PROPORTIONAL AND DERIVATIVE CONTROLLER USING OP-AMP

Proportional control

- The proportional control mode is in most cases the main driving force in a controller. It changes the controller output in proportion to the error. If the error gets bigger, the control action gets bigger. This makes a lot of sense, since more control action is needed to correct large errors.

- The adjustable setting for proportional control is called the Controller Gain (Kc). A higher controller gain will increase the amount of proportional control action for a given error. If the controller gain is set too high the control loop will begin oscillating and become unstable. If the controller gain is set too low, it will not respond adequately to disturbances or set point changes.

- Adjusting the controller gain setting actually influences the integral and derivative control modes too. That is why this parameter is called controller gain and not proportional gain.

Derivative control

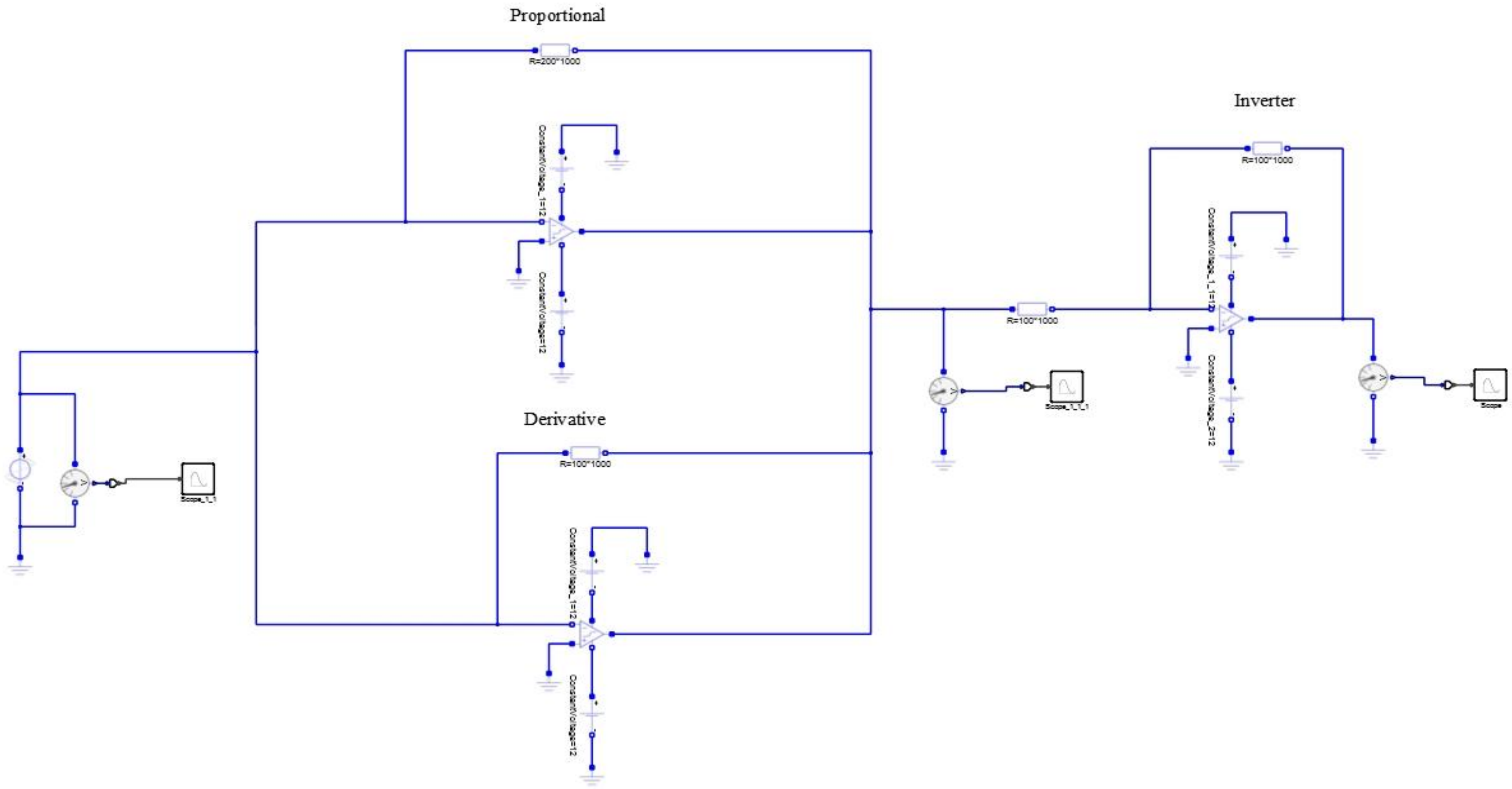
- The derivative control mode gives a controller additional control action when the error changes consistently. It also makes the loop more stable (up to a point) which allows using a higher controller gain and a faster integral (shorter integral time or higher integral gain).
- The derivative is a measurement of the rate of change. The ideal differentiator circuit looks similar to the high pass filters in other schematics. Low frequencies are attenuated, while high frequencies are allowed to pass. The mathematics that describe the differentiator is Vout = -RC * (rate of change).
- Rate of change is equivalent to measuring the slope of a line. Slope is a measure of the change in voltage divided by the change in time. In mathematical terms, this is referred to as a delta voltage over delta time or simply dv / dt.

Proportional + Derivative control

- The proportional and the derivative controls are operated in the parallel mode and the inverting terminal of the operational amplifier in the proportional control and the derivative control are connected to the positive terminal of the sinusoidal frequency, the output obtained is the inverting sinusoidal waveform and by using the inverter circuit the output waveform is obtained.

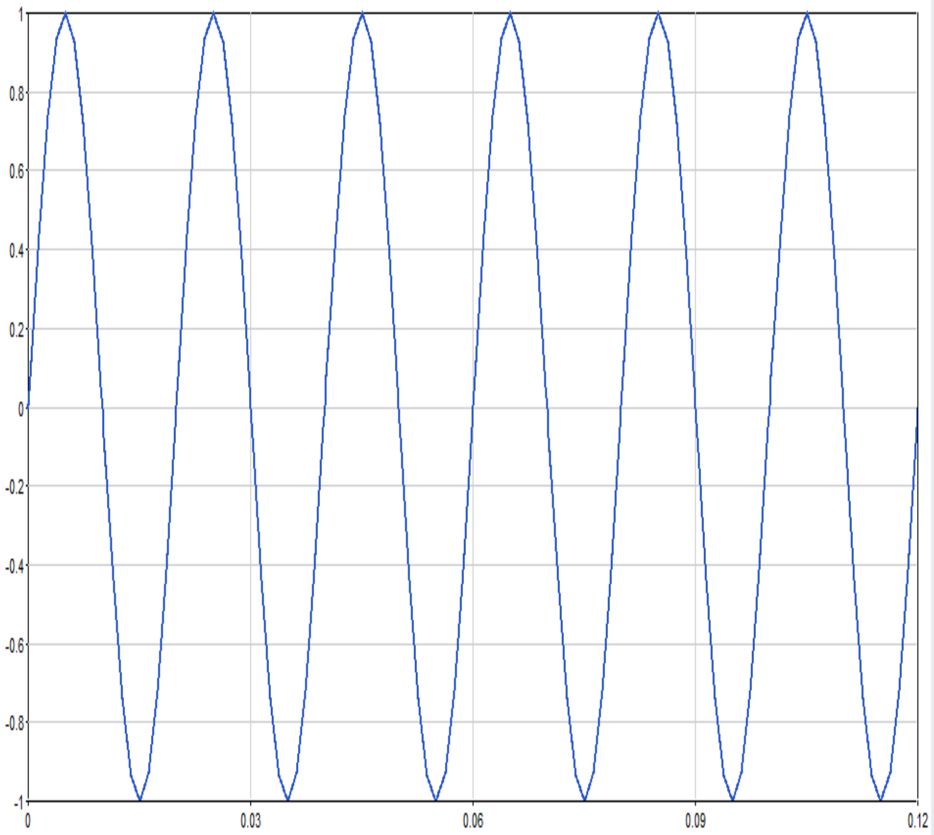
- The usage of the P-D controller is to increase the stability of the system by improving control since it has an ability to predict the future error of the system response. In order to avoid effects of the sudden change in the value of the error signal, the derivative is taken from the output response of the system variable instead of the error signal. Therefore, Derivative mode is designed to be proportional to the change of the output variable to prevent the sudden changes occurring in the control output resulting from sudden changes in the error signal. In addition Derivative directly amplifies process noise therefore Derivative only control is not used.

