FF-102 SERIES

double nozzle flapper force feedback flow control EHSV
AVIC Nanjing Servo Control Systems Co., Ltd has been manufacturing servo valves for over 50 years. FF-102 series servo valves have been widely used in both military applications and industrial applications, such as aerospace, aviation, radar, metallurgy, chemical industry, manufacture, geological exploration, construction, power generation, textiles, printing and various kinds of test equipment. Now we can deliver over 10,000 pieces annually of FF-102 is an affordable equivalent to Mroz 51 T it takes a large share of domestic market and enjoys great reputation among users both at home and abroad.

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Servo valves in this catalog are in conformity with GJB3370-1998 of China military standard for servo valves used for aircraft.

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ISO

Our quality management system has passed ISO 9001:2000 quality assurance system.

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Note
please clear the whole hydraulic system before installing servo valve as per ISO 6072.
Please refer to general technical data and electrical performance.

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This catalog is for users with professional knowledge. Please refer to this catalog to ensure safety and every function of system. We reserve the right to change the specifications in this catalog before notice. Please contact AVIC Nanjing Servo Control Systems Co., Ltd.

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For further information, please visit us at http://www.njservo.com
**Characteristics**

- High precision control, fast dynamic response and ease of operation.
- Stainless steel body / high structure strength.
- Compact structure, small size and light weight.
- Stable performance, high reliability and long working life.
- Low internal leakage and low power consumption.
- Low hysteresis, high threshold and high repeat-ability precision.
- Excellent linearity, driving force and small null shift.

**Structure**

- Servo valve consists of permanent magnetic torque motor (first stage hydraulic amplifier) and power amplifier (second stage hydraulic amplifier).
- Permanent magnetic torque motor consists of armature assembly (11), an upper pole piece (2), a permanent magnet (13), a left and right coil (4), a flexure tube (57), a lower pole piece (6), two nozzles (7), a fixed orifice (10), and internal oil filer (11). The armature assembly (11) is made up of armature, flexure tube, flapper and feedback spring. They are connected by soldering and crimping. The armature assembly is fixed on the valve body (12) by 2 bolts.
- Power stage amplifier is made up of sleeve (8) and spool (9) and other parts.

**Operation**

FF-102 ER/SV has a polarized torque motor, which consists of 2 permanent magnets, armature assembly, upper and lower pole piece, and 2 coils in the torque motor. Two pieces of charged permanent magnets polarize pole pieces, and both ends of the armature are respectively inserted into the gaps formed by upper and lower pole pieces. A flexure tube is employed to play the role not only in a spring support for the armature-flapper assembly but also in a sealing between electromagnetic and hydraulic parts. The flapper of the first stage hydraulic amplifier is inserted between two nozzles, forming two variable orifices. A feedback spring extends from flapper lower and inserts it ball end in the small slot of the spool.

When electrical current input is applied to the torque motor coils, due to the interaction between controlling and permanent flux, a magnetic torque is created on the armature. This torque makes the armature-flapper assembly rotate about the flexure tube support, moving the flapper in one direction or in another direction. The movement of the flapper results in increasing the area of one flapper-nozzle orifice and decreasing the area of the other one, creating differential pressure in the two nozzle controlled chambers. This differential pressure moves the spool, pushing the ball end of feedback spring and creating restoring torque on the armature-flapper assembly. The spool goes on moving until the feedback torque becomes equal to the magnetic torque caused by control current input. At that time, the flapper is moved back to a nearly neutral position. As the magnetic torque is proportional to the current input, and the feedback torque is proportional to the spool position as well, therefore, the spool position is proportional to the input current while the mentioned torques are being balanced.

