



# FF-102 SERIES

double nozzle flapper force feedback flow control EHSV



Add:6 Lanhui Road,Nanjing New&Hightech Development Zone  
Tel:+86 25 58055995 58055996 58055997  
Fax:+86 25 58840205  
Post Code: 210061  
Website:www.njservo.com



609伺服阀

A V I C N A N J I N G S E R V O C O N T R O L S Y S T E M C O . , L T D

航 空 工 业 南 京 伺 服 控 制 系 统 有 限 公 司

# CATALOG

INTRODUCTION ..... 1

PRODUCT OVERVIEW .....2/3

FUNCTION and ELECTRICAL DATA .....4/5

TECHNICAL DATA .....6/7/8/9/10/11

ORDERING INFORMATION .....12

ENTERPRISE PROFILE ..... 13

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 10000 pieces annually.FF-102 is an affordable equivalent to Moog 31 .It takes 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 aircraft.



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 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.



609 is the trademark of former China Research Institute of Aero-Accessories (609 Research Institute). AVIC Nanjing Servo Control Systems Co.,Ltd,a restructuring unit of 609,reserves the right to ownership and change.  
For further information, please visit us at <http://www.njservo.com>

### ※ Characteristics

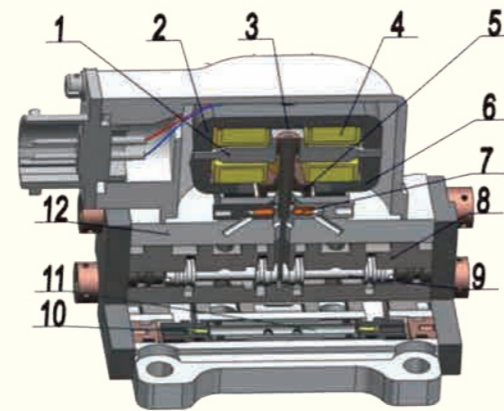
- High precision control,fast dynamic response and ease of operation.
- Stainless steel body,high structure strength
- Compact structure,small size and light weight
- Stable performance,high reliability and long working life.
- Low internal leakage and low power consumption.
- Low hysteresis,high threshold 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 (1) ,upper polepiece (2) ,2 permanent magnet (3) ,left and right coils (4) ,flexure tube (5) ,lower polepiece (6) , 2 nozzles (7) ,2 fixed orifices (10) and internal oil filter (11) .The armature assembly (1) 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 EHSV has a polarized torque motor,which consists of 2 permanent magnets,armature assembly, upper and lower polepiece and 2 coils.In the torque motor,two pieces of charged permanent magnets polarize polepieces, and both ends of its armature are respectively inserted into the gaps formed by upper and lower polepieces. 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 inseted between two nozzles,forming two variable orifices.A feedback spring extends from flapper inner and inserts its 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 moved 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. Then,with constant valve pressure drop, valve flow output to load is proportioned 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: ≤0.6MPa
- Temperature and humidity: Ambient temperature: -30°C~150°C fuel temperature: -55°C~150°C  
Relative humidity: 10%~90%
- Sealing material: NBR、FPM (other materials at request)
- Working fluid: Petrol based hydraulic fluid DIN 51524 or yh-15 or yh-10 aircraft fluid as per clients' hydraulic fluid viscosity 10~400mm<sup>2</sup>/s at 38°C.
- Fluid viscosity: cSt 5~400,recommend cSt 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.
- Cleanliness level: (for normal operation): NAS 1638: 5 (for longer life): NAS 1638: 4  
(for normal operation): ISO 4406: 14/11 (for longer life) : ISO 4406: 13/10  
note: Fluid cleanliness level affects servo valve performance greatly(spool null position, resolution) and wear ( metering edges, pressure gain, leakage)
- Filtration: for normal operation β<sub>10</sub> ≥75 (10μabsolute) for longer life β<sub>3</sub> ≥75 (3μabsolute)
- Installation: It can be installed in any position.
- Vibration: 30g, 3 axis, 5Hz~2KHz
- Weight: 0.4kg
- Protection plate: Included in standard delivery

