

1. Development of the high-response linear servo valve

Our “high-response linear servo valve” is an electro-hydraulic servo valve. It replaces conventional nozzle flapper-type electro-hydraulic servo valve. Incorporating a newly developed voice coil linear motor as a control actuator, the valve has been put into commercial use.

The valve has been designed to provide a frequency response of 400 Hz or more, which is approximately twice that of nozzle flapper-type servo valves (100 to 200 Hz). It is intended for use in forging press machines. For commercialization, the valve has also been designed to offer long service life, high reliability (tolerance to hydraulic fluid contamination), and energy savings. It has been applied in a wide range of areas, because of its excellent performance and reliability.

2. Structure and operation

The valve controls the flow and direction of hydraulic fluid by moving the spool for flow passage control. With the spool coupled directly to a compact, high thrust voice coil linear motor, the valve operates under electrical feedback control using a dedicated high speed amplifier. The valve structure is shown in Fig. 1. The valve components and their design and engineering improvements are shown in Fig. 2.

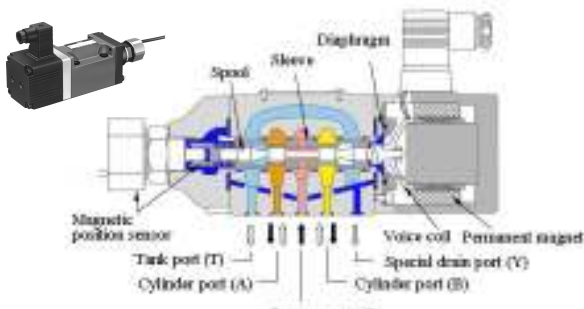


Fig. 1 Appearance and structure

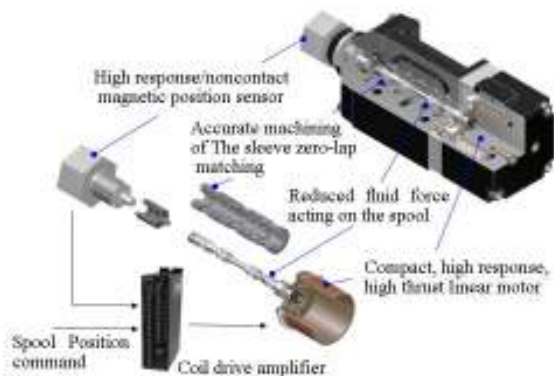


Fig. 2 Components and features

The valve comprises a body, a linear motor, and a position sensor, with a high power neodymium-iron-boron (Nd-Fe-B) permanent magnet placed in a fixed position and a movable coil out of contact with the permanent magnet and the yoke. The position sensor is a noncontact high response magnetic sensor. The valve has a simple structure and lightweight movable parts; it is user-friendly with high response and tolerance to hydraulic fluid contamination (allowing for a contamination level of NAS class 10).

3. Specifications and performance

The valve has been adopted in applications with a maximum operating pressure of 35 MPa and a flow rate of 4 to 3,800 L/min. It supports a wide range of flow rates, performance requirements, and functions.

Basically, the valve is a single stage servo valve configured as described above and operates at a flow rate of 4 to 40 L/min, a frequency response of 450 Hz/90°, and a step response (0 <=> 100 %) of 2 msec. At higher flow rates, the two stage type of the valve is employed and operates at a frequency response of about 100 Hz/90° and a step response (0 <=> 100 %) of 8 to 12 msec (representative performance).

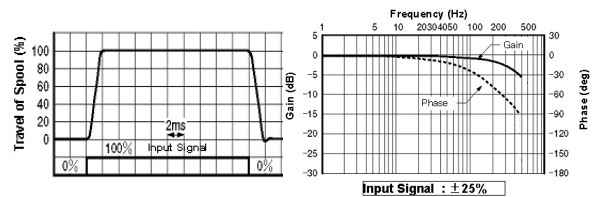


Fig. 3 Response characteristics (representative example)

4. Applications and commercial results

Because of its high response, the valve is used in injection molding machines that deliver a resin filling speed of 1,000 to 1,500 mm/sec in 8 to 12 msec and die casting machines that deliver an aluminum filling speed of 4 m/sec or a magnesium filling speed of 8 m/sec. Since the valve has excellent following capability, it is also used in various testing machines. The valve with tolerance to hydraulic fluid contamination is useful in steel making facilities. The total sales volume of the valve since 2001 has been about 10,000 units.

Type	Applicable industries/machines
[1] External amplifier type ■ Direct acting Max. operating pres.: 35 MPa Flow rate: 4 to 60 L/min ■ Two-stage -Max. operating pres.: 35 MPa Flow rate: Up to 900 L/min -Max. operating pres.: 31.5 MPa Flow rate: Up to 3800 L/min	-Steel making facilities -Machine tools -Injection molding machines -Die casting machines
[2] On-board electronic type ■ Direct acting Max. operating pres.: 35 MPa Flow rate: Up to 4 to 60 L/min ■ Two-stage Max. operating pres.: 31.5/35 MPa Flow rate: Up to 1300 L/min	-Offshore equipment -Forging press machines -Testing machines

Table 1 Applicable industries/machines