EEP3010: Laboratory Report

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Project Title

Different Modulation Techniques using Basic components (Without Using Trainer Kit)

Project Report

Amplitude shift Keying

Abstract

In this experiment, we have implemented amplitude shift keying modulation and demodulation using diodes, resistors, capacitors, and inductors. After that, we have transmitted and received text data using the amplitude modulation and demodulation

Equipment Used

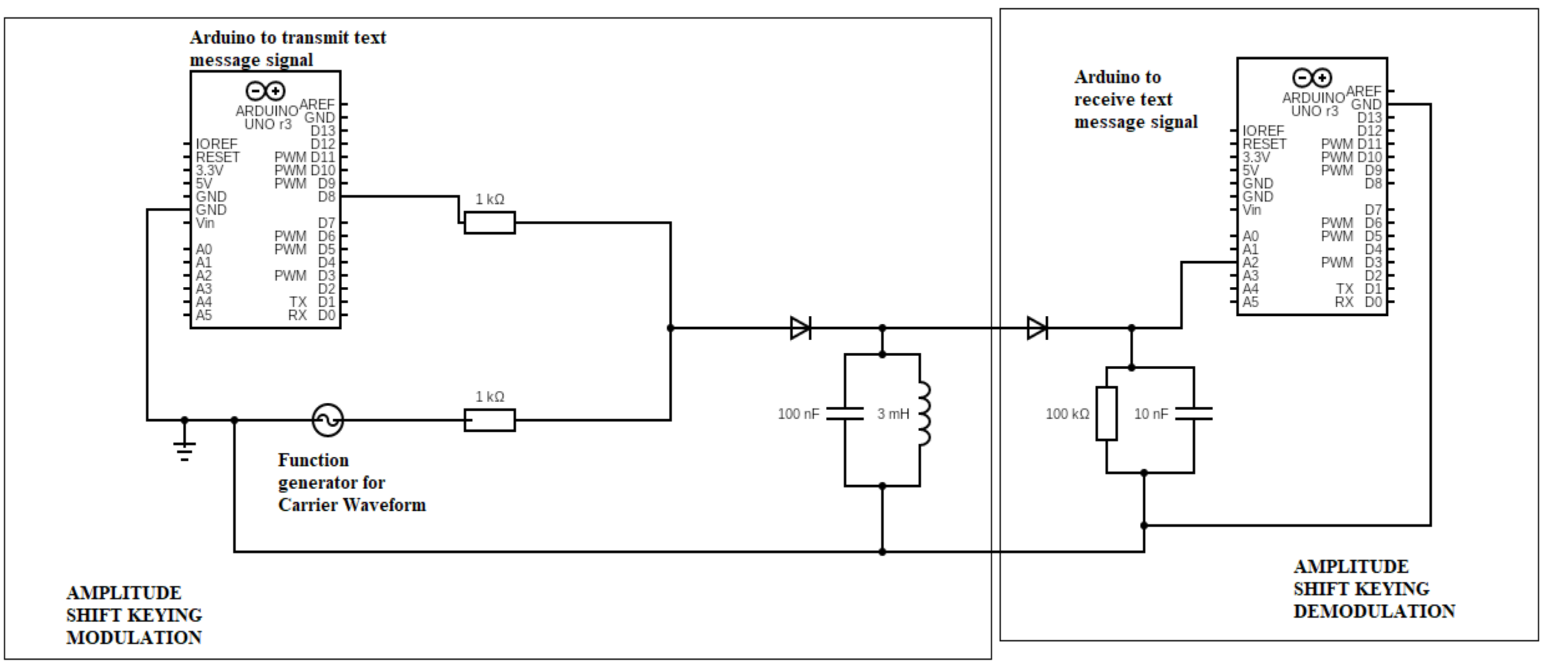
1. Arduino Uno board x 2
2. 1k ohm Resistor x 2
3. Diode IN4007 x 2
4. 0.1 uF Capacitor x 1
5. 1 mH Inductor x 3
6. 100k ohm Resistor x 1
7. 0.01 uF Capacitor x 1
8. Connecting wires
9. Function Generator
10. Oscilloscope

Theory

Amplitude-shift keying (ASK) is a form of amplitude modulation that represents digital data as variations in the amplitude of a carrier wave. In an ASK system, a symbol, representing one or more bits, is sent by transmitting a fixed-amplitude carrier wave at a fixed frequency for a specific time duration.
Retrieving the message signal from the modulated signal is called demodulation.

Methodology

Circuit Diagram



1. First we have to make the connections as shown in the circuit diagram.
2. Then we feed the code in both the Arduino Uno boards.
3. Arduino at the transmitter side will convert the text into ascii code and then the ascii code into binary sequence and data is transmitted in the form of bits.
4. After that we will set the frequency and amplitude of the carrier waveform in the function generator.
5. Then we will observe the modulated and demodulated waveform using the oscilloscope.
6. Arduino at the receiver side will convert the received bit string into the text data and will present it on the screen.
7. When we transmit the text data from the arduino we can observe the modulated and demodulated waveform of the data in the oscilloscope

and we will receive it at the receiver end of the arduino and our message signal will be shown on the serial monitor of the arduino.