### Flow calculation

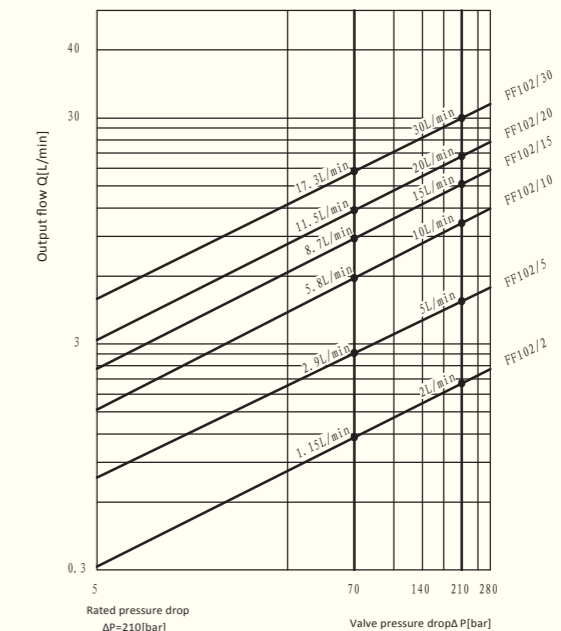
Valve actual no-load will be decided by spool position and pressure drop between valve supply and return chambers.Under rated pressure dropΔP=210bar (3046psi) and 100% command signal when valve spool moves furthest, valve no-load rated is defined as rated flow rated Q<sub>N</sub>.

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

$$Q = Q_N \sqrt{\frac{\Delta P}{\Delta P_N}}$$

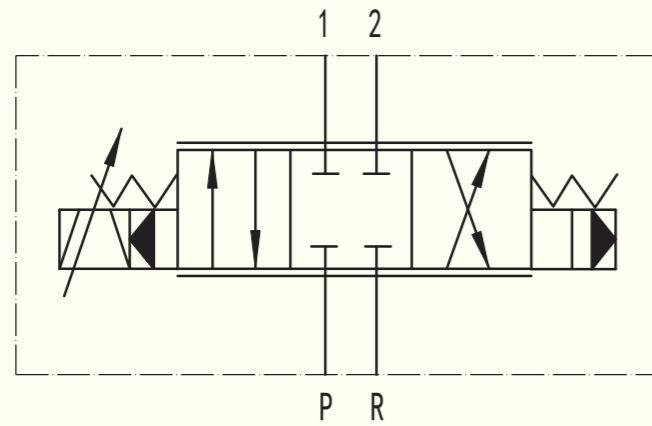
- Q<sub>N</sub>— (L/min) rated flow rate
- ΔP— (MPa) actual pressure drop
- ΔP<sub>N</sub>— (MPa) rated pressure drop
- Q— (L/min) actual flow rate

When the average flow rate of P,1,2 or R is less than 30m/s(98ft/s),valve volume flow Q can be calculated using this method.

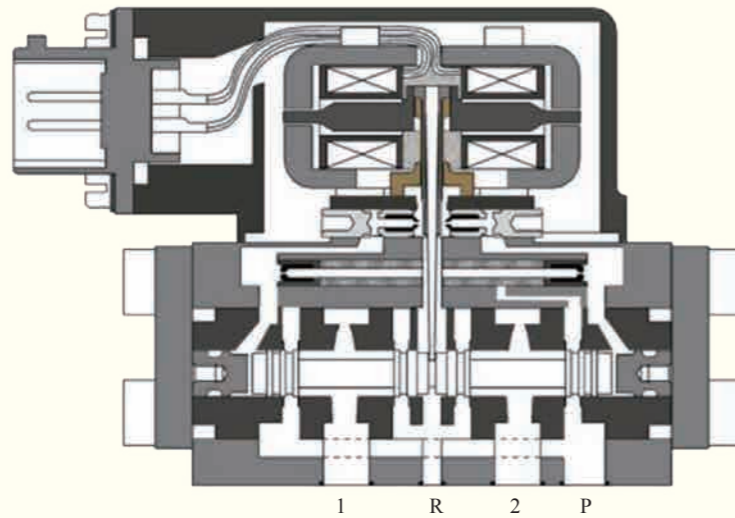


Flow Diagram  
At 100% command signal, valve no-load flow is linear with valve pressure drop.  
Note: 70bar=1017psi.

