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Pulse Width Modulation and Demodulation.

Course: Communication Systems EE-351.

Instructor: Huma Ghafoor.

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Introduction:

Pulse-width modulation, or pulse-duration modulation, is a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts. The average value of voltage fed to the load is controlled by turning the switch between supply and load on and off at a fast rate. The longer the switch is on compared to the off periods, the higher the total power supplied to the load. Along with maximum power point tracking (MPPT), it is one of the primary methods of reducing the output of solar panels to that which can be utilized by a battery. PWM is particularly suited for running inertial loads such as motors, which are not as easily affected by this discrete switching, because their inertia causes them to react slowly. The PWM switching frequency has to be high enough not to affect the load, which is to say that the resultant waveform perceived by the load must be as smooth as possible.

Pulse-width modulation uses a rectangular pulse wave whose pulse width is modulated resulting in the variation of the average value of the waveform. If we consider a pulse waveform f(t), with period T, low value y_{min}, a high value y_{max} and a duty cycle D, the average value of the waveform is given by:

$$\bar{y} = \frac{1}{T}\int_0^T f(t)\,dt$$

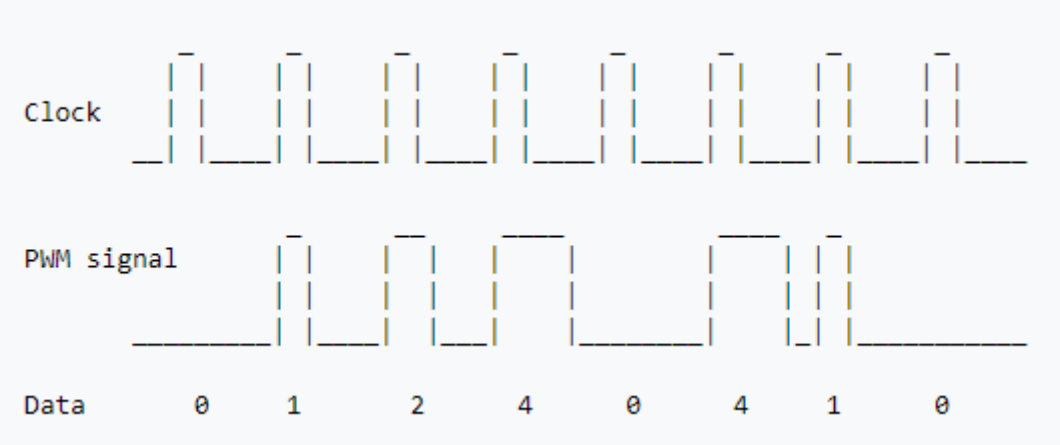
$$\begin{aligned}\bar{y} &= \frac{1}{T}\left(\int_0^{DT} y_{\max}\,dt + \int_{DT}^{T} y_{\min}\,dt\right)\\ &= \frac{1}{T}\left(D\cdot T\cdot y_{\max} + T\left(1-D\right)y_{\min}\right)\\ &= D\cdot y_{\max} + \left(1-D\right)y_{\min}\end{aligned}$$

Three types of pulse-width modulation (PWM) are possible:

1. The pulse center may be fixed in the center of the time window and both edges of the pulse moved to compress or expand the width.

2. The lead edge can be held at the lead edge of the window and the tail edge modulated.
3. The tail edge can be fixed, and the lead edge modulated.

In telecommunications, PWM is a form of signal modulation where the widths of the pulses correspond to specific data values encoded at one end and decoded at the other. Pulses of various lengths (the information itself) will be sent at regular intervals (the carrier frequency of the modulation).



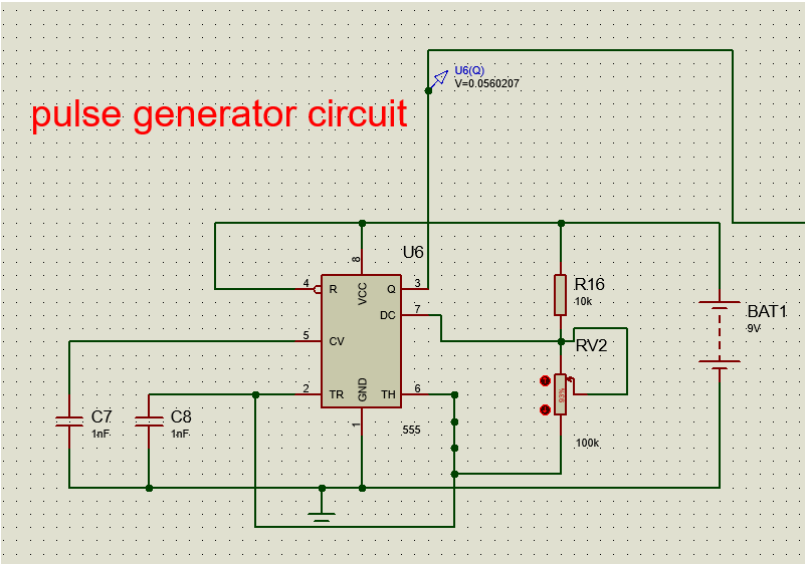
The inclusion of a clock signal is not necessary, as the leading edge of the data signal can be used as the clock if a small offset is added to each data value in order to avoid a data value with a zero-length pulse.

