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PWM Control via an Active Sensor

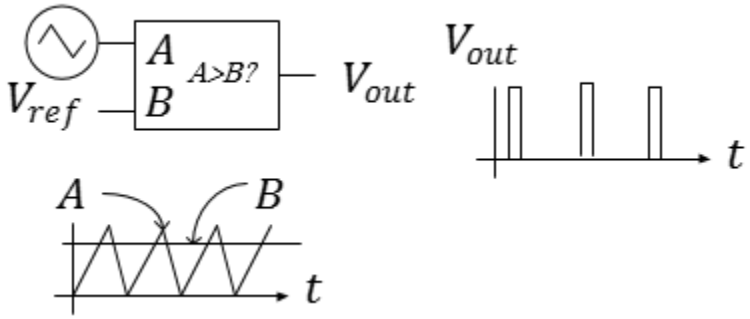

***Figure 1**: A reference voltage supplied by an active sensor transforms a triangular waveform into a PWM waveform.*

Laboratory Outline

Figure 1 provides a block diagram demonstrating how a triangular waveform is transformed into a PWM waveform controlled by a reference voltage. In this module, your reference voltage will be supplied by one of several active sensors and the output PWM waveform will control the angle of a servo motor.

Prerequisites

- *Explore More!*: The Voltage-Follower Buffer
- *Explore More!*: The Voltage Comparator
- *Explore More!*: The Amplifier: Gain and Offset Control

Parts Needed

- Electronics circuits from the prerequisite materials
- Infrared emitter/detector (yellow dot, red dot, respectively) from your kit
- (1) Servo Motor from your kit

Notes:

In the Laboratory: Construction and Adjustments

- ✓ Build the circuit shown in Figure 2 using a simple voltage divider as the active sensor and a servo motor as the physical output device driven by the PWM waveform. It is okay if you used the LM358 version of the comparator. This entire device (minus the servo) should have already been constructed piecewise in the prerequisite materials listed above.

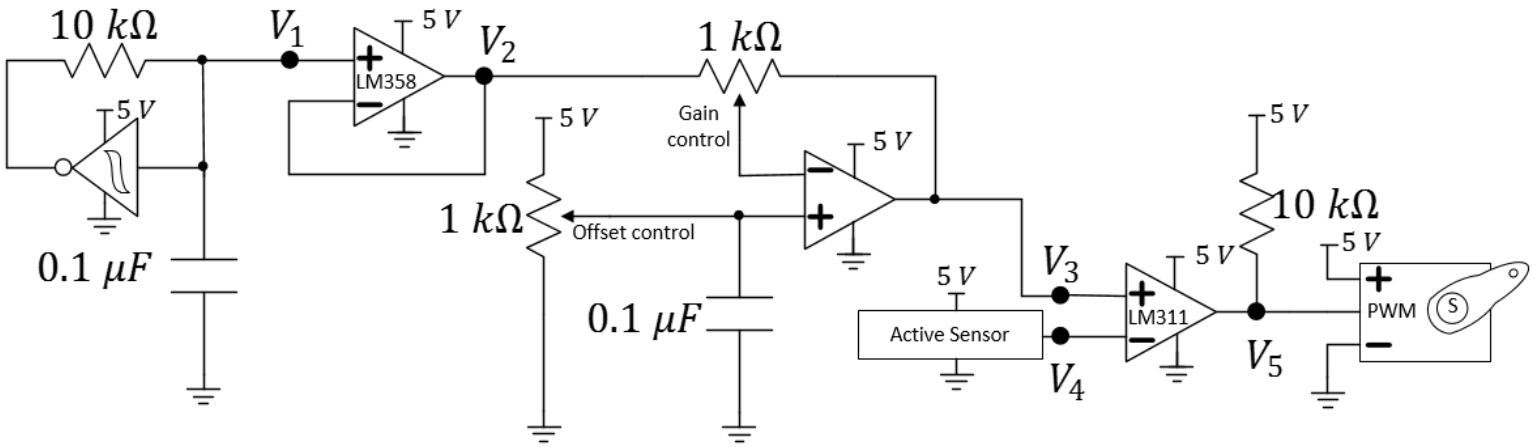

***Figure 2**: PWM control via an active sensor (several sensors might be explored).*

Notes:

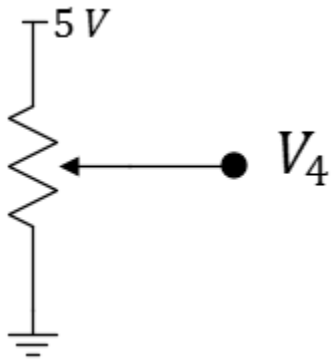

***Figure 3**: A voltage-divider-type sensor.*

- ✓ Build the circuit shown in Figure 3 using a trimpot on the order of 1 to 10 kOhms. Use this circuit as the active sensor of Figure 2 for initial setup.