### Hydraulic symbol

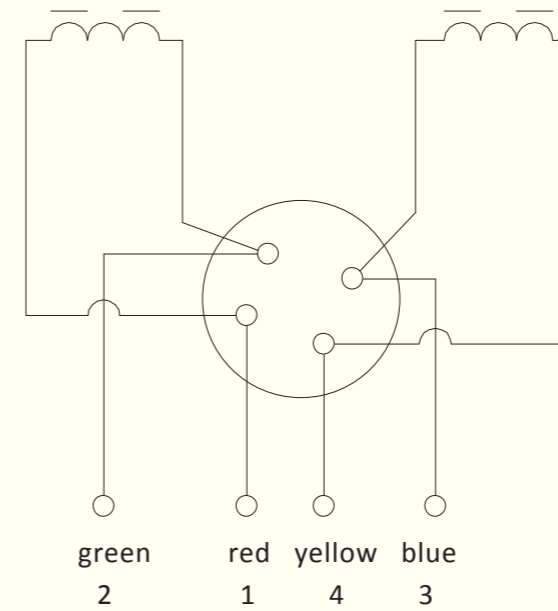


This symbol is for EHSV status with supply pressure and command signal at 0.



Note: Supply pressure port P;  
Return pressure port R(T);  
Control port 1(port A);  
Control port 2 (port B)

### Electrical connection:



Polarity: current from green+ to red-,flow outputs from port 1  
Polarity: current from blue+ to yellow-,flow outputs from port 2

### Rated current, coil resistance and inductance:

| Each coil resistance at 20° (Ω) | Rated current (mA)                    |        | Coil inductance approx(H) |        |        |          |
|---------------------------------|---------------------------------------|--------|---------------------------|--------|--------|----------|
|                                 | Differential, parallel or single coil | Series | Differential              | Series | Single | Parallel |
| 50                              | 40                                    | 20     | 0.28                      | 0.57   | 0.15   | 0.13     |
| 700                             | 10                                    | 5      | 3                         | 6      | 2      | 1.7      |

