TEXAS A&M UNIVERSITY

ENGR 111B: Foundations of Electrical & Computer Engineering

Lab 5: Pulse Width Modulation

Team Members: _____

_____

Section Number: _____ **Team Number:** _____

This Lab is due by the Beginning of the Next Lab Session.

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Lab 5: Pulse Width Modulation

Time Limit: 1 week

OVERVIEW

Using RC circuits we can not only time individual events, but we can also create repeating timers. This oscillatory timing is used in virtually every electronic device available. In this lab students will examine the use of a digitally oscillating signal to control DC motor speed. This approach contrasts with the simple resistor-based current limiting method you used previously. Topics covered in this lab include the following material:

- Digitally Oscillating Signals
- Pulse Width Modulation
- Average Voltage, Current, and Power
- How a PWM signal can be generated using a 555 timer
- Diodes
- PWM Signal Control of DC Motor

BACKGROUND

To assist students in completing the exercises required by this lab, the following background information has been provided. It is recommended that each student read all of the following information as a beneficial review of the topics required.

DIGITAL OSCILLATIONS

An oscillating signal is one which changes between two levels according to a regular pattern of intervals. AC (Alternating Current) voltages are included in the realm of oscillating voltages, but the term AC is reserved for signals which include both positive and negative voltages. A digital oscillation also switches between two levels according to defined intervals, and the ideal digital signal exists only at the specified levels and does not exist at the levels in between. The signals represented in Figures B1 are two different digitally oscillating signals.

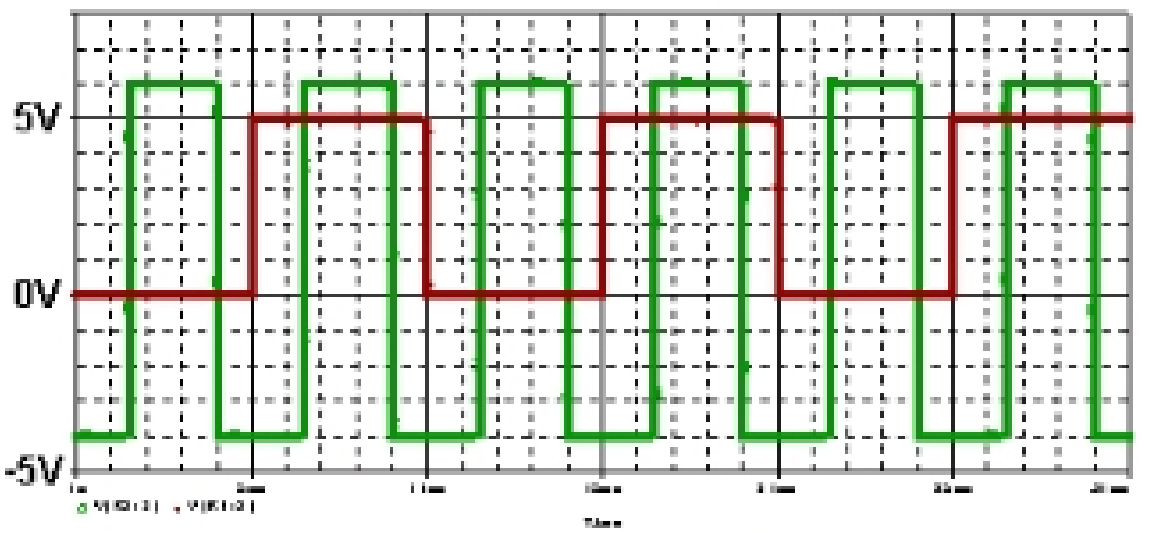

Figure B1: Digitally Oscillating Signals

Examining the signals in Figure B1, notice that the lower of the two voltages does not have to be set to zero volts, or ground; the lower voltage of a digital signal is defined to be a logical LOW or 0, but the value is not required to be zero. When a signal is not centered around zero the signal is said to have a DC offset that raises or lowers the signal to a new center voltage. Signals that do not have DC offsets fall into the realm of AC signals, since their voltages will fall below zero and therefore reverse the flow of current.

Each time that the voltage of a digital signal rises to its HIGH state and then back to its LOW state, the signal is said to have *pulsed*. The amount of time that a digital signal remains in its HIGH state before returning to the LOW state is called the *pulse width*. The *period* of a digital signal is length of time before a signal repeats itself. Adding the HIGH pulse width and the LOW state time together is also equal to the period of the signal. The *frequency* of a digital signal is equal to the inverse of the period, and represents the number of times that a signal repeats itself in one second. All of the stated elements of a digitally oscillating signal are shown and labeled in Figure B2.

