The actual flow is dependent upon electrical command signal and valve pressure drop. The flow for a given valve pressure drop can be calculated using the square root function for sharp edge orifices:

\[ Q = Q_N \sqrt{\frac{\Delta p}{\Delta p_N}} \]

where:
- \( Q \) [gpm] = calculated flow
- \( Q_N \) [gpm] = rated flow
- \( \Delta p \) [psi] = actual valve pressure drop
- \( \Delta p_N \) [psi] = rated valve pressure drop

The 78 Series flow control servovalves are throttle valves for 3- and preferably 4-way applications. They are high performance, two-stage design that covers the range of rated flows from 20 to 40 gpm at 1000 psi valve drop. The output stage is a closed center, four-way sliding spool. The pilot stage is a symmetrical double-nozzle and flapper, driven by a double air gap, dry torque motor. Mechanical feedback of spool position is provided by a cantilever spring. The valve design is simple and rugged for dependable, long life operation.

These valves are suitable for electrohydraulic position, speed, pressure or force control systems with high dynamic response requirements.

**Principle of operation**

An electrical command signal (flow rate set point) is applied to the torque motor coils, and creates a magnetic force which acts on the ends of the pilot stage armature. This causes a deflection of armature/flapper assembly within the flexure tube. Deflection of the flapper restricts fluid flow through one nozzle, which is carried through to one spool end, displacing the spool.

Movement of the spool opens the supply pressure port (P) to one control port, while simultaneously opening the tank port (T) to the other control port. The spool motion also applies a force to the cantilever spring, creating a restoring torque on the armature/flapper assembly. Once the restoring torque becomes equal to the torque from the magnetic forces, the armature/flapper assembly moves back to the neutral position, and the spool is held open in a state of equilibrium until the command signal changes to a new level.

In summary, the spool position is proportional to the input current and with constant pressure drop across the valve, flow to the load is proportional to the spool position.

**Valve Features**

- 2-stage design with dry torque motor
- Low friction double nozzle pilot stage
- High spool control forces
- High dynamics
- Rugged, long-life design
- High resolution, low hysteresis
- Completely set-up at the factory
- Intrinsically safe or flameproof valve versions are available

Intrinsically safe valve versions are available for use in hazardous locations. Specific models are certified to FM, ATEX, CSA, and TIIS standards. Contact the factory for details.
**Operating Pressure**
- Ports P, T, A and B up to 3,000 psi

**Temperature Range**
- Fluid: -40°F to 275°F
- Ambient: -40°F to 275°F

**Seal Material**
- Viton, others on request

**Operating Fluid**
- Compatible with common hydraulic fluids, other fluids on request.

**Recommended viscosity**
- 60 – 450 SUS @ 100°F

**System Filtration:** High pressure filter (without bypass, but with dirt alarm) mounted in the main flow and, if possible, directly upstream of the valve.

**Class of Cleanliness:** The cleanliness of the hydraulic fluid greatly effects the performance (spool positioning, high resolution) and wear (metering edges, pressure gain, leakage) of the servovalve.

**Recommended Cleanliness Class**
- For normal operation: ISO 4406 < 14/11
- For longer life: ISO 4406 < 13/10

**Filter Rating**
- For normal operation: $\beta_0 \geq 75$ (10 µm absolute)
- For longer life: $\beta_0 \geq 75$ (5 µm absolute)

**Installation Operations**
- Any position, fixed or movable.

**Vibration**
- 30 g, 3 axes

**Weight**
- 6.3 lbs (2.9 kg)

**Shipping Plate**
- Delivered with an oil sealed shipping plate.

---

**Valve Flow Diagram**
- Valve flow for maximum valve opening (100% command signal) as a function of the valve pressure drop.
Model... Type
Valve Body Version

Pilot Stage
Pilot Connection
Rated Flow
(±10%) at Δp = 1,000 psi
Standard [gpm] 20.0 30.0 40.0
High Response [gpm] 20.0 30.0 40.0

Response Time*
Standard [ms] 30.0 30.0 40.0
High Response [ms] 15.0 20.0 N/A

Threshold*
[%] < 0.5%

Hysteresis*
[%] < 3.0%

Null Shift
at ΔT = 100°F [%] < 2.0%

Null Leakage Flow*
max. [gpm] 0.65 to 0.92

* Measured at 1,000 psi pilot or operating pressure

Step Response

Typical characteristic curves with ±40% and ±100% input signal, measured at 3,000 operating pressure.