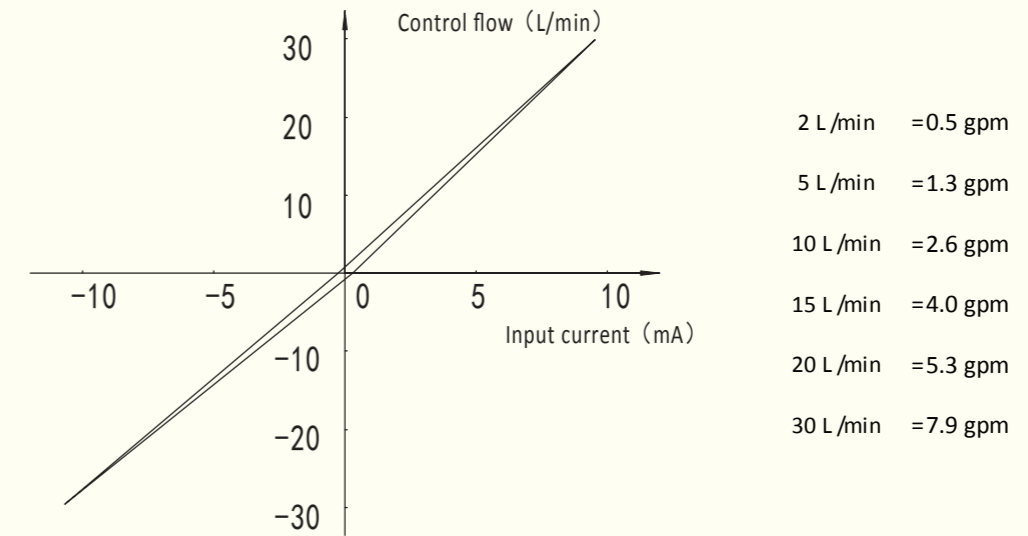
### FF-102 series EHSV performance

| Item   | unit                   | FF-102 series |           |           |           |          |          |
|--|------------------------|---------------|-----------|-----------|-----------|----------|----------|
|  |                        | FF-102/30     | FF-102/20 | FF-102/15 | FF-102/10 | FF-102/5 | FF-102/2 |
| Supply pressure range                                  | bar                    | 20~280        |           |           |           |          |          |
| Rated supply pressure $P_N$                            | bar                    | 210           |           |           |           |          |          |
|  | psi                    | 3050          |           |           |           |          |          |
|  | MPa                    | 21            |           |           |           |          |          |
| Rated flow rate $Q_n$                                  | L/min                  | 30            | 20        | 15        | 10        | 5        | 2        |
|  | (gpm)                  | 7.9           | 5.3       | 4         | 2.6       | 1.3      | 0.5      |
| Rated current $I_N$                                    | mA                     | 10            |           | /         | 40        |          |          |
| Coil resistance  | $\Omega$               | 700±70        |           | /         | 50±5      |          |          |
| Insulation resistance                                  | M $\Omega$             | ≥50           |           |           |           |          |          |
| Hysteresis   | %                      | ≤4            |           |           |           |          |          |
| Threshold  | %                      | ≤1            |           |           |           |          |          |
| Linearity  | %                      | ≤±7.5         |           |           |           |          |          |
| Symmetry   | %                      | ≤±10          |           |           |           |          |          |
| Pressure gain  | %                      | >30           |           |           |           |          |          |
| Internal leakage                                       | L/min                  | 1.7           | 1.3       | 1.1       | 0.9       | 0.7      | 0.58     |
|  | (gpm)                  | 0.45          | 0.34      | 0.29      | 0.24      | 0.18     | 0.15     |
| Null bias  | %                      | ≤±3           |           |           |           |          |          |
| Null shift with supply pressure (80~110% $P_s$ )       | %                      | ≤±2           |           |           |           |          |          |
| Null shift with return pressure (0~20% $P_s$ )         | %                      | ≤±2           |           |           |           |          |          |
| Null shift with temperature<br>For every change of 56° | %                      | ≤±5           |           |           |           |          |          |
| Frequency response                                     | Amplitude ratio (-3dB) | Hz            |           |           |           |          |          |
|  | Phase lag (-90°)       | Hz            |           |           |           |          |          |
| Working temperature                                    | °C                     | -55~+125      |           |           |           |          |          |
| Net weight   | Kg                     | ≤0.4          |           |           |           |          |          |

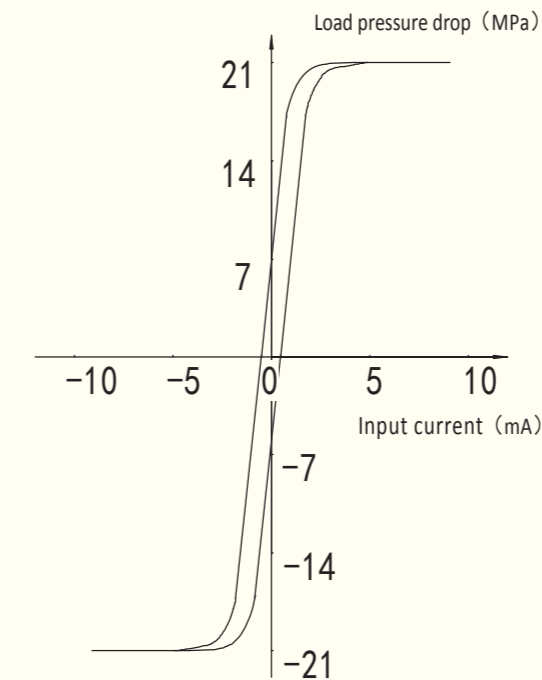
Note: FF-102 is totally interchangeable with MOOG 31 in terms of technical data and dimension.  
1bar=14.5psi;  
1gpm=3.785L/min.

Static performance curve: It is measured at system operation pressure or supply pressure of 210bar (3050psi), fluid viscosity of 32mm<sup>2</sup>/s(1.26in<sup>2</sup>/s) and fluid temperature of 40° (104°F)

