>
</tr>
<tr>
<td>52.0</td>
<td>14.0</td>
</tr>
<tr>
<td>20.</td>
<td></td>
</tr>
</tbody>
</table>

- Specify coil connection and coil resistance per Table page 9
- Specify connector or cable per page 8
- Specify location of connector or cable
- Specify O-ring seal material per Table page 10

Performance of Standard Series 34 Servovalves

(Tested on non-magnetic manifold)

Static ...........................................................see table page 13
Dynamic ....................response limits at ±25% input per table

Supply pressure ..............................................................3000 psi
Rated flow...............................................73 cis (19 gpm) no-load
O-rings..............................................................................Buna N
Test fluid ....................................................................MIL-H-5606
Rated current .........................................................10 ma parallel
Coil resistance .....................................................1000 ohms/coil
Coil connection......................................................individual coils
Connector ...................................................Bendix PC-02E-8-4P
Connector location ..........................................over control port 2

Typical frequency response for Standard Series 34 Servovalves shown below

Installation Details

Installation Details

NOTE: MOTOR CAP ENVELOPE WILL CHANGE FOR ALTERNATE CONNECTOR LOCATIONS

Dimensions in parentheses are in millimeters

Typical frequency response for Standard Series 34 Servovalves shown below
**Standard Series 35 Nozzle-Flapper Servovalves**

**Installation Details 35S020**

*NOTE: MOTOR CAP ENVELOPE WILL CHANGE FOR ALTERNATE CONNECTOR LOCATIONS*

**Dimensions in parentheses are in millimeters**

**Typical frequency response for Standard Series 35 Servovalves shown below**

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**Standard design valves may be ordered by completing part number (see page 20)**

- Specify rated control flow in cis within limits of table
- Use two digits and decimal point or three digits as indicated
- Specified flow will be provided for test fluid used (see page 10)
- Lower rated flows available on special order
- Specified supply pressure from 500 to 4000 psi to nearest 50 psi
- Lower and higher pressures available on special order

<table>
<thead>
<tr>
<th>SUPPLY PRESSURE (no load valve pressure drop)</th>
<th>Range of No-Load Rated Flow with MIL-H-5606</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI</td>
<td>MINIMUM VALUE</td>
</tr>
<tr>
<td>CIS</td>
<td>GPM</td>
</tr>
<tr>
<td>500</td>
<td>34.</td>
</tr>
<tr>
<td>1000</td>
<td>46.</td>
</tr>
<tr>
<td>1500</td>
<td>56.</td>
</tr>
<tr>
<td>2000</td>
<td>61.</td>
</tr>
<tr>
<td>2500</td>
<td>68.</td>
</tr>
<tr>
<td>3000</td>
<td>73.</td>
</tr>
<tr>
<td>3500</td>
<td>77.</td>
</tr>
<tr>
<td>4000</td>
<td>84.</td>
</tr>
</tbody>
</table>

**Stock Series 35 Servovalve**

Part number 35 115 3000 11000 4 PC 2 BUN

normally carried in stock

Supply pressure .......................................................... 3000 psi

Rated flow ............................................................ 115 cis (30 gpm) no-load

O-rings ................................................................. Buna N

Test fluid .............................................................. MIL-H-5606

Rated current .......................................................... 10 ma parallel

Coil resistance ....................................................... 1000 ohms/coil

Coil connection ....................................................... individual coils

Connector ............................................................. Bendix PC-02E-8-4P

Connector location ................................................... over control port 2

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TYPICAL RESPONSES FOR PEAK SINUSOIDAL INPUTS OF ±25% AND ±100% RATED CURRENT

3000 PSI SUPPLY 100°F OIL TEMP.

- **10.0%**
- **25.0%**

**Performance of Standard Series 35 Servovalves**

(Tested on non-magnetic manifold)

Static ........................................................... see table page 13

Dynamic ............... response limits at ±25% input per table

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**Stock Series 35 Servovalve**

Part number 35 115 3000 11000 4 PC 2 BUN

normally carried in stock

Supply pressure .......................................................... 3000 psi

Rated flow ............................................................ 115 cis (30 gpm) no-load

O-rings ................................................................. Buna N

Test fluid .............................................................. MIL-H-5606

Rated current .......................................................... 10 ma parallel

Coil resistance ....................................................... 1000 ohms/coil

Coil connection ....................................................... individual coils