Question 1: Verify the correct circuit operation between V_1 and V_2. Then verify the correct circuit operation between V_2 and V_3; V_3, V_4 and V_5. You may need to tweak the trimpots of the gain-and-offset amplifier as you did in ***Explore More!*: The Amplifier: Gain and Offset Control**. Make notes on what you do in the space below. You will want to use the Oscilloscope!

Notes:

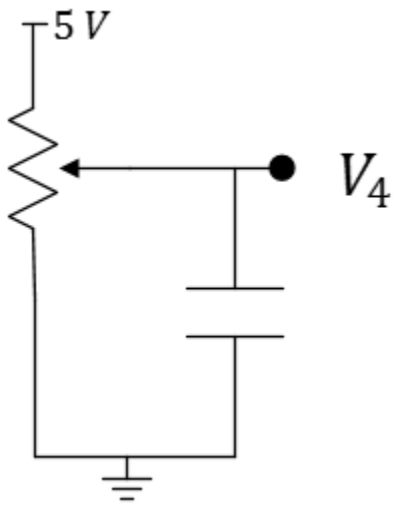

***Figure 5**: A voltage-divider-type sensor with filtering (the capacitor).*

- ✓ Build the circuit shown in Figure 5 using a trimpot on the order of 1 to 10 kOhms. The capacitor might be chosen to be $100\ \mu F$. The purpose of the capacitor is to prevent sudden changes in the voltage V_4 as the trimpot is adjusted. Because the charge and therefore the voltage across the capacitor cannot change instantaneously, the capacitor removes fast (high frequency) changes that would otherwise be present. We consider a capacitor used in this fashion a LowPass filter as it passes only lower frequency portions of waveforms.

Question 2: Observe the response of V_4 on the oscilloscope with and without the use of the capacitor (it should be easy to remove and re-insert it). Comment on how the waveform differs with the presence of the capacitor when the trimpot is changed very quickly.

Notes:

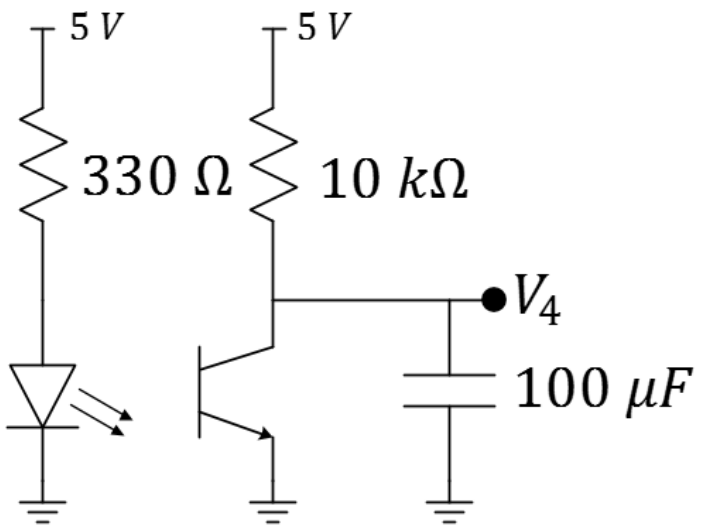

***Figure 4**: An infrared emitter/detector-type sensor with filtering (the capacitor).*

At Home: Investigation

- ✓ Build the infrared sensor shown in Figure 4 and replace the earlier voltage-divider sensor. The sensors should be facing each other.

Question 3: What happens as you move your finger between the sensors?

Question 4: Remove the capacitor from the active sensor circuit. What happens as you move your finger between the sensors? Explain why there is such a significant change from before. (Although it is not required, the use of an oscilloscope would be warranted here if you want to see the difference in lab later.)

Notes:

Learning Objectives

- To build and validate a PWM waveform controlled by an active sensor.
- To procedurally add and test smaller circuits used to construct a complex system.

Learn More!

There are other *Explore More!* Modules that encourage you to look at other active sensors. Seek these out and think about what projects you might use knowing that you could use sensors and motors in a feedback form to perform tasks and solve problems.