### Flow characteristic curve:

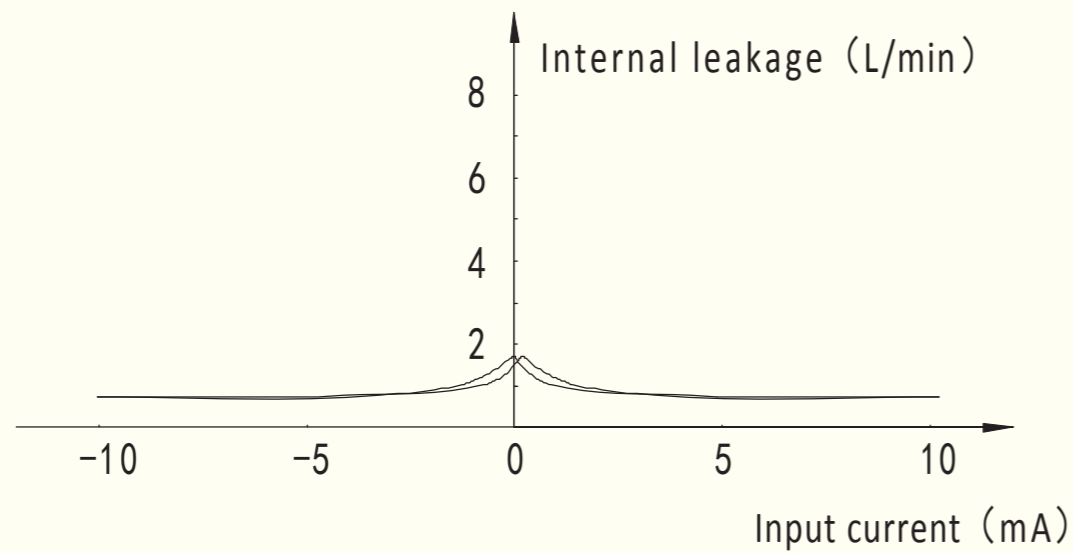


### Pressure characteristic curve:



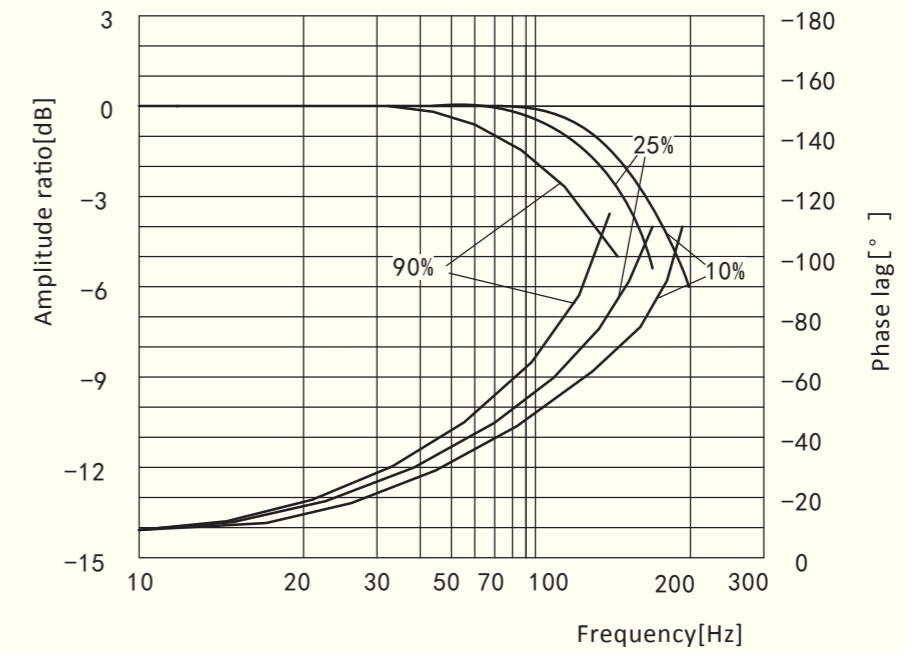
### Internal leakage curve:

