Lab 5 Pulse Width Modulation Generator Circuit

The circuit examined in this lab exercise will generate a square wave which has duty cycle that can be varied over a wide range. The duty cycle can be varied from approximately 5% to approximately 95%   The purpose of this lab exercise is to observe the operation of such a circuit.

The circuit utilizes an op-amp which has positive feedback instead of negative feedback. Negative feedback is used in all linear applications of an op-amp such as amplifiers, etc. In linear applications the output of the op-amp is controlled to be in the linear range of voltages.

Positive feedback always forces the output of an op-amp to maximally high or maximally low, instead of in the linear range. Here positive feedback will cause the op-amp to generate a square wave – i.e., the output of the op-amp will most commonly be "maxed out high" or "maxed out low." How much of the time the output is high and low is of course the duty cycle of the square wave, and it is controlled by a potentiometer.

Later this circuit will be used to drive a semiconductor switch to provide varying degrees of power to a D.C. motor – which will in turn make the motor run at varying speeds. The semiconductor switch will be implemented utilizing the concept of "The transistor as a switch." First the switch will be implemented with a bipolar transistor (NPN transistor in the Darlington configuration and then the switch will be implemented using a power MOSFET.)

1. Build the circuit shown in Fig.1.

2. After checking your connections, set the control pot in its middle position and apply power to the circuit.
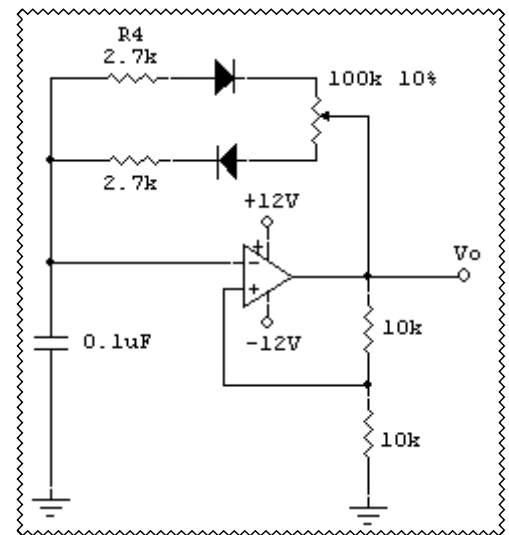

Fig. 1

3. Use channel 1 of the oscilloscope to observe the output voltage of the circuit. Be sure that the oscilloscope is set at the vertical and horizontal settings shown in the diagram. Adjust the triggering of the oscilloscope so that the square wave is stable and the trace begins with the rising edge of the square wave.

   A. Draw the output voltage waveform of the circuit on the scope screen shown in Fig. 2.

   B. What is the highest value of V_O seen on the oscilloscope?

   C. What is the lowest value of V_O seen on the oscilloscope?

Fig. 2

   D. What is the time period observed for V_O?
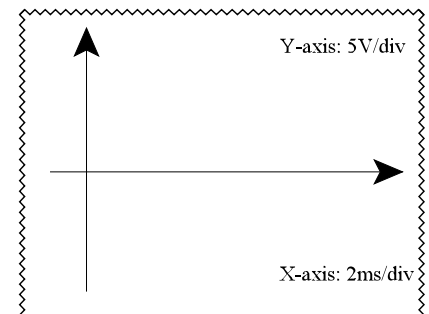
   E. What is the frequency calculated for V_O?

4. Turn the control pot maximally counter-clockwise.

    A. Draw the output voltage waveform of the circuit on the scope screen shown in Fig. 3.

    B. Measure the time for which V_O is high.

    C. What is the duty cycle for V_O at this setting of the control pot?
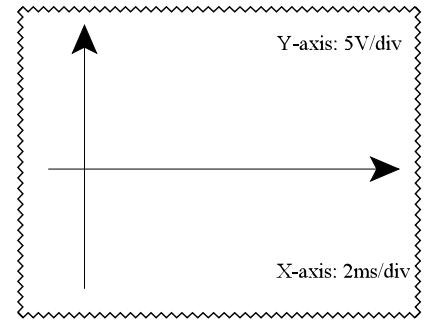

Y-axis: 5V/div

X-axis: 2ms/div

Fig. 3

5. Turn the control pot maximally clockwise.
    A. Draw the output voltage waveform of the circuit on the scope screen shown Fig. 4.

    B. Measure the time for which V_O is high.

    C. What is the duty cycle for V_O at this setting of the control?
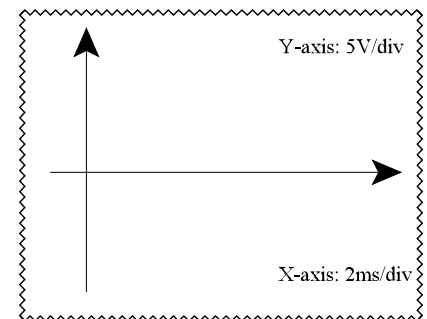

Y-axis: 5V/div

X-axis: 2ms/div

Fig. 4

6. Save this circuit for use in Lab 6 D.C. Motor Speed Control. Several more components, a D.C. motor and an additional power supply will be used. Write one summary for both Lab 5 and Lab 6.