Circuit Topology

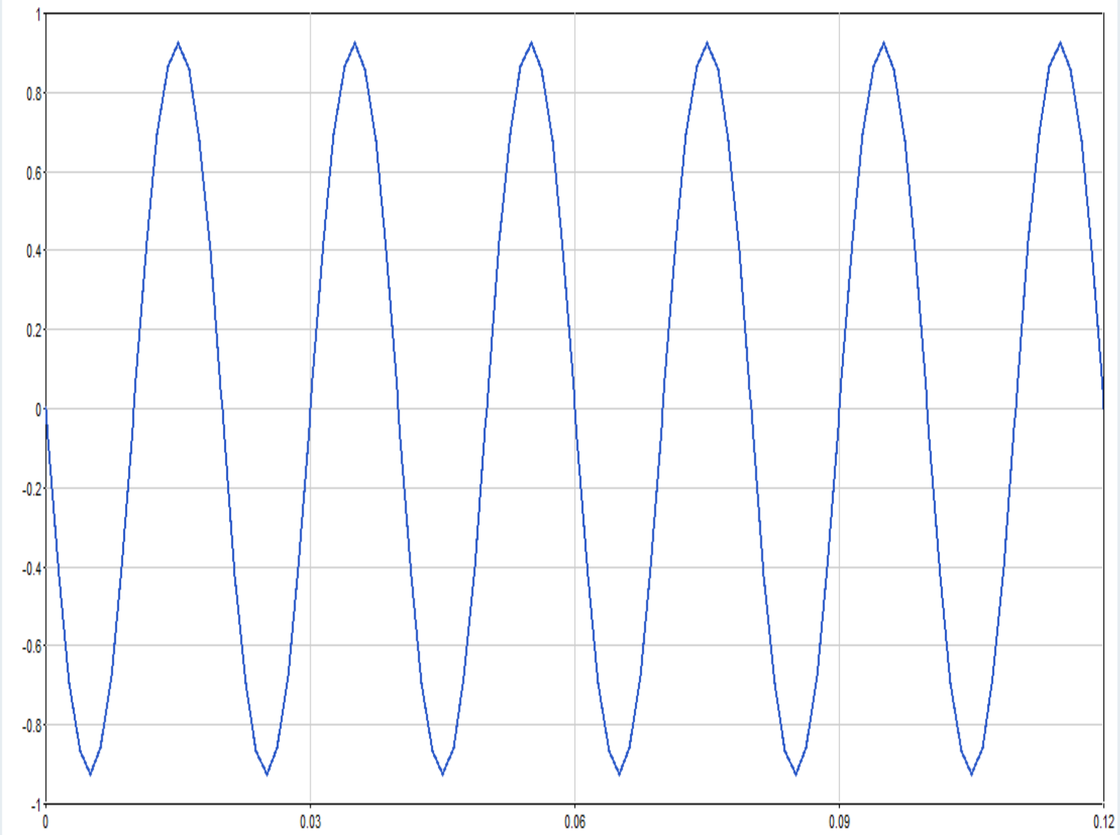


Waveforms

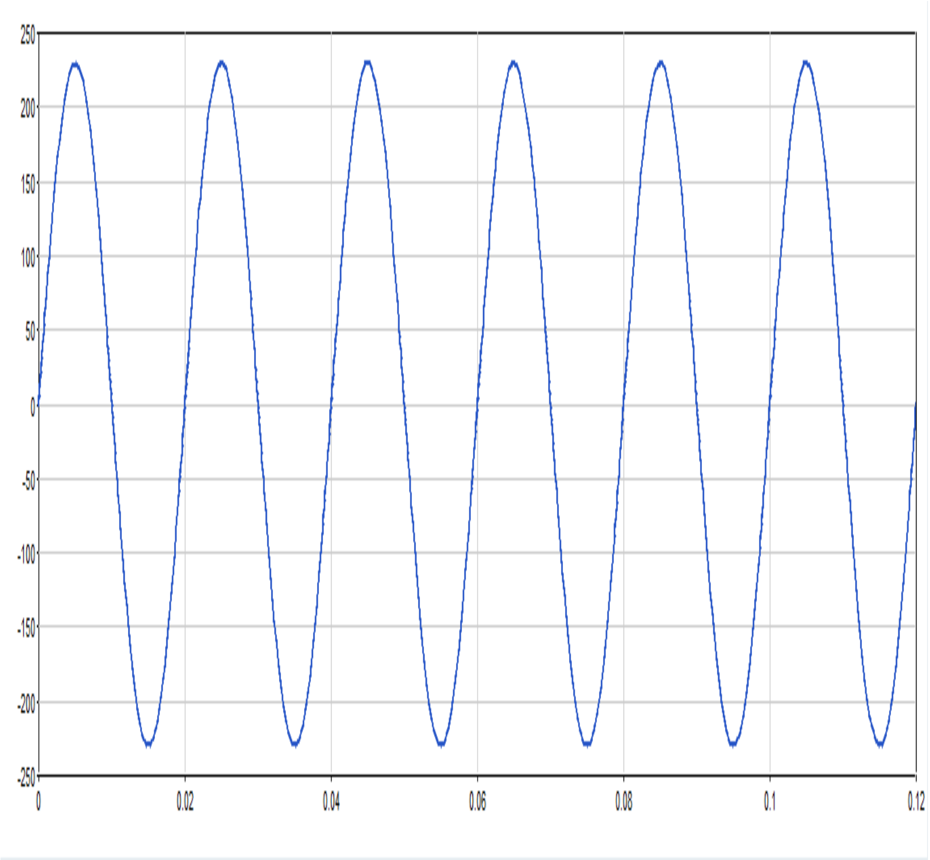
Input Voltage



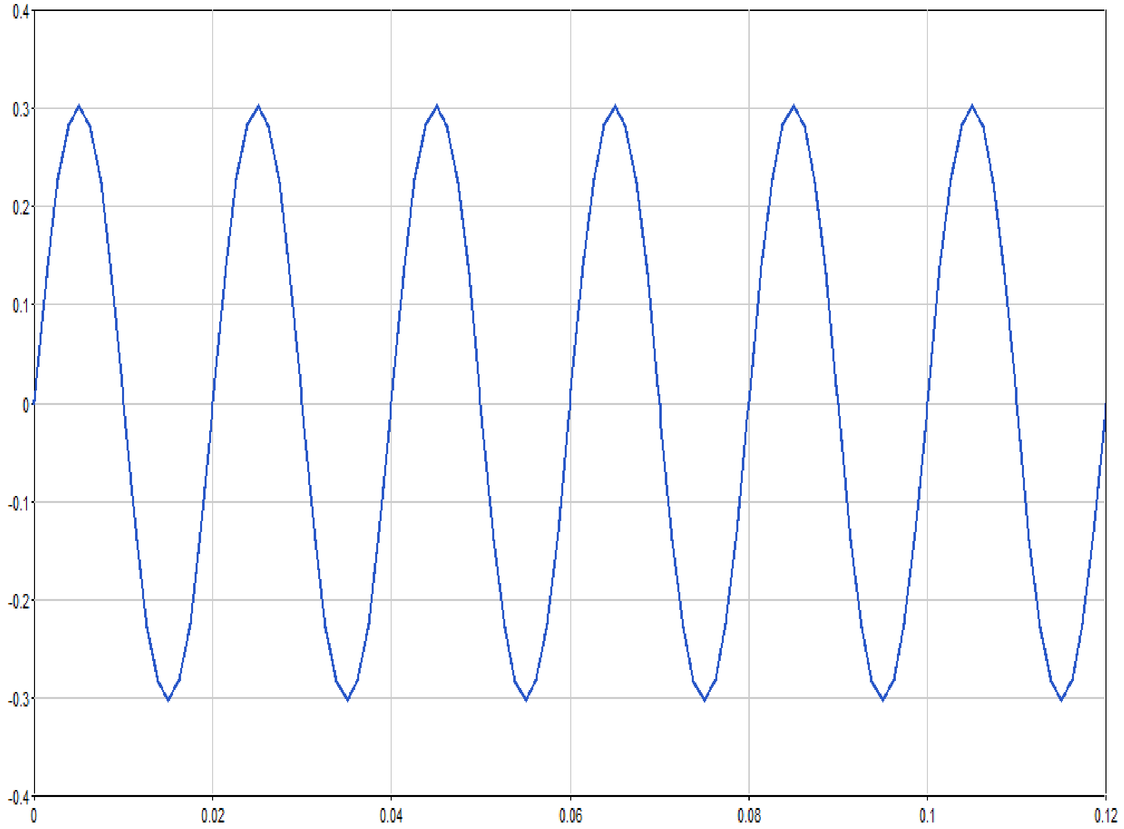
Output Voltage



Input Voltage



Output Voltage after Inverted



- In Proportional Only mode, the controller simply multiplies the Error by the Proportional Gain (Kp) to get the controller output. The Proportional Gain is the setting that we tune to get our desired performance from a “P only” controller.

- In a proportional controller its output changes in proportion to a change in the measured error. The greater the error, the greater the control effort and as long as the error remains, the controller will continue to try to generate a corrective effort.

- If a proportional controller tends to settle on the wrong corrective effort. As a result, it will generally leave a steady state error (offset) between the set point and the process variable after it has finished responding to a set point change or a load.

- In Derivative Only mode, the controller simply multiplies the Error by the derivative Gain (Kd) to get the controller output. The derivative Gain is the setting that we tune to get our desired performance from a “D only” controller.

- To handle the Controller, the first derivative over time is calculated, and multiplied by another (negative) constant D, and also added to (subtracting error from) the controlled quantity. The derivative term controls the response to a change in the system. The larger the derivative term, the more rapidly the controller responds to changes in the process's output.

- Here in the circuit firstly the proportional and the derivative logics are implemented using the Operational Amplifier, and then the output is measured as the inverting waveform of the Sine wave, and in the second stage of the operational amplifier, the obtained sine wave is inverted and obtained into the perfect waveform.

Conclusion

- The proportional and the derivative control of the system is used to increase the stability of the system by improving control since it has an ability to predict the future error of the system response.
- Thus the proportional and Derivative Control model using the Operational Amplifier is implemented using the Activate tool.