Code for transmitting and receiving text data

Transmitter code

```
String myText = " ";
void setup() {
  Serial.begin(9600);
  pinMode(8, OUTPUT);
  digitalWrite(8, LOW);
}

void loop() {
  // put your main code here, to run repeatedly:

  Serial.println("Enter");
  while(Serial.available() == 0){}
  myText = Serial.readString();
  Serial.println(myText);
  digitalWrite(8, 255);
  delay(400);
  for (int i = 0; i < myText.length(); i++
      ) {

    char myChar = myText.charAt(i);



    for (int i = 7; i >= 0; i--) {
      byte bytes = bitRead(myChar, i);
      Serial.print(bytes, BIN);
      if (bytes == 0) {
        digitalWrite(8, 0);
        delay(50);

      }
```

```
      else if (bytes == 1)
      {
        digitalWrite(8, 255);
        delay(50);
      }
    }


  }
  digitalWrite(8, LOW);
  delay(800);
  Serial.println(" ");
  myText = " ";

}
```

Receiver Code

```
#define LDR_PIN A2
#define THRESHOLD 300
int count = 0;
int ct = 0;
String A = "";
void setup()
{
  Serial.begin(9600);
}

void loop()
{
  int voltage = analogRead(LDR_PIN);
  if (voltage > THRESHOLD && count < 8)
  {
    count = count + 1;
  }
  if (voltage < THRESHOLD && ct < 15)
```

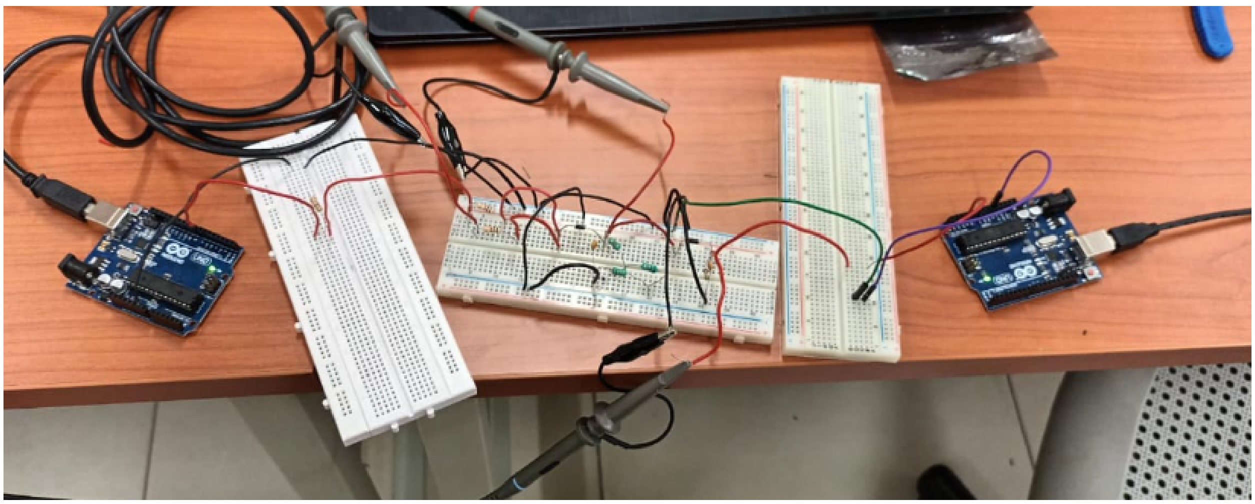
```
  {
    ct = ct + 1;
  }
  else if (voltage > THRESHOLD && ct > 0)
  {
    ct = 0;
  }
  if (ct == 15)
  {
    count = 0;
    Serial.print(" ");
    print_byte(A);
    ct = 19;
    A = "";
  }
  if (count == 8)
  {
    if (voltage > THRESHOLD) {
      delay(50);
      A.concat('1');
      Serial.print("1");
    }
    else
    {
      delay(50);
      A.concat('0');
      Serial.print("0");
    }
  }


}
void print_byte(String wow)
{
  wow.remove(0,8);
  int j = wow.length();
  int k = 0;
  int how = 0;
  int sum = 0;
  for (int i = 0; i < j; i++)
```