- 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

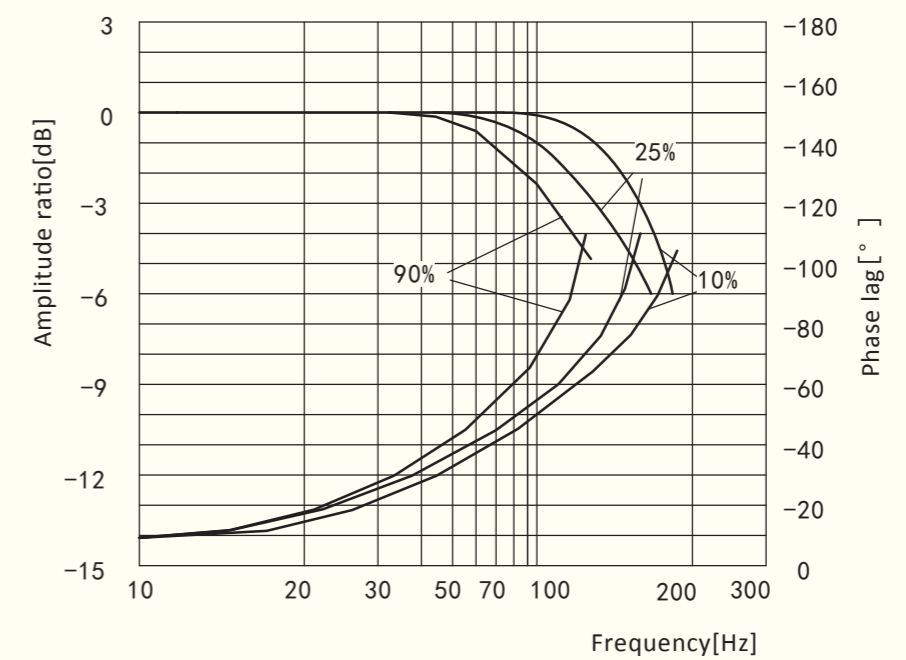


Dynamic performance curve: It is measured at system operation pressure or supply pressure of 210bar (3050psi), fluid viscosity of 32mm<sup>2</sup>/s(1.26in<sup>2</sup>/s) and fluid temperature of 40° (104°F) .

### Frequency response curve:

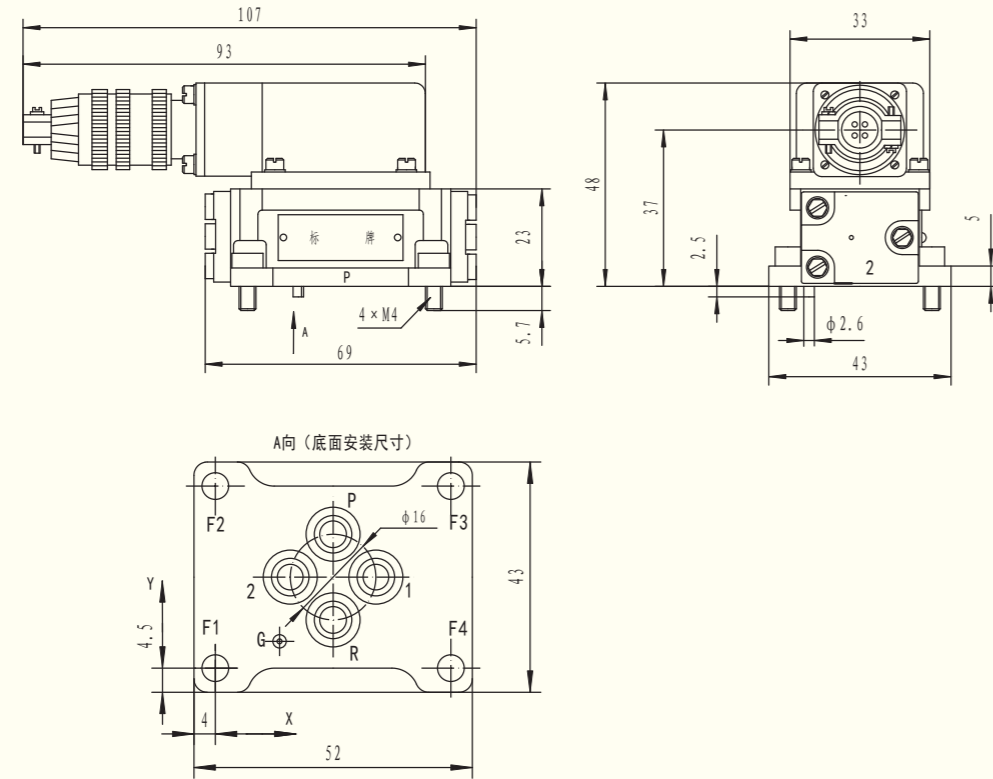


FF-102/30 frequency response at 10%、25%、90%In



FF-102 Frequency response at10%、25%、90%In

Installation drawing (metric system)



