

## EXPERIMENT NUMBER 5

### Pulse Width Modulation (PWM)

**AIM:** To understand and implement Pulse Width Modulation (PWM) using IC 555 by varying the amplitude of the modulating signal and plot the relevant waveforms.

#### LEARNING OBJECTIVE:

- To compare the two modes of operation of timer IC 555.
- To classify the types of pulse modulation.

**PRIOR CONCEPTS:** Types of Modulation, Amplitude modulation, Pulse modulation and Sampling Theorem.

#### EQUIPMENT REQUIRED

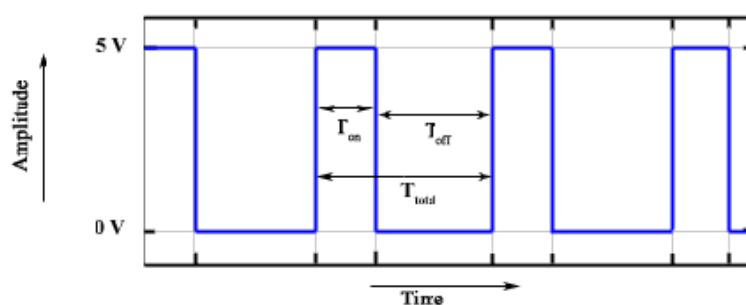
Equipment	Range	Quantity
CRO	(0-20)MHz	1
Function Generator	(0-1)MHz	2
Experiment Kit		1

#### COMPONENTS REQUIRED

Components	Value	Quantity
Timer IC	IC 555	1
Capacitor	0.01 $\mu$ F	1
Resistor	10k $\Omega$	1
	47 k $\Omega$	1

**THEORY:** Pulse-width Modulation is achieved with the help of a square wave whose duty cycle is changed to get a varying voltage output as a result of average value of waveform. The duty cycle is defined as the percentage of digital 'high' to digital 'low' signals present during a PWM period. Consider a square wave shown in the figure below.  $T_{on}$  is the time for which the output is high and  $T_{off}$  is time for which output is low. Let  $T_{total}$  be time period of the wave such that,

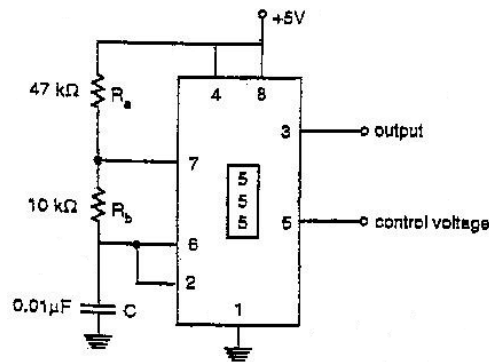
$$T_{total} = T_{on} + T_{off}$$



#### PROCEDURE

1. Connections are made as shown in the circuit diagram.
2. Vary the control voltage (0-5) V and observe the corresponding waveform.
3. Change in the control voltage changes the width of the square wave generated by the IC.
4. Note down  $T_{ON}$  and  $T_{OFF}$ .
5. Plot the observed waveform.

## CIRCUIT DIAGRAM OF PULSE WIDTH MODULATION



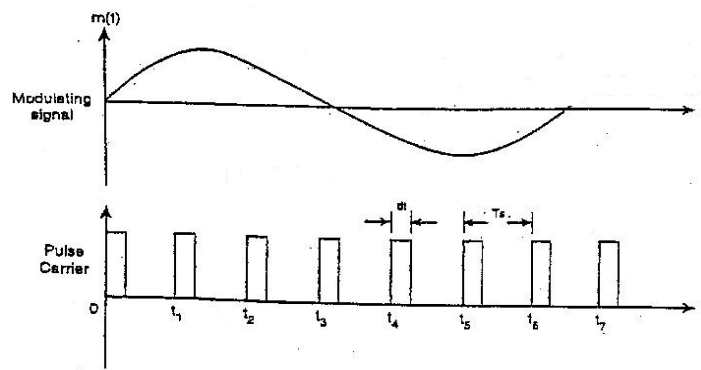
PIN	DESCRIPTION	PURPOSE
1	Ground	DC Ground
2	Trigger	The trigger pin triggers the beginning of the timing sequence. When it goes LOW, it causes the output pin to go HIGH. The trigger is activated when the voltage falls below 1/3 of +V on pin 8.
3	Output	The output pin is used to drive external circuitry. The HIGH output is usually about 1.7 volts lower than +V when sourcing current. The output pin is driven HIGH when the trigger pin is taken LOW. The output pin is driven LOW when the threshold pin is taken HIGH, or the reset pin is taken LOW.
4	Reset	The reset pin is used to drive the output LOW, regardless of the state of the circuit. When not used, the reset pin should be tied to +V.
5	Control Voltage	The control voltage pin allows the input of external voltages to affect the timing of the 555 chip. When not used, it should be bypassed to ground through an 0.01μF capacitor.
6	Threshold	The threshold pin causes the output to be driven LOW when its voltage rises above 2/3 of +V.
7	Discharge	The discharge pin shorts to ground when the output pin goes HIGH. This is normally used to discharge the timing capacitor during oscillation.
8	+V	DC Power - Apply +3 to +18VDC here.

### OBSERVATIONS:

- $T_{ON}$  period of carrier signal (Output of IC<sub>1</sub>) =
- Total Period =  $T_{ON} + T_{OFF}$
- Amplitude of the carrier signal =
- Amplitude of the modulating signal =
- Frequency of the modulating signal =

**CONCLUSION:** Thus, in PWM, (width/amplitude/position) of carrier changes in accordance to the instantaneous \_\_\_\_\_ of the modulating signal. Write the conclusion based on the duty cycle

## WAVEFORMS:



## Sample Input-Output:

