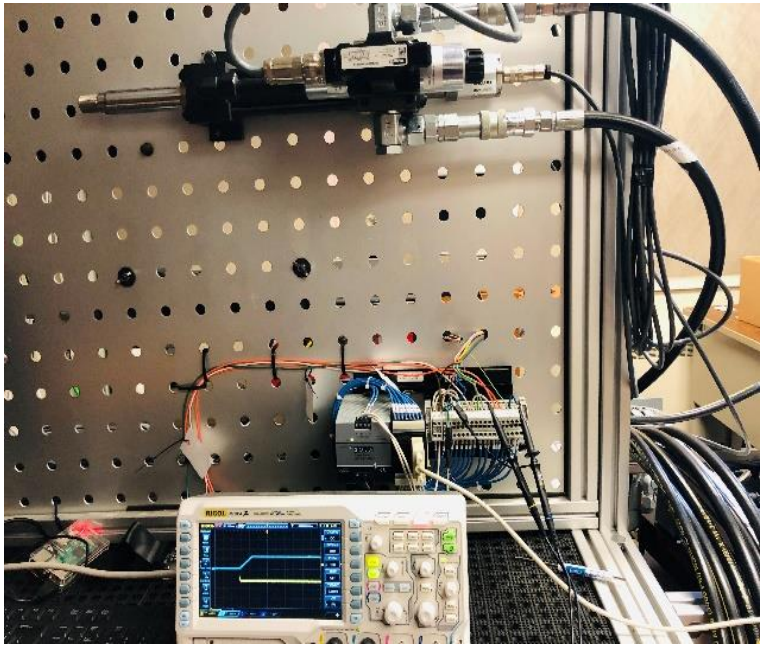
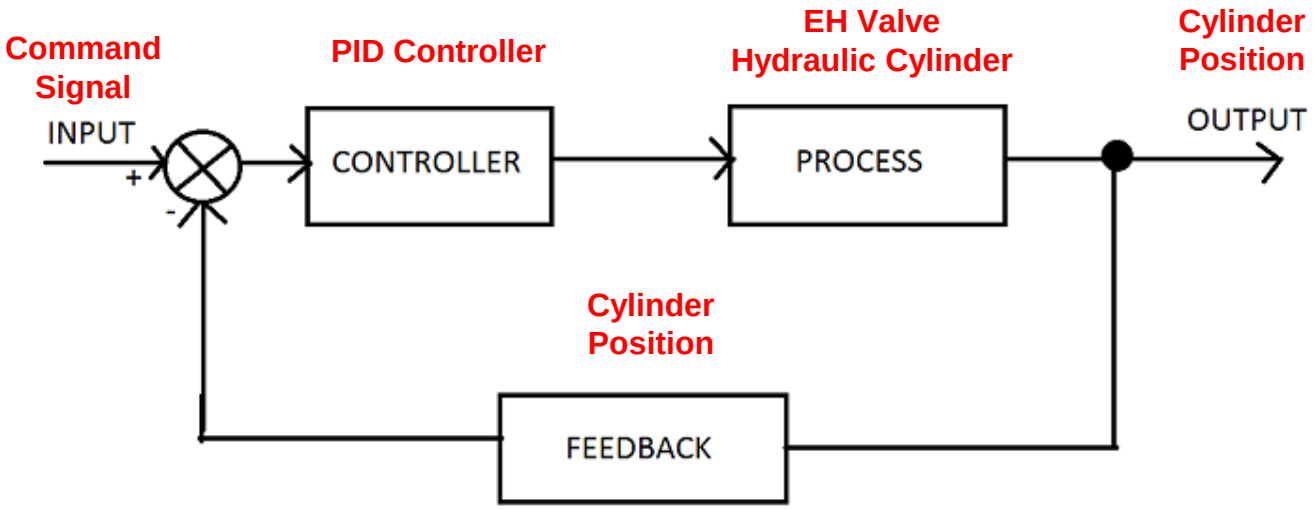
An EH Closed-loop Control System

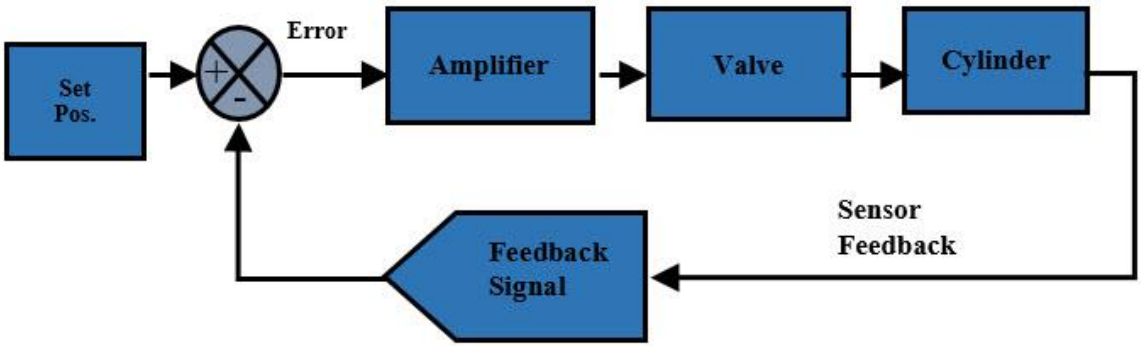


Closed-Loop Control Diagram

- Command signal (current) is dependent upon the system output.
- A position sensor (transducer) is required to monitor the cylinder position and send the feedback to the controller.



