FF-101 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-101 series servo valves of AVIC Nanjing Servo Control Systems Co., Ltd have been widely used in both military and industrial applications, such as aviation, aerospace, 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. FF-101 is an affordable equivalent to Moog 30. It boasts a large share of domestic market and enjoys great reputation among users both at home and abroad.

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

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

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

This catalog is for users with professional knowledge. Please refer to this catalog to ensure the 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 in case of any doubt.

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For further information, please visit us at http://www.njsx servo.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 repeatability precision;
- Excellent linearity, driving force and small null shift.
- Wire isolation is available in IP54/IP65.

Structure:
- Servo valve consists of a permanent magnetic torque motor (first stage hydraulic amplifier) and power amplifier (second stage hydraulic amplifier).
- Permanent magnetic torque motor consists of a armature assembly (1) upper pole piece (2), 2 permanent magnets (3) left and right coils (4) lower pole piece (5), 2 nozzles (6). The armature assembly (2) is made up of armature, flexure tube, flapper and feedback spring. They are connected by oiling and oiling. The armature assembly is fixed on the valve body (8) by 2 bolts. Power stage amplifier is made up of two oil holes (7) body (8) and other parts.

Operation:
- FF-101 EHSV has a polarized torque motor, which consists of 2 permanent magnets, armature assembly, upper and lower pole pieces and 2 coils in the torque motor. Two pieces of charged permanent magnets polarize pole pieces, and both ends of its 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. Feedback oil spring extends from the flapper inner and inserts its ball end in the small slot of the armature. Hydraulic oil continuously flows from supply port through an inner filter and both inlet nozzles, past both variable orifices formed by the flapper and nozzles, and then through a drain orifice to return port. Pressures in both flapper-controlled chambers are respectively acted on both ends of the second stage four-way spool.

When electrical current input is applied to the torque motor coil, 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 moved flapper results in increasing the area of one flapper-nozzle orifice and decreasing the area of the other one, creating different 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. Then, with constant valve pressure drop, valve flow output is proportional to current input when rectangular holes (slots) or annular grooves are employed in the valve bushing.

Performance:
- Working pressure: Rated supply pressure: 21MPa
- Return pressure: 0~60MPa
- Temperature and humidity: Ambient temperature: -55°C ~ +150°C
- Fuel temperature: -36°C ~ +150°C
- Relative humidity: 10%~90%
- Sealing material: NBR/FPM/other material at request
- Working fluid: Petroleum based hydraulic fluid per DIN 51524 or hydraulic fluid viscosity 10~400 mm²/s at 38°C as per clients. Recommended yh-15 or yh-10 aircraft fluid.
- Fluid viscosity: 15~500
- 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 a fast regulating speed pump, outside system circulating filter is recommended.
- Cleanliness level:
  - For normal operation: level 8 of G1R (level17/140G/140G/140G 14003-2002)
  - For longer life: NAC 1638: level4/(level 15/15 of GB/T 14039-2002)
- Filter rating: For normal operation: β: >75 (β92spool) for longer life: β: >75 (β92spool)
- Installation: any position or move with system.
- Vibration: 30g, (3 axis), 5Hz ~ 2KHz
- Weight: 0.3kg
- Protection plate: Included in standard delivery

Flow calculation:
- Valve actual flow will be decided by spool position and pressure drop between valve supply and return chambers. Under the rated pressure drop (P=210bar (7300psia) and 100% command signal when valve spool moves further, valve no-load rated is defined as rated flow rated Q0.
- At non-rated pressure drop and given commander signal, valve actual flow is proportional to square root of valve supply and return chamber.

\[ Q = Q_0 \times \left( \frac{1}{P} \right)^{0.5} \]

Where, \( Q_0 \) — valve rated flow rate (L/min) \( P \) — valve actual pressure drop (MPa) \( Q_0 \) — valve rated pressure drop (MPa) \( Q \) — valve actual flow rate (L/min)

When the average flow rate of R1,2 or R is less than 30m³/h (880GPM), valve volume flow Q can be calculated using this method.

Flow Diagram:
- At 100% command signal, valve no-load flow is linear with valve pressure drop. Note: 70bar=1017psi. The curve demonstrates actual flow rate at different pressure drop. Users can pick up EHSV accordingly as per system supply pressure.
Hydraulic symbol

This symbol is for EH/SV status with supply pressure and command signal of 0.