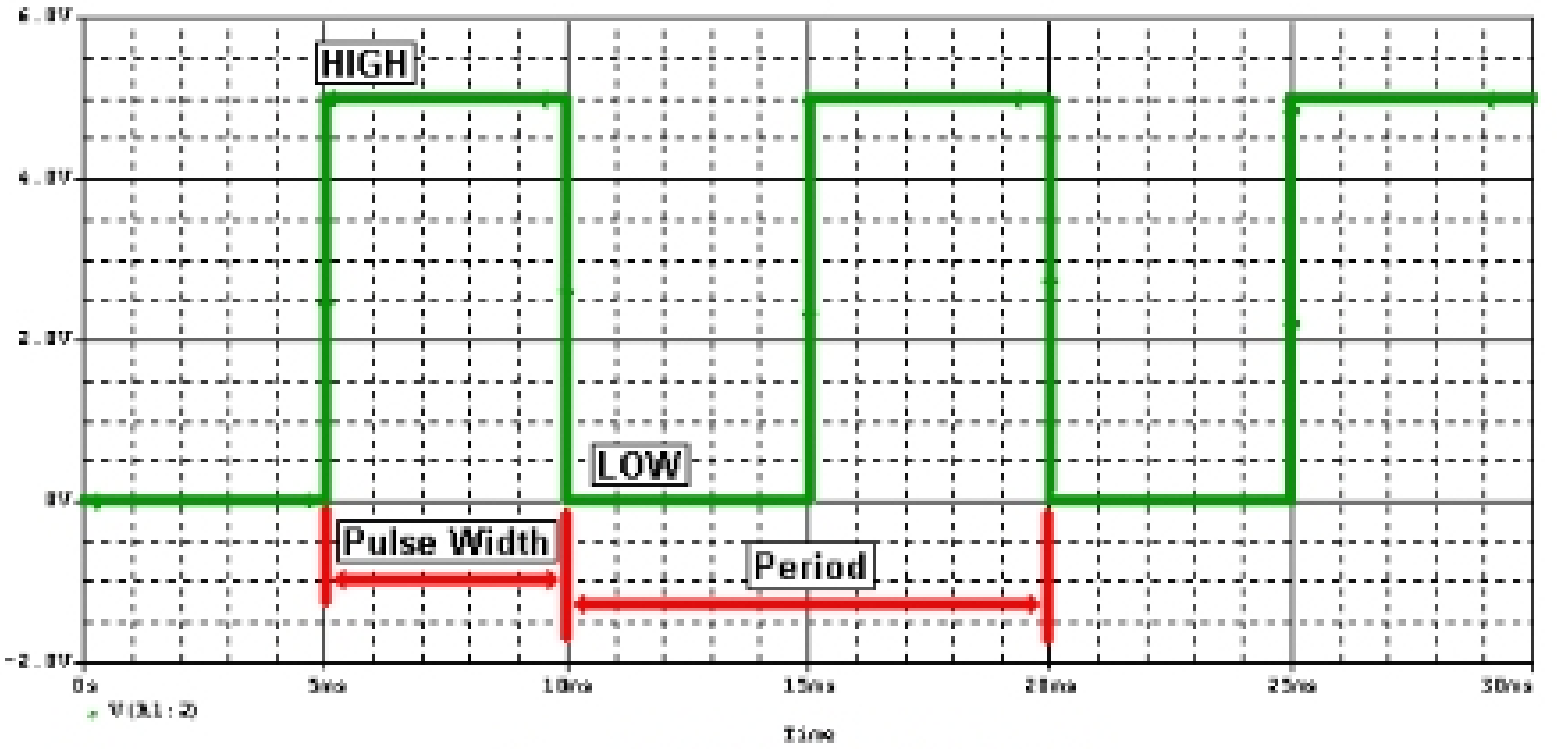

Figure B2: Digital Signal with Labels

PWM Signals

Pulse Width Modulation (PWM) is a process which changes the pulse width of a signal, while keeping the frequency/period constant. The result is a signal that may be switched HIGH for a longer or shorter amount of time than it is switched LOW. When a PWM circuit alters the pulse width in this way, it is said to be changing **the duty cycle of the signal, which is the ratio of the pulse width time over the total period**. Duty Cycle is a dimensionless quantity that is stated as a percentage. Figure B3 shows two examples of pulse width modulated signals.