PID Theory



Closed-loop PID Control Circuit

$$u(t) = ke(t) + k_i \int_0^t e(t)dt + k_d \frac{de}{dt}$$

- Classic PID controller has three gains – proportional gain, integral gain, and derivative gain. And the purpose of this control is to give fast and smooth response to input step signals.
- Error= Set Point - Process Variable
  - Set Point = Desired value
  - Process variable = Actual value

PID Theory

$$u(t) = ke(t) + k_i \int_0^t e(t)dt + k_d \frac{de}{dt}$$

- The ***proportional component (k_e)*** acts on the current value of the error. The output of this gain is proportional to the error signal. The error will decrease with increasing gain value, but the system could become more oscillatory and unstable.
- The ***integral component (k_i)*** sums the error signals over time and provides an output proportional to the overall error. The integral output will continually increase over time unless the error is zero. The system can respond to errors faster for lager integral gains, but the system also becomes unstable.
- The ***derivative component (k_d)***is proportional to the rate of change of the process variable. The result will decrease the output if the process variable is increasing rapidly. Increasing the derivative time will cause the control system to respond strongly to error signals and then increase the speed of the overall system response. If the sensor feedback signal is noisy or the control loop rate is too slow, the derivative response can make the control system unstable.

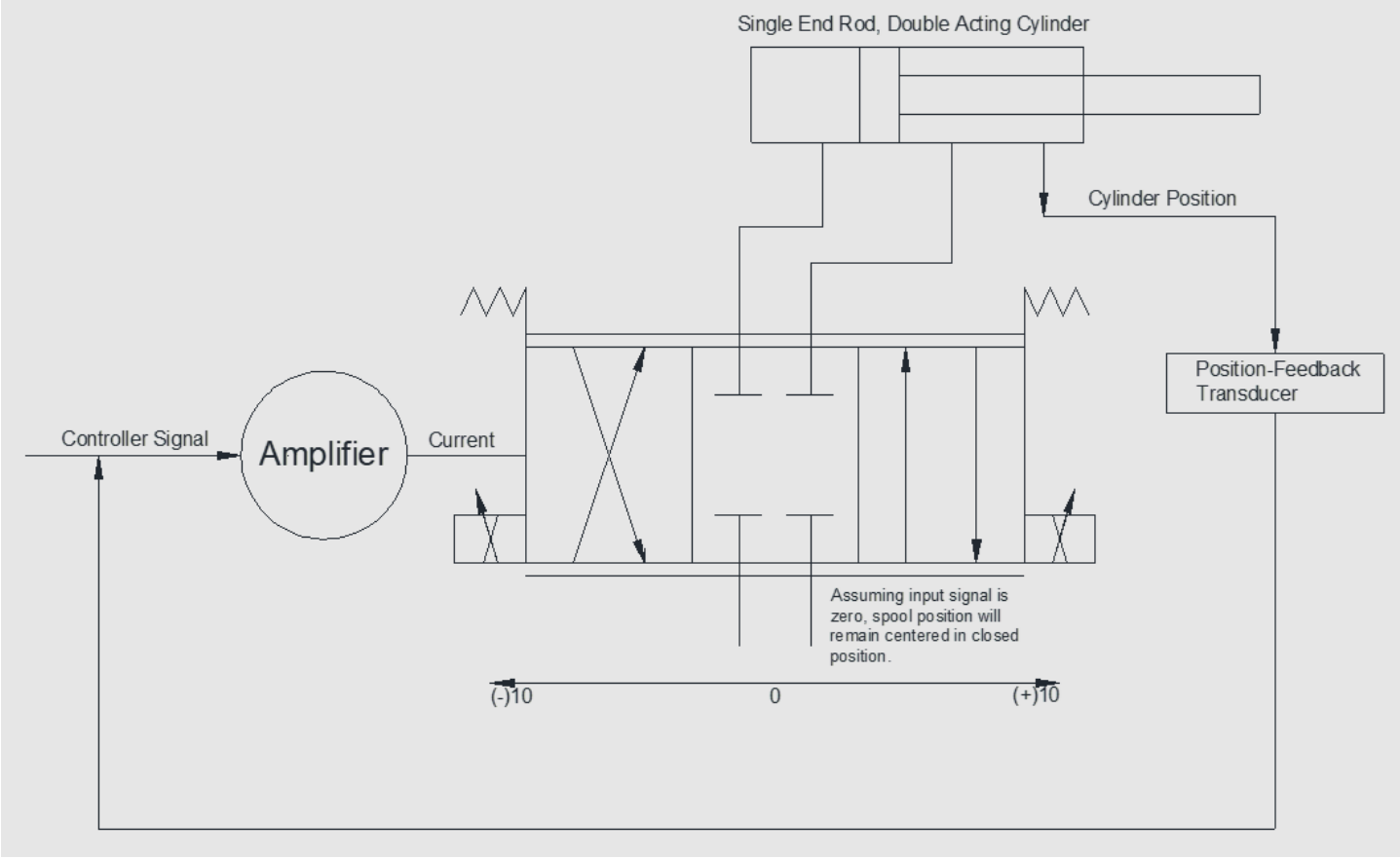
System Setup

- Hardware Components:
  - SOLA Power Supply
  - PID00A-40 Controller
  - Series D*1FB Proportional Directional Control Valve
  - Potentiometer
  - Balluff Micro Pulse Transducer (Linear Displacement Transducer)

Feedback Component

- Balluff Micro Pulse Transducer (LDT)
  - The position sensor converts position to an electric signal proportional to the displacement of the cylinder.
  - The LDT measures the cylinder position and sends a voltage signal of 0v ~ -10v.
  - A signal of 0v being fully retracted and -10v being fully extended.
  - A voltage signal from the potentiometer and the signal from the LDT will be summed together in the controller
  - The LDT is powered b 24 v

Electrohydarulic System Setup for PID Control



Electrohydarulic System Setup for PID Control