MOOG®
77 Series
Flow Control Servovalves

Design Features*

- rugged aluminum body
- o-ring floated, center pinned bushing with convenient null adjust
- dry torque motor in sealed compartment
- frictionless, flexure tube supported armature-flapper
- modular torque motor and pilot stage assembly
- balanced, double coil, double air gap torque motor
- mechanical feedback with simple cantilever spring
- spool-bushing diametral tolerances held within 35 microinches (1 micron)
- motor coils protected during thermal and vibration extremes by resilient potting
- pilot stage filter flushed by second stage flow

The 77 Series are custom designed industrial servovalves that are interchangeable with certain aerospace standard port patterns. These servovalves offer the attractive combination of high performance and low cost achieved by the standard Moog 76 Series industrial servovalves.

A special model of the 77 Series can be created to duplicate the performance of almost any servovalve (of 15 gpm or lower flow capacity) now in use. This permits changeover to the Moog industrial servovalve without disrupting nor modifying the mounting manifold, the electronics, loop gains, etc.

All 77 Series servovalves use the same torque motor, pilot stage, spool-sleeve assembly, and mechanical feedback as the standard 76 Series. This provides the cost and technical advantages of an established production design.

*Patent Numbers 3,023,782 and 3,228,423
General Specifications

- **Rated Supply Pressure**: 100 psi (7 bars) minimum
- **Proof Pressure**: 3000 psi (210 bars) maximum
- **Input Current**: 150% supply
- **Fluid**: petroleum base hydraulic fluids
- **Filtration Required**: 10μ nominal, 25μ absolute (or better)
- **Operating Temperature**: -65°F to +275°F
- **Range**: -54°C to +135°C (or as limited by fluid)
- **External Leakage**: none
- **Weight**: 2 pounds (0.9 Kg)

Electrical Characteristics

- **Rated Current & Coil Resistance**
  A variety of coils are available for 77 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, 77 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.

- **Coil Connections**
  The two coils of the 77 Series servovalve may be connected in several different ways as shown in Table II. Usually a four-pin connector (that mates with an MS3106-14S-2S) is supplied, although MS connectors with fewer pins, or Bendix Pigmy connectors, or pigtails are also available.

- **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.

- **Quiescent Current**
  If used, it is recommended that quiescent current not exceed 100% rated current.

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

*Buna-N Seals generally used
Flow Rating

Rated Flow will be limited by port pattern and valve pressure drop. Maximum rated flow can be increased by allowing higher nonlinearity due to flow saturation effects. See Figure 2.

<table>
<thead>
<tr>
<th>Port Circle Diameter</th>
<th>Max. Rated Flow at 1000 psi (70 bars)</th>
<th>&lt;5% nonlinearity</th>
<th>&lt;10% nonlinearity</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>gpm</td>
<td>lit/min</td>
<td>gpm</td>
</tr>
<tr>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.625</td>
<td>8</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>0.780</td>
<td>10</td>
<td>38</td>
<td>12</td>
</tr>
<tr>
<td>0.937</td>
<td>12</td>
<td>46</td>
<td>15</td>
</tr>
</tbody>
</table>

Flow-load Characteristics

Control flow to the load will change with load pressure drop and electrical input as shown in Figure 3. 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

Static Performance

- rated flow tolerance ±10%
- hysteresis <3%
- threshold <1/2%
- null externally adjustable
- internal leakage at 1000 psi (70 bars) <1.4 cis (1.4 lit/min)
- pressure gain >50% supply for 1% input
- null shift with temp. (100°F variation) <2%
- null shift with pressure (±20% supply variation) <2%

Dynamic Response

- amplitude ratio (with pp no peaking input = 40% rated)
  - 90° phase lag >100 Hz for lower rated flows  
  - >60 Hz for higher rated flows
  - step response, 50% input  
    - <15 ms for lower rated flows  
    - <30 ms for higher rated flows

![Typical Frequency Response](image)

Table I. Available Coils for 77 Series Servovalves

<table>
<thead>
<tr>
<th>Nominal Resistance Per Coil At 70°F (21°C) Ohms</th>
<th>Recommended Rated Current – ma</th>
<th>Approx. Inductance Per Coil* Henrys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential, Parallel, or Single Coil Configuration</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Series Coils</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>40</td>
<td>150</td>
<td>0.15</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>0.30</td>
</tr>
<tr>
<td>130</td>
<td>20</td>
<td>0.55</td>
</tr>
<tr>
<td>200</td>
<td>15</td>
<td>0.80</td>
</tr>
<tr>
<td>500</td>
<td>10</td>
<td>2.2</td>
</tr>
<tr>
<td>1000</td>
<td>5</td>
<td>4.5</td>
</tr>
<tr>
<td>1500</td>
<td>4</td>
<td>6.5</td>
</tr>
</tbody>
</table>

*Approximate inductance at 50 Hz; servovalve pressurized; total coil inductance will be approximately three times value given.

Table II. Standard Coil Connections

<table>
<thead>
<tr>
<th>Coil Configuration</th>
<th>Differential Coils</th>
<th>Series Coils</th>
<th>Parallel Coils</th>
<th>Single Coils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector pins</td>
<td>B, A, C</td>
<td>B, A</td>
<td>B, A</td>
<td>B, A, D, C</td>
</tr>
<tr>
<td>Pigtail colors</td>
<td>gnr, red, blu</td>
<td>gnr, red</td>
<td>gnr, red</td>
<td>gnr, red, yel, blu</td>
</tr>
<tr>
<td>Input current</td>
<td>for A+, when current A to B &lt; A to C; for A-, when current B to A &gt; C to A; for series coils use B to C.</td>
<td>with B+, A-</td>
<td>with B+, A-</td>
<td>with B+, A- or D+, C-; for differential coils tie A to D; for series coils tie A to D; for parallel coils tie A to C and B to D.</td>
</tr>
</tbody>
</table>
Installation Details

Three standard designs are available

<table>
<thead>
<tr>
<th>Series</th>
<th>Port Circle Diameter</th>
<th>Port Diameter</th>
<th>Section</th>
<th>O-rings</th>
<th>ID</th>
<th>Mounting Bolt Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>77-100</td>
<td>0.625</td>
<td>0.191</td>
<td>0.070</td>
<td>0.239</td>
<td>6.07</td>
<td>10-24 × 2.0</td>
</tr>
<tr>
<td>77-200</td>
<td>0.780</td>
<td>0.260</td>
<td>0.070</td>
<td>0.364</td>
<td>9.25</td>
<td>10-32 × 2.0</td>
</tr>
<tr>
<td>77-500</td>
<td>0.937</td>
<td>0.312</td>
<td>0.070</td>
<td>0.426</td>
<td>10.82</td>
<td>¼-28 × 2.0</td>
</tr>
</tbody>
</table>

Note: Dimensions in parentheses are in millimeters.