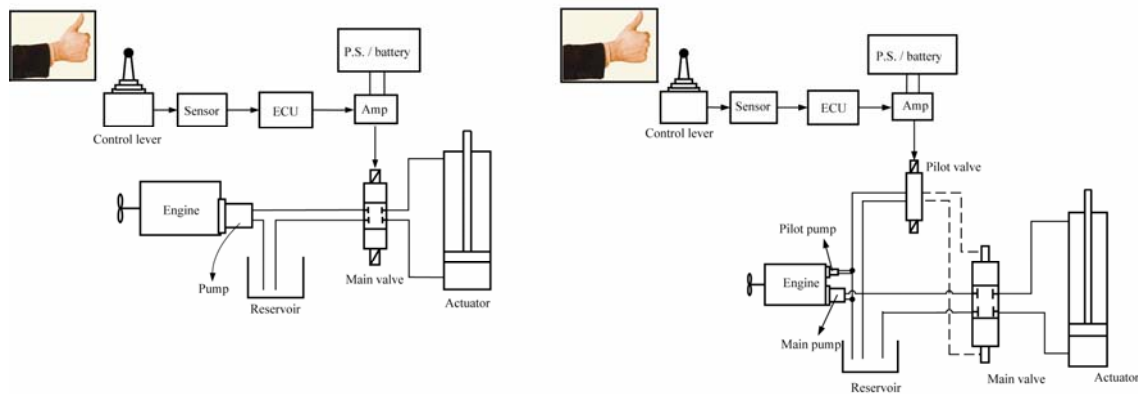


# High Bandwidth Electrohydraulic Pilot Valve Actuator

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Electrohydraulic valves are used as flow metering devices in hydraulic systems. By metering the flow, position, speed, force or torque of a cylinder or a rotary motor can be controlled. The bandwidth of the overall system is highly dependent upon the bandwidth of the electrohydraulic valve. The EH valves can be categorized into five major sizes in terms of their flow rate: less than 1) 100 lpm, 2) 250 lpm, 3) 500 lpm, 4) 500 lpm upto 1500 lpm, 5) above 1500 lpm range. A valve is called single stage if the valve actuator directly moves the main spool, two stage if the valve actuator motion is amplified by an intermediate pilot stage (i.e. double nozzle flapper servo valve, jet pipe servo valve, EH pilot actuated proportional valve), and three stage if there are two intermediate pilot stage amplification before the valve actuation force reaches the main spool.



Valves in flow range 1 can be directly actuated by electric solenoid or torque motor or by two stage designs where the electrical actuator power is amplified hydraulically by a pilot stage to shift the main spool. In range 2 and 3, the stage pilot actuation is almost standard, while in range 4, three stage valve is used. In flow range 5 (above 1500 lpm upto 10000 lpm), poppet valves with a two-stage pilot valve are commonly used for each metering orifice. The bandwidth of the EH valve (whether it is single, two or three stage) is a function of the electric actuator used to in the first stage and the bandwidth of the pilot stage. The EH valve bandwidth can not be larger than the bandwidth of the valve actuation stage. Therefore, in order to break new boundaries in valve bandwidth, 1. the bandwidth of the first stage actuation must be improved, and 2. the pilot stage bandwidth should be improved either by eliminating the pilot stage (direct drive valve), or reducing the number of pilot stages in very high flow ranges, or increasing the bandwidth of the pilot stage by special designs.

The purpose of this project is to develop concepts and technologies for a high bandwidth electric actuator for EH valves. Various actuator technologies are studied including piezoelectric, electro-magnetic (linear force motor, linear brushless DC motor, linear stepper motor) and others. In each category, we study their basic operating principles, current state of art manufacturing methods, cost, reliability and design constraints. The actuator can be used in four-way directional proportional flow control valves as well as in two-way poppet valves.

The design specifications for a proto-type high bandwidth EH valve actuator are that it should have up to 1 kHz bandwidth, have a spool travel range of +/- 1.0 mm, and support a flow rate of 50 lpm at 70 bar pressure drop across the valve ports.