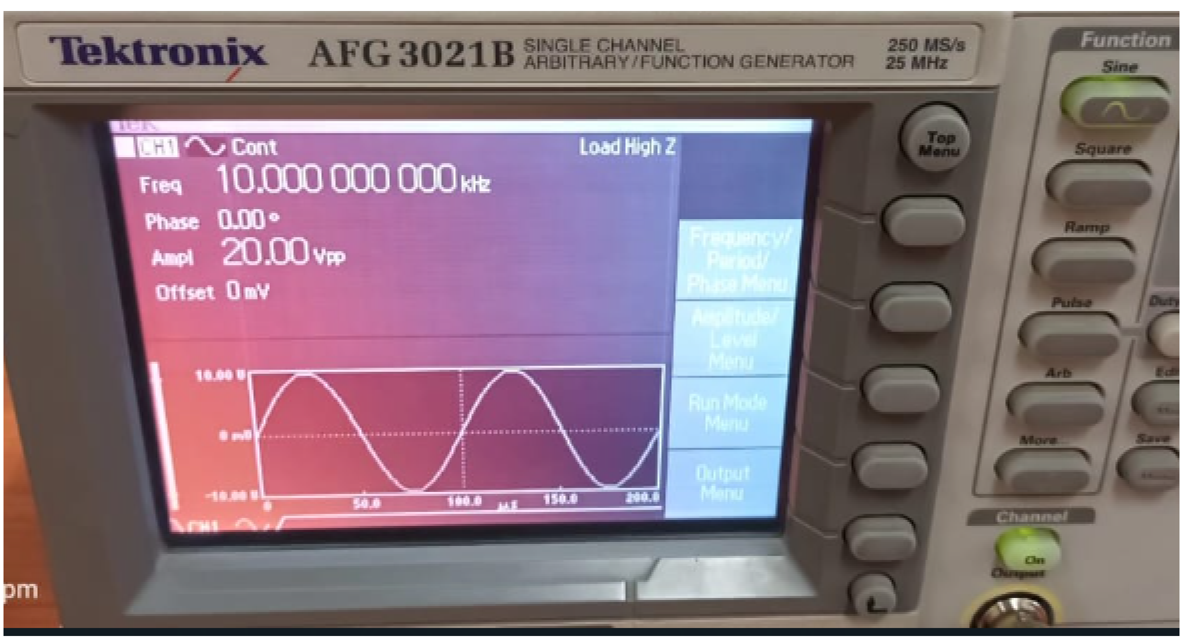
```
  {
    if (wow[i] == '1')
    {
      how = 1;
    }
    else if (wow[i] == '0')
    {
      how = 0;
    }
    int jj = pow(2, 7 - k) + pow(2, 0) * how;
    sum = sum + jj * how;
    if (how == 1 && k == 6)
    {
      sum = sum - 1;
    }
    if (how == 1 && k == 7)
    {
      sum = sum - 1;
    }
    k = k + 1;
    if (k == 8)
    {
      Serial.print(char(sum));
      k = 0;
      sum = 0;
    }
  }
}
```

Test Results and Circuit screenshots

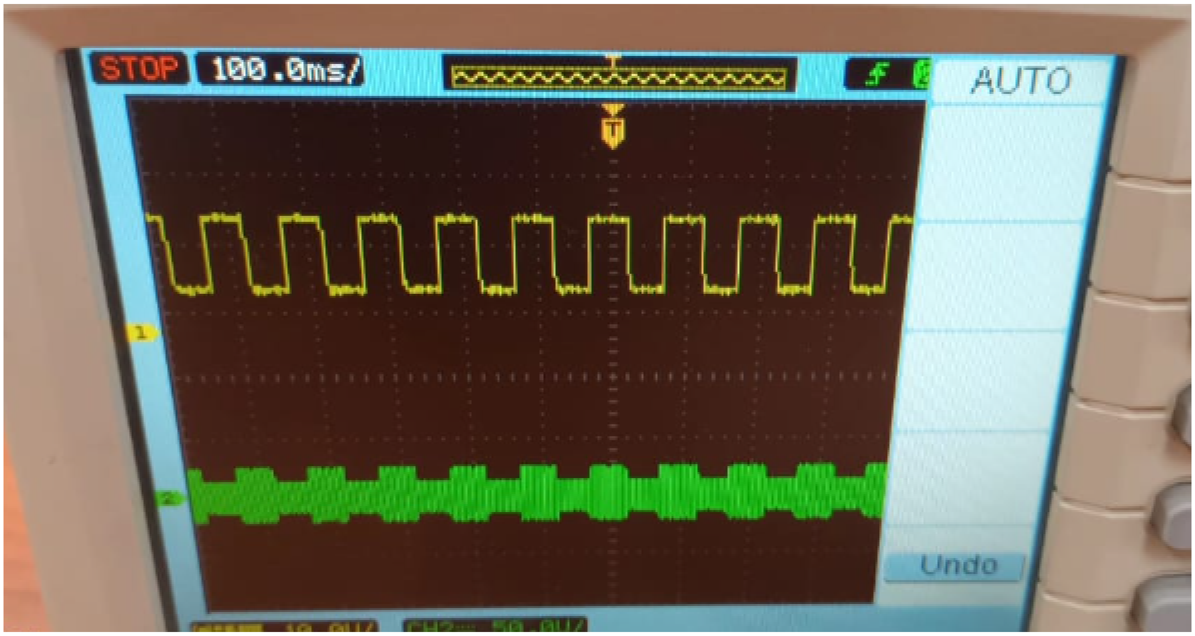
Circuit



