

Three-Stage Valve Tuning Procedure

The following topics are covered in this document:

- Calibration – this section contains a calibration procedure for a three-stage valve
- Valve Balance – this section discusses a method to balance all stages of a four-stage valve
- Valve Tuning – this section covers valve tuning

Calibration Procedures

This section contains the 3-stage valve calibration procedure.

Pilot pressure only:

Valve Third Stage Calibration:

Apply hydraulic pressure (pilot pressure) to the three-stage valve. Invert the valve phase polarity. This will cause the third stage spool to slide to one end or the other. Adjust the spool position AC conditioner gain to obtain a conditioner output of approximately 7.00 volts. Adjust the conditioner demodulator phase to maximize the conditioner voltage output. Next, the conditioner gain should be adjusted to obtain a $20.000 \text{ V} \pm 20 \text{ mV}$ difference from one end of the transducer to the other. Adjust the conditioner gain to obtain a conditioner voltage output of $\pm 10.000 \text{ V} \pm 20 \text{ mV}$. Reverse the valve phase polarity. The valve will regain control. Reverse the spool AC conditioner output polarity. The valve spool should slide to the opposite spool stop. The conditioner output should be the opposite polarity from before. Adjust the spool AC conditioner gain until the difference from one end to the other is $20.000 \text{ V} \pm 20 \text{ mV}$. Reset all polarities to the original state. The third stage should now be in control and calibrated. Valve balancing can be done after calibration of this stage or after calibration of all stages. Refer to the Valve Balance section to balance the third stage.

Valve Balance

This section contains the three-stage valve balance procedure.

Pilot pressure only:

With the third stage setup and calibrated (refer to preceding sections), apply hydraulic pressure (pilot pressure) to the third stage. Monitor the valve driver error signal. With zero in the valve driver valve balance slide bar, the error signal should be 50 mV or less. If the error is >50 mV, adjust the mechanical null on the Moog pilot valve (252.XX) to obtain an error signal of ≤ 10 mV. Error signal values of <50 mV can be zeroed using the valve driver valve balance slide bar.

The next adjustment requires main low and then high pressure.

To adjust the third-stage spool zero on the valve driver panel for a single actuator is a simple process. With main pressure applied, adjust the valve driver spool zero to zero the error signal of the actuator control loop. With several actuators connected to a table the process is more complex. The table is over-constrained, therefore we cannot adjust all of the actuators to zero displacement. First, turn off the force balance control on the axes that is being adjusted. Remember the force balance settings, because it shall be turned on after the valve adjustments have been made. Monitor the forces of all of the actuators of the axes being adjusted. Alternately adjust the valve driver spool zeros to zero the actuator forces. As the actuators are all connected to each other through the table these adjustments inter-act. This procedure can first be done with low pressure to the actuators and when the forces are all near zero, high pressure may be applied to finish the zeroing process. After the valves have been zeroed reset the force balance adjustments to the original values.

Valve Tuning

The input signal to tune the valves should be about .5 to 1.0 volts whether a square wave or random signal is used.

Servo control loops have traditionally been tuned using a square wave command and controls were adjusted to obtain a critically damped feedback response. Another common tuning method is to input a sine wave and adjust the controls to achieve minimum phase lag between command and feedback. Both methods work well for a single actuator and single servo valve system.

When a system contains multiple actuators and/or multiple servo valves on a single actuator, the tuning process is more complex. It is not as important that each loop has maximum response as it is to have all the loops have the same response. Tuning multiple channels and multiple valves using a random signal input and measuring transfer function and phase is a more desirable method to achieve good fidelity over the desired operating bandwidth. It is not difficult to match the ninety-degree phase lag point for all actuators.