**Performance**

- Working pressure: Rated supply pressure: 21.0 MPa, return pressure: 10.0 MPa.
- Temperature and humidity: Ambient temperature: -30°C to 150°C, fuel temperature: -55°C to 150°C.
- Relative humidity: 10% to 90%.
- Sealing material: NBR, PTFE (other materials at request).
- Working fluid: Petroleum hydraulic fluid DIN 51524 or yh-15 or yh-10 aircraft fluid as per clients’ hydraulic fluid viscosity 10 to 400 mm²/s at 38°C.
- Fluid viscosity: 5 to 600, recommended 5 to 15.
- System filtration: High pressure filter, mounted in the main flow without by-pass, but with dirt indicator. If possible, directly upstream of valve. For system with variable speed pump, outside system circulating filter is recommended.
- Fluid cleanliness level affects servo valve performance greatly (spool null position, resolution) and wear (metering edges, pressure gain, leakage).
- Filtration: for normal operation B₁₁ > 75, 100µm absolute; for longer life B₁₁ > 75, 3µm absolute.
- Installation: It can be installed in any position.
- Vibration: 30g, 3 axis, 50Hz ~ 2kHz.
- Weight: 0.4kg.
- Protection plate: Included in standard delivery.

**Flow Calculation**

Valve actual no-load will be decided by spool position and pressure drop between valve supply and return chambers. Under rated pressure drop P=21.0bar (3006psi) and 100% command signal when valve spool moves furthest, valve no-load rated is defined as rated flow Qn.

At non-rated pressure drop and given commander signal, valve no-load flow is proportional to square root of valve supply and return chamber.

\[
Q_n = \sqrt{\frac{\Delta P}{\Delta A}}
\]

Qn – (l/min) rated flow rate

\[\Delta P = (\text{MPa})\] rated pressure drop

\[\Delta A = (\text{mm}^2)\] actual pressure drop

Qn – (l/min) actual flow rate

When the average flow rate of P3,2 or it is less than 30ml/(l/min), valve volume flow Q can be calculated using this method.

\[
Q = \frac{Q_n}{\sqrt{\frac{\Delta P}{\Delta A}}}
\]

Flow Diagram:

At 100% command signal, valve no-load flow is linear with valve pressure drop. Note: 70bar~1017psi.
Hydraulic symbol

Electrical connection:

Coil connection mode
- Individual coils: 2+1, 3- or 4+, 3-
- Series coils: connecting 1 with 4, 2 with 3-
- Parallel coils: connecting both 1 with 3 and 2 with 4: (1,3) - (2,4) =

Polarity regulation
- If the current flows from 2+ to 1-, traffic outputs from window 1
- If the current flows from 1+ to 2-, traffic outputs from window 2

Rated current, coil resistance and inductance:

<table>
<thead>
<tr>
<th>Each coil resistance at 20°C (Ω)</th>
<th>Rated current (mA)</th>
<th>Coil inductance approx(H)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parallel or Individual</td>
<td>Series</td>
</tr>
<tr>
<td>50</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>700</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: Supply pressure port P;
Return pressure port R(R);
Control port 1 (port A);
Control port 2 (port B)
FF-102 series EHSV performance