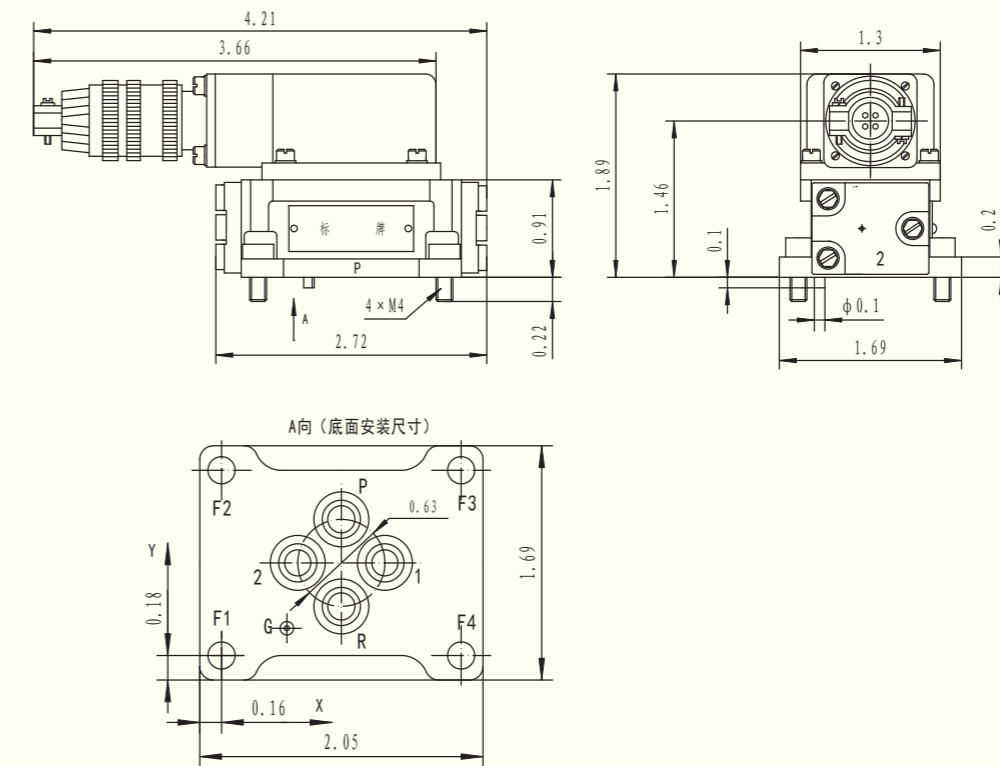
mm

|          | P  | 1    | R  | 2    | G    | F1 | F2 | F3 | F4 |
|----------|----|------|----|------|------|----|----|----|----|
|          | Φ5 | Φ4.8 | Φ5 | Φ4.8 | Φ2.5 | M4 | M4 | M4 | M4 |
| <b>x</b> | 22 | 30   | 22 | 14   | 12   | 0  | 0  | 44 | 44 |
| <b>y</b> | 9  | 17   | 25 | 17   | 5    | 0  | 34 | 34 | 0  |

### Spare parts and accessories

|   |                      |            |           |
|---|----------------------|------------|-----------|
| Oring ( included in standard delivery)  |                      |            |           |
| NBR 75 Shore FPM 75 Shore   |                      |            |           |
| Used for port P,R,1,2   | 4 pieces, ID6.6×Φ1.8 | 5080、5176S | F370、F275 |
| Mating connector  |                      |            |           |
| XK11J4Z/E,XK11J4Z/XKE11R4Q 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 $\beta_{35} \geq 75$ (corresponding to filtration 35μm absolute ) |                      |            |           |

Installation drawing (English system)