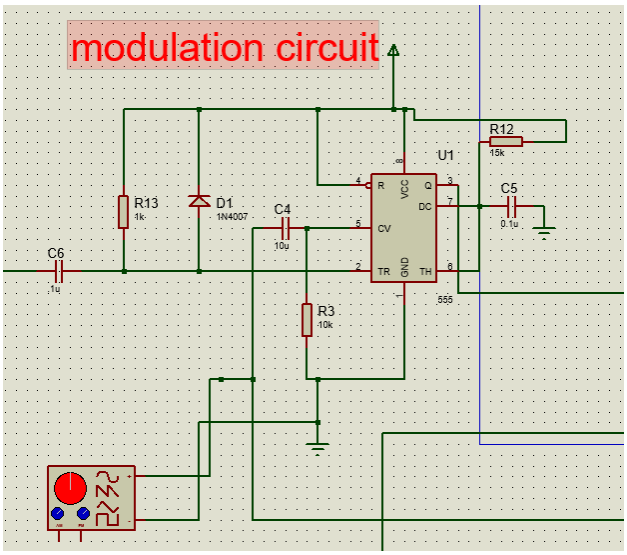
PWM is used to control servomechanisms. PWM is also used in efficient voltage regulators. By switching voltage to the load with the appropriate duty cycle, the output will approximate a voltage at the

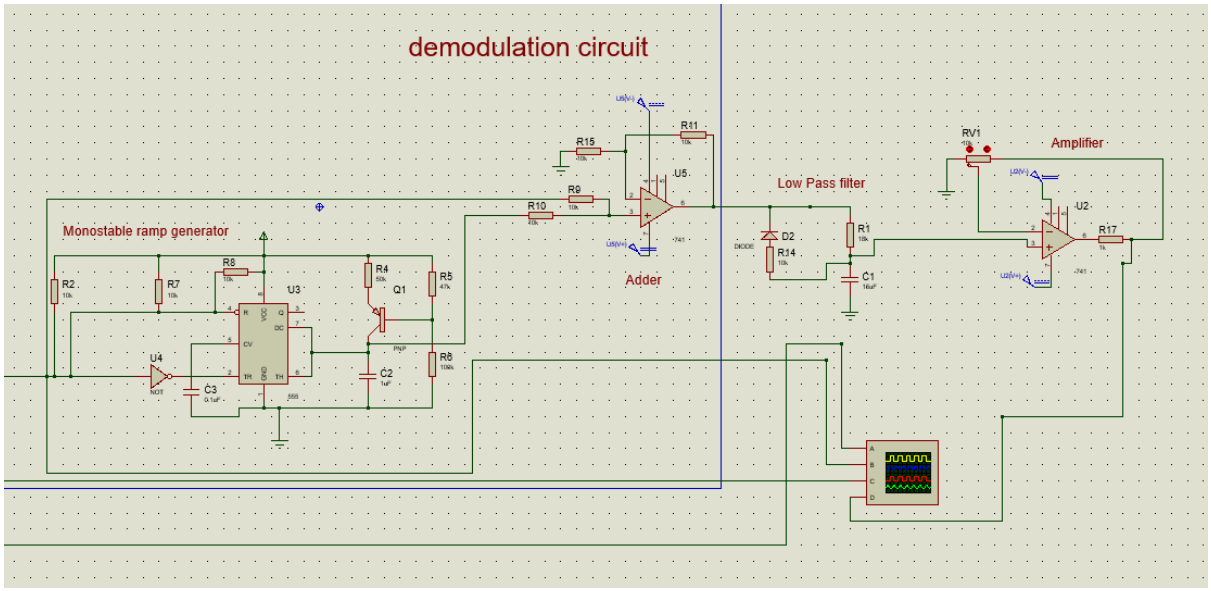
desired level. The switching noise is usually filtered with an inductor and a capacitor. One method measures the output voltage. When it is lower than the desired voltage, it turns on the switch. When the output voltage is above the desired voltage, it turns off the switch.