Connector ............................................................. Bendix PC-02E-8-4P

Connector location ................................................... over control port 2

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**Typical frequency response for Standard Series 35 Servovalves shown below**

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**Nominal Supply Pressure (psi)**

<table>
<thead>
<tr>
<th></th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum amplitude ratio</td>
<td>&lt; 2db</td>
<td>&lt; 2db</td>
<td>&lt; 2db</td>
<td>&lt; 2db</td>
</tr>
<tr>
<td>Frequency of 90° phase point</td>
<td>Low Flow &gt; 50 Hz</td>
<td>&gt; 70 Hz</td>
<td>&gt; 85 Hz</td>
<td>&gt; 100 Hz</td>
</tr>
<tr>
<td></td>
<td>High Flow* &gt; 40 Hz</td>
<td>&gt; 55 Hz</td>
<td>&gt; 65 Hz</td>
<td>&gt; 80 Hz</td>
</tr>
</tbody>
</table>

*Rated flow above equivalent 115 cis at 3000 psi.
**Installation Information**

**Fluid Cleanliness**
- Supply fluid must be well filtered for long, trouble-free operation
- System contamination levels better than NAS 1638 Class 6 are recommended
- Type 30 Servovalves will operate on contaminated fluid, but will exhibit increased null leakage and threshold with valve life

**System Filtration**
- Supply fluid to Type 30 Servovalves should be filtered with a 10µm nominal (or better), full flow, non-bypass type filter
- Servovalve internal filter (20µm nominal) protects hydraulic amplifier from gross contamination
- System should be flushed for clean-up prior to installing servovalves

**Manifold Details**
- Manifold flatness less than 0.001 TIR
- O-ring port sealing surface finish 32
- Manifold material to suit application
  - Standard servovalves tested on non-magnetic material manifolds; some change in servovalve gain may occur when mounted on magnetic material manifolds

**Ordering Information for Standard Type 30 Servovalves**

**Please Specify Part Number as follows**

<table>
<thead>
<tr>
<th>Valve Series</th>
<th>No-load rated flow in cis (include decimal point for flow &lt;100 cis)</th>
<th>Supply Pressure in psi (to nearest 50 psi)</th>
<th>Coil Connection</th>
<th>Type of Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>.75</td>
<td>3000</td>
<td>P Parallel</td>
<td>PC = Bendix PC screw connector</td>
</tr>
<tr>
<td>31</td>
<td>7.5</td>
<td>1500</td>
<td>S Series</td>
<td>PT = Bendix PT bayonet connector</td>
</tr>
<tr>
<td>32</td>
<td>75.</td>
<td>0750</td>
<td>D Differential</td>
<td>CA = 18 inch cable</td>
</tr>
<tr>
<td>34</td>
<td>120</td>
<td>etc.</td>
<td>I Individual</td>
<td>See page 8</td>
</tr>
<tr>
<td>35</td>
<td>etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coil resistance in ohms</th>
<th>Location of Connector or Cable</th>
<th>Number of pins or wires</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P over pressure port</td>
<td>30 PC 4 PC</td>
</tr>
<tr>
<td></td>
<td>R over return port</td>
<td>4 PC 3 PC</td>
</tr>
<tr>
<td></td>
<td>1 over cylinder 1 port</td>
<td>1 2</td>
</tr>
<tr>
<td></td>
<td>2 over cylinder 2 port</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>O-Ring Compound</th>
<th>Location of Connector or Cable</th>
<th>Number of pins or wires</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIT</td>
<td>P over pressure port</td>
<td>30 PC 4 PC</td>
</tr>
<tr>
<td>EPR</td>
<td>R over return port</td>
<td>4 PC 3 PC</td>
</tr>
<tr>
<td></td>
<td>1 over cylinder 1 port</td>
<td>1 2</td>
</tr>
<tr>
<td></td>
<td>2 over cylinder 2 port</td>
<td></td>
</tr>
</tbody>
</table>

**Shipping**
- Standard valves shipped with shipping plate
- Valves are sealed in plastic bags and individually boxed
- Shipping carton for standard servovalves contains copy of valve flow plot and internal leakage plot

**Special Order**
- Contact Moog Sales

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**See page 8**

**See page 9**

**See page 10**
Quality Reflects Culture...

Good People, working in an environment that is built on mutual trust and respect will react with a commitment that results in positive accomplishment for the Company and for the individual.

...The Moog Philosophy