Standard Valves
High Response Valves
Null Adjust: Flow out of Control Port A will increase with clockwise rotation of null adjust screw (1/16 hex key).

Surface to which valve is mounted requires a ∆[Δ] finish, flat within 0.002[0.05] TIR.
78 SERIES
ELECTRICAL CONNECTIONS

**Rated current and coil resistance**
A variety of coils are available for 78 Series Servovalves, which offer a wide choice of rated current. See Table 1.

**Coil connections**
A four-pin electrical connector (that mates with an MS3106F145/2S) is standard. All four torque motor leads are available at the connector so external connections can be made for series, parallel or differential operation. 78 Series Servovalves can be supplied on special order with other connectors or a pigtail.

**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.

---

**ELECTRICAL CONNECTIONS**
(Examples with typical 78 series coils)

<table>
<thead>
<tr>
<th>Connections for Valve Opening</th>
<th>Parallel</th>
<th>Series</th>
<th>Single</th>
</tr>
</thead>
<tbody>
<tr>
<td>P # B, A # T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A and C (+)</td>
<td>A (+), D (-)</td>
<td></td>
<td>A (+), B (-) or C (+), D (-)</td>
</tr>
<tr>
<td>B and D (-)</td>
<td>B and C connected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Before applying electrical signals, the pilot stage has to be pressurized.

### TABLE 1

<table>
<thead>
<tr>
<th>Nominal Resistance Per Coil at 77°F (25°C) Ω</th>
<th>Recommended Rated Current–mA</th>
<th>Approximate Coil Inductance*–Henrys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel, Differential or Single Coil Operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Series Coils</td>
<td>Single Coils</td>
<td>Series Coils</td>
</tr>
<tr>
<td>80</td>
<td>±40</td>
<td>±20</td>
</tr>
<tr>
<td>200</td>
<td>±15</td>
<td>±7.5</td>
</tr>
<tr>
<td>1000</td>
<td>±8</td>
<td>±4</td>
</tr>
</tbody>
</table>

* Measured at 50 Hz
### Model Number

**Model Designation**
- Assigned at the factory

**Optional Feature**
- Series specification
- Intrinsically safe
- Flameproof

### Type Designation

**Model Designation**
- Assigned at the factory

**Optional Feature**
- Signals for 100% Spool Stroke
  - 4 ±4 mA series (±8 mA parallel)
  - H ±7.5 mA series (±15 mA parallel)
  - L ±20 mA series (±40 mA parallel)
  - Z ±100 mA series (±200 mA parallel)
  - Y Special signal (see spec. sheet)

**Valve Version**
- S Standard response
- H High response

**Rated Flow**
- \( Q_{-1\text{gpm}} \) at \( \Delta p_{N} = 1,000 \text{ psi} \)
  - 07 20
  - 11 30
  - 15 40

**Maximum Operating Pressure \( p_p \) and Body Material**
- F 3,000 psi aluminum

**Main Spool Type**
- O 4-way / axis cut / linear
- D 4-way / +/-10% overlap / linear
- X Special

**Seal Material**
- V Fluorocarbon
- N NBR
- Others on request

**Pilot Connections and Pressure**
- Pressure [psi]
- Supply
  - 4 250 to 3,000 internal

**Pilot Stage**
- F Standard dynamics
- G Improved dynamics

**Spool Position without Electrical Signal**
- M Mid position

### Preferred configurations highlighted.
- All combinations may not be available.
- Options may increase price and delivery.
- Technical changes are reserved.