Design:

Components used are T555 timer ICs, OP-Amp 741 ICs, NOT-gate IC-7404, PNP transistor, Diodes, capacitors, inductor, capacitor, 10k Potentiometer.

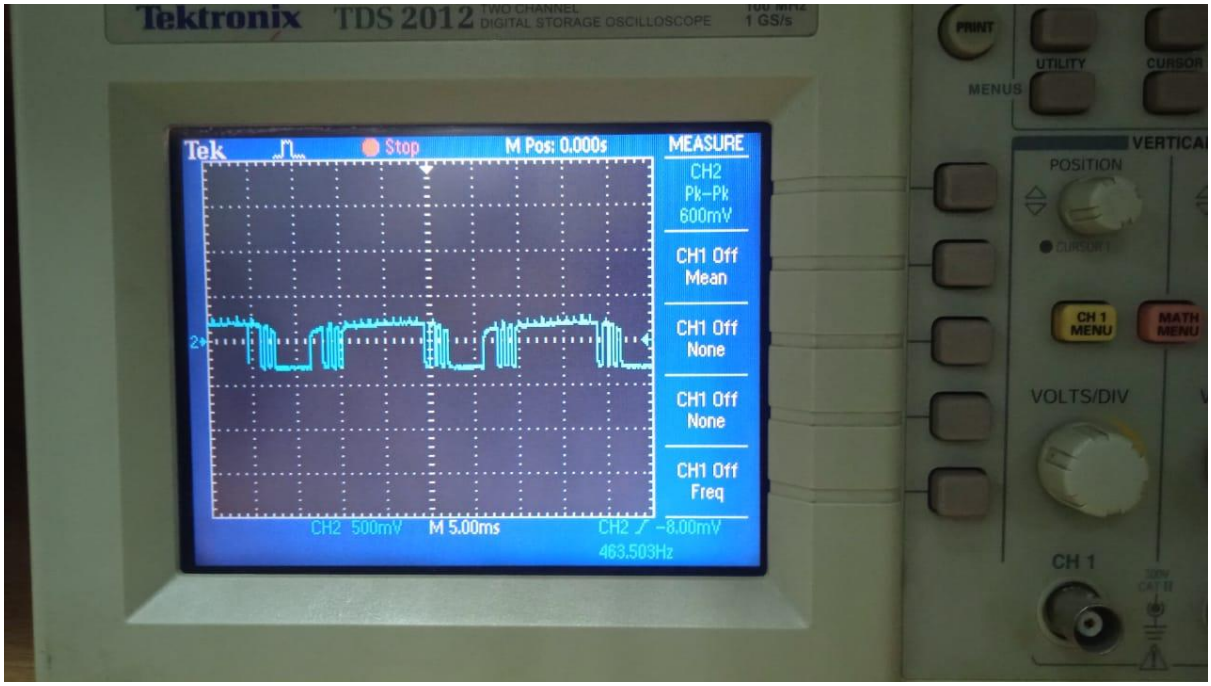


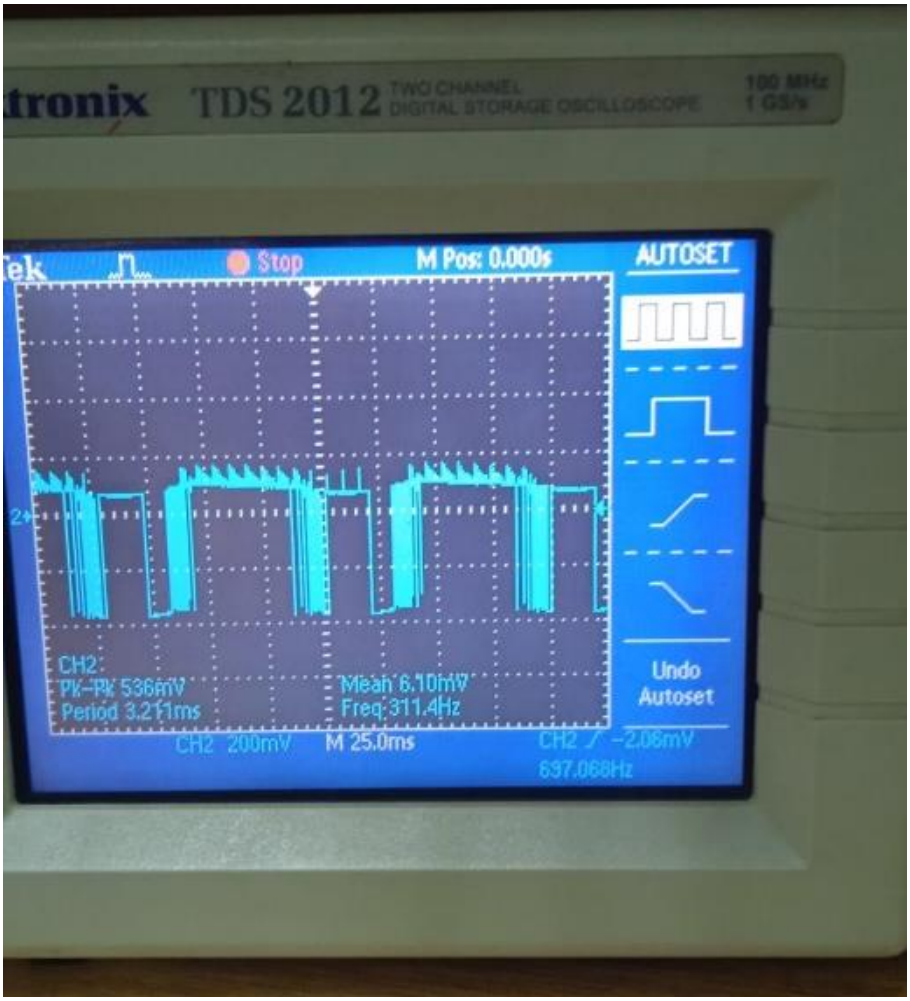


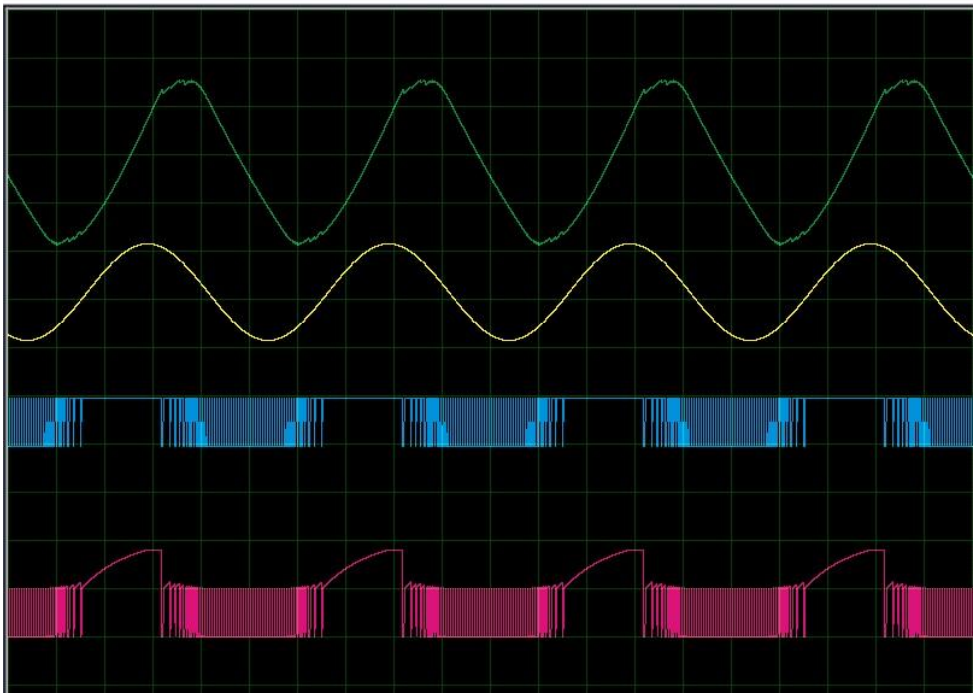


Hardware Implementation:

This the waveform of PWM on oscilloscope. The pink colored waveform represents the PWM signal.




tronix TDS 2012 TWO CHANNEL DIGITAL STORAGE OSCILLOSCOPE
100 MHz
1 GS/s
Stop
M Pos: 0.000s
AUTOSET
CH2
Pk-Pk 536mV
Period 3.211ms
Mean 6.10mV
Freq 311.4Hz
CH2 200mV
M 25.0ms
CH2 -2.08mV
697.068Hz
Undo
Autoset



Conclusion:

In our project, we have accomplished the following task:

1. Generate a pulse signal.
2. Create a PWM signal for a given message signal.
3. Transmit and demodulate the PWM signal.

During our project, we also have learned the working of :

- 555 IC.
- Generate monostable ramp.
- Create adder circuit of two signals.
- OP amp.