Electrical connection:

Coil connection mode
- Individual coils: 2+, 1- 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>Resistance of each coil 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>200</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: Supply pressure P1
- Return pressure R(T1)
- Control port 1 (control port A1)
- Control port 2 (control port B)
FF-101 series EHSV performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>FF-101/1.0</th>
<th>FF-101/1.5</th>
<th>FF-101/2.0</th>
<th>FF-101/2.4</th>
<th>FF-101/6</th>
<th>FF-101/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply pressure range</td>
<td>bar</td>
<td>20—280</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated supply pressure</td>
<td>psi</td>
<td>3050</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated flow Qn</td>
<td>gpm</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>1.1</td>
<td>1.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Rated current in</td>
<td>mA</td>
<td>10</td>
<td>7</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil resistance</td>
<td>Ω</td>
<td>500±50</td>
<td>7</td>
<td>500±50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>MΩ</td>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hysteresis %</td>
<td></td>
<td>≤ 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold %</td>
<td></td>
<td>≤ 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linearity %</td>
<td></td>
<td>≤ 2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symmetry %</td>
<td></td>
<td>≤ 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure gain %</td>
<td></td>
<td>≥ 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal leakage</td>
<td>µA</td>
<td>0.35</td>
<td>0.325</td>
<td>0.35</td>
<td>0.45</td>
<td>0.55</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>gpm</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.12</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>Null bias %</td>
<td></td>
<td>≤ ±3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Null shift with supply pressure (60°C=—10°C)</td>
<td>%</td>
<td>≤ ±2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Null shift with return pressure (P=200kpa)</td>
<td>%</td>
<td>≤ ±2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Null shift with temperature (18°C=—135°C)</td>
<td>%</td>
<td>≤ ±4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency response</td>
<td>Hz</td>
<td>≥ 40</td>
<td>≥ 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amplitude min (—90°)</td>
<td>Hz</td>
<td>≥ 40</td>
<td>≥ 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working temperature</td>
<td>ºC</td>
<td>—55 ~ +150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net weight Kg</td>
<td></td>
<td>≤ 0.2</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note: FF-101 is totally interchangeable with MD003D in terms of technical data and dimension. And custom design is available at request and rated flow between 15L/min and 46L/min is also available.

FF-101/1.0=14.5 psi; 1 gpm=3.785L/min.

Static performance curve: It is measured at system supply pressure of 210 bar (3050 psi), fluid viscosity of 32 mm²/s (1.26 cSt) and fluid temperature of 40°C (104°F).

Flow characteristic curve:

Pressure characteristic curve:
Internal leakage curve:

0.35 L/min = 0.09 gpm
0.325 L/min = 0.08 gpm
0.45 L/min = 0.12 gpm
0.55 L/min = 0.14 gpm
0.65 L/min = 0.17 gpm

Dynamic performance curve: It is measured at system supply pressure of 210bar (3050psi), fluid viscosity of 32mm²/s (1.26cSt) and fluid temperature of 40°C (104°F).

Frequency response curve:

FF-101/S frequency response at 10% - 25% - 50% - 100%
Installation drawing (metric system)

Installation drawing (English system)

<table>
<thead>
<tr>
<th>mm</th>
<th>P</th>
<th>1</th>
<th>R</th>
<th>2</th>
<th>G</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ø0.5</td>
<td>Ø3.8</td>
<td>Ø0.5</td>
<td>Ø3.8</td>
<td>Ø1.5</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>x</td>
<td>12</td>
<td>18.2</td>
<td>12</td>
<td>5.7</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>y</td>
<td>19.1</td>
<td>13</td>
<td>0.7</td>
<td>13</td>
<td>6</td>
<td>0</td>
<td>26</td>
<td>26</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inch</th>
<th>P</th>
<th>1</th>
<th>R</th>
<th>2</th>
<th>G</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ø0.14</td>
<td>Ø0.15</td>
<td>Ø0.14</td>
<td>Ø0.15</td>
<td>Ø0.06</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>x</td>
<td>0.47</td>
<td>0.72</td>
<td>0.47</td>
<td>0.22</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td>y</td>
<td>0.76</td>
<td>0.51</td>
<td>0.26</td>
<td>0.51</td>
<td>0.24</td>
<td>0</td>
<td>1.02</td>
<td>1.02</td>
<td>0</td>
</tr>
</tbody>
</table>

Spare parts and accessories

- O ring (included in standard delivery): NBR75 Shore FPM 75 Shore
  - for port P, R, 1, 2: 4 pieces, ID5×Ø1.5
  - 5080, 51765
  - F370, F275
- Installation bolt (included in standard delivery): M4×9 ISO 4762-10.9
  - 4 pieces
- Replaceable filter
  - for pilot stage, installed before orifice: β50≥75(corresponding to filtration 35μm absolute)

- O ring (included in standard delivery): NBR75 Shore FPM 75 Shore
  - for port P, R, 1, 2: 4, ID0.2×Ø0.06
  - 5080, 51765
  - F370, F275
- Installation bolt (included in standard delivery): M4×9 ISO 4762-10.9
  - 4
- Replaceable filter
  - for pilot stage, installed before orifice: filtration 137μm absolute
For example part No. 421840 means rated flow 4l/min, rated supply pressure 21MPa, wire is at the side of port return, 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 609 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 technicians. Our factory covers an area of 30000 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 manufacturing, 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 APU.

Our product line covers over 200 models, including force-feedback single stage servo valve, nozzle-flapper two stage servo valve, jet pipe EHSV (jet pipe and jet deflector type), LDOV 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 2 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, intelligence and high pressuration of EHSV. We will strive to keep our clients happy.