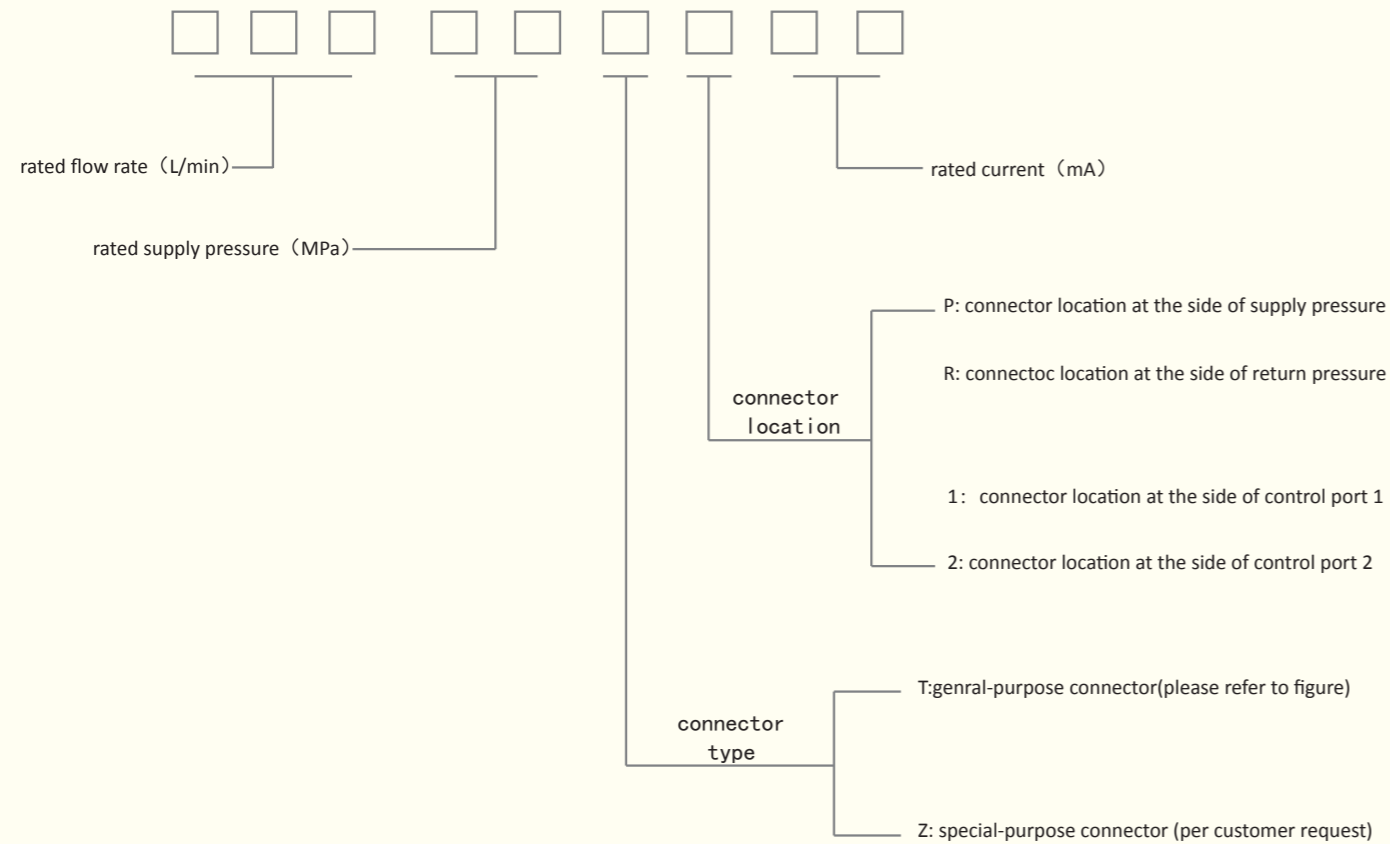


inch

|          | P    | 1     | R    | 2     | G    | F1 | F2   | F3   | F4   |
|----------|------|-------|------|-------|------|----|------|------|------|
|          | Φ0.2 | Φ0.19 | Φ2   | Φ0.19 | Φ0.1 | M4 | M4   | M4   | M4   |
| <b>x</b> | 0.87 | 1.18  | 0.87 | 0.55  | 0.47 | 0  | 0    | 1.73 | 1.73 |
| <b>y</b> | 0.35 | 0.67  | 0.98 | 0.67  | 0.2  | 0  | 1.34 | 1.34 | 0    |

### Spare parts and accessories

|   |                                 |            |           |
|---|---------------------------------|------------|-----------|
| Oring ( included in standard delivery)                              |                                 |            |           |
| NBR 75 Shore FPM 75 Shore   |                                 |            |           |
| Used for port P,R,1,2   | 4 pieces, ID0.26×Φ0.07          | 5080、5176S | F370、F275 |
| Mating connector  |                                 |            |           |
| Normal choice:XK11J4Z/E   |                                 |            |           |
| Installation bolt (included in standard delivery)                   |                                 |            |           |
| Mounting bolt   | 4 pieces, M4×10.5 ISO 4762-10.9 |            |           |
| Replaceable filter  |                                 |            |           |
| for pilot stage and installed before orifice filter absolute 1378μm |                                 |            |           |



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.

# ENTERPRISE PROFILE

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 1968), 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 10000 m<sup>2</sup> and our lab covers an area of 4000 m<sup>2</sup>. 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 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), DDV and RDDV, 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, intelligization and high pressuration of EHSV. We will strive to keep our clients happy.