<table>
<thead>
<tr>
<th>Item</th>
<th>FF-102/20</th>
<th>FF-102/25</th>
<th>FF-102/30</th>
<th>FF-102/35</th>
<th>FF-102/40</th>
<th>FF-102/45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply pressure range (bar)</td>
<td>20–280</td>
<td>20–280</td>
<td>20–280</td>
<td>20–280</td>
<td>20–280</td>
<td>20–280</td>
</tr>
<tr>
<td>Rated supply pressure (Psig)</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Rated flow rate (L/min)</td>
<td>30, 20, 15, 10, 5, 2</td>
<td>7.9, 5.3, 4, 2.6, 1.8, 0.9</td>
<td>7.9, 5.3, 4, 2.6, 1.8, 0.9</td>
<td>7.9, 5.3, 4, 2.6, 1.8, 0.9</td>
<td>7.9, 5.3, 4, 2.6, 1.8, 0.9</td>
<td>7.9, 5.3, 4, 2.6, 1.8, 0.9</td>
</tr>
<tr>
<td>Rated current (mA)</td>
<td>10, /, 40</td>
<td>10, /, 40</td>
<td>10, /, 40</td>
<td>10, /, 40</td>
<td>10, /, 40</td>
<td>10, /, 40</td>
</tr>
<tr>
<td>Coil resistance (Ω)</td>
<td>700Ω±10%</td>
<td>700Ω±10%</td>
<td>700Ω±10%</td>
<td>700Ω±10%</td>
<td>700Ω±10%</td>
<td>700Ω±10%</td>
</tr>
<tr>
<td>Insulation resistance (MΩ)</td>
<td>&gt;50</td>
<td>&gt;50</td>
<td>&gt;50</td>
<td>&gt;50</td>
<td>&gt;50</td>
<td>&gt;50</td>
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<tr>
<td>Hysteresis (%)</td>
<td>≤4</td>
<td>≤4</td>
<td>≤4</td>
<td>≤4</td>
<td>≤4</td>
<td>≤4</td>
</tr>
<tr>
<td>Threshold (%)</td>
<td>≤1</td>
<td>≤1</td>
<td>≤1</td>
<td>≤1</td>
<td>≤1</td>
<td>≤1</td>
</tr>
<tr>
<td>Linearity (%)</td>
<td>≤2.75</td>
<td>≤2.75</td>
<td>≤2.75</td>
<td>≤2.75</td>
<td>≤2.75</td>
<td>≤2.75</td>
</tr>
<tr>
<td>Symmetry (%)</td>
<td>≤±10%</td>
<td>≤±10%</td>
<td>≤±10%</td>
<td>≤±10%</td>
<td>≤±10%</td>
<td>≤±10%</td>
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<tr>
<td>Pressure gain (%)</td>
<td>&gt;30</td>
<td>&gt;30</td>
<td>&gt;30</td>
<td>&gt;30</td>
<td>&gt;30</td>
<td>&gt;30</td>
</tr>
<tr>
<td>Internal leakage (μA)</td>
<td>0.45, 0.34, 0.29, 0.24, 0.18, 0.15</td>
<td>0.45, 0.34, 0.29, 0.24, 0.18, 0.15</td>
<td>0.45, 0.34, 0.29, 0.24, 0.18, 0.15</td>
<td>0.45, 0.34, 0.29, 0.24, 0.18, 0.15</td>
<td>0.45, 0.34, 0.29, 0.24, 0.18, 0.15</td>
<td>0.45, 0.34, 0.29, 0.24, 0.18, 0.15</td>
</tr>
<tr>
<td>Null bias (%)</td>
<td>≥0.3</td>
<td>≥0.3</td>
<td>≥0.3</td>
<td>≥0.3</td>
<td>≥0.3</td>
<td>≥0.3</td>
</tr>
<tr>
<td>Null shift with supply pressure (50–135%Psig) (%)</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
</tr>
<tr>
<td>Null shift with return pressure (5–125%Psig) (%)</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
<td>≤±2</td>
</tr>
<tr>
<td>Null shift with temperature for every change of 5°C (%)</td>
<td>≤2.5</td>
<td>≤2.5</td>
<td>≤2.5</td>
<td>≤2.5</td>
<td>≤2.5</td>
<td>≤2.5</td>
</tr>
<tr>
<td>Frequency response (%)</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Power loss (W/kg)</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Working temperature (°C)</td>
<td>-35° to 62°C</td>
<td>-35° to 62°C</td>
<td>-35° to 62°C</td>
<td>-35° to 62°C</td>
<td>-35° to 62°C</td>
<td>-35° to 62°C</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>≤0.4</td>
<td>≤0.4</td>
<td>≤0.4</td>
<td>≤0.4</td>
<td>≤0.4</td>
<td>≤0.4</td>
</tr>
</tbody>
</table>

Static performance curve: It is measured at system operation pressure or supply pressure of 210bar (3050psi), fluid viscosity of 32mm²/s (1.265cSt) and fluid temperature of 40°C (104°F).

Flow characteristic curve:

Pressure characteristic curve:
Internal leakage curve:

- 0.58 L/min = 0.15 gpm
- 0.7 L/min = 0.18 gpm
- 0.9 L/min = 0.24 gpm
- 1.1 L/min = 0.29 gpm
- 1.3 L/min = 0.34 gpm
- 1.7 L/min = 0.45 gpm

Frequency response curve:

- FF-102 Series: 10% - 25% - 90%
### Installation drawing (metric system)

![Diagram](image)

### Installation drawing (English system)

![Diagram](image)

### Spare parts and accessories

**O-ring (included in standard delivery):**
- NBR 75 Shore  FPM 75 Shore

**Used for part P,R,1,2:**
- 4 pieces, ID6.6×O1.8
- 5080, 51765  F370, F275

**Mating connector:**
- XX11142/2,XX11142/XXE1144 is available on request

**Installation bolt (included in standard delivery):**
- M4×10.5 ISO 4762-10.9  4 pieces

**Replaceable filter:**
- for pilot stage, installed before orifice  Φ12×75 (corresponding to filtration: 35μm absolute)

**Spare parts and accessories**

**O-ring (included in standard delivery):**
- NBR 75 Shore  FPM 75 Shore

**Used for part P,R,1,2:**
- 4 pieces, ID6.6×O0.07
- 5080, 51765  F370, F275

**Mating connector:**
- Normal choice:XX11142/2

**Installation bolt (included in standard delivery):**
- 4 pieces, M4×10.5 ISO 4762-10.9

**Replaceable filter:**
- for pilot stage and installed before orifice  Filtration absolute: 3.77μm
rael flow rate (L/min)

rated supply pressure (MPa)

dp: connector location at the side of supply pressure

Q: connector location at the side of return pressure

1: connector location at the side of control port 1

2: connector location at the side of control port 2

T: general-purpose connector (please refer to figure)

Z: special-purpose connector (per customer request)

For example part NO.03021TP10 means rated flow 30L/min, rated supply pressure 21MPa, general-purpose connector is at the side of port p, rated current 10mA.

Custom design is also available in terms of rated flow, rated current, coil resistance, rated supply pressure, envelope and connector.

AVIC Nanjing Servo Control System Co., Ltd., a subsidiary of Nanjing Engineering Institute Of Aircraft Systems (former AVIC 605 Research Institute), is the national leader in the research and development, manufacture of electro-hydraulic servo valves (EHSV in short), with the longest history (since 1948), the largest size and the most advanced level in China. AVIC also has invested in the company. Our company is mainly engaged in the research and development, manufacture, test and delivery and repairs of EHSV and also has the ability to develop servo systems and non-standard equipment for industrial applications.

We have a staff of over 200 people with 29 of them being engineers or senior engineers and 51 being senior technicians. Our factory covers an area of 50000 m² and our lab covers an area of 4000 m². We have over 300 sets of equipment and machines, with fixed assets valued at USD 25 million. We are the only one in China to carry out performance test and environment test and validation with working fluid of mineral based hydraulic fuel, phosphate fuel and fuel.

Our EHSV are widely used in aeronautics, space, navigation, metallurgy, machine manufacture, geological exploration, construction machines and all kinds of test equipment. In aeronautics applications, EHSV are used in rudder actuation system, front wheel control system, inlet control system, electronic anti-skid system, radar servo system, cargo door retraction system, engine digital control system, APS and APUs.

Our product line covers over 200 models, including force-feedback single stage servo valve, nozzle - flap two stage servo valve, jet pipe FHSV (jet pipe and jet deflector type), CCDV and RDOV, combined control valve, electro-magnetic hydraulic lock, pressure-reducing valve, hydraulic pump, servo amplifier and EHSV static and dynamic test bench. EHSV’s working fluid covers mineral based hydraulic fuel, phosphate fuel and fuel.

We are also the national leader in terms of EHSV performance test and environment test and validation using hydraulic fluid and fuel. Our test bench includes static and dynamic test, high and low temperature, vibration and shock, temperature-altitude environment test. Temperature test bench can go as far as fluid temperature: -55°C ~ +150°C, environment temperature: -55°C ~ +250°C.

Now we are setting up national military standards and one industrial standard. We have 28 technical patents covering EHSV design, measurement and process and test method for whole valve and parts. We also have state of art equipment for hydraulic grinding, deburring etc.

AVIC Nanjing Servo Control System Co. boasts itself in its complete quality management system, advanced manufacture and development level. We are the national leader working towards the digitization, intelligentization and high pressuration of EHSV. We will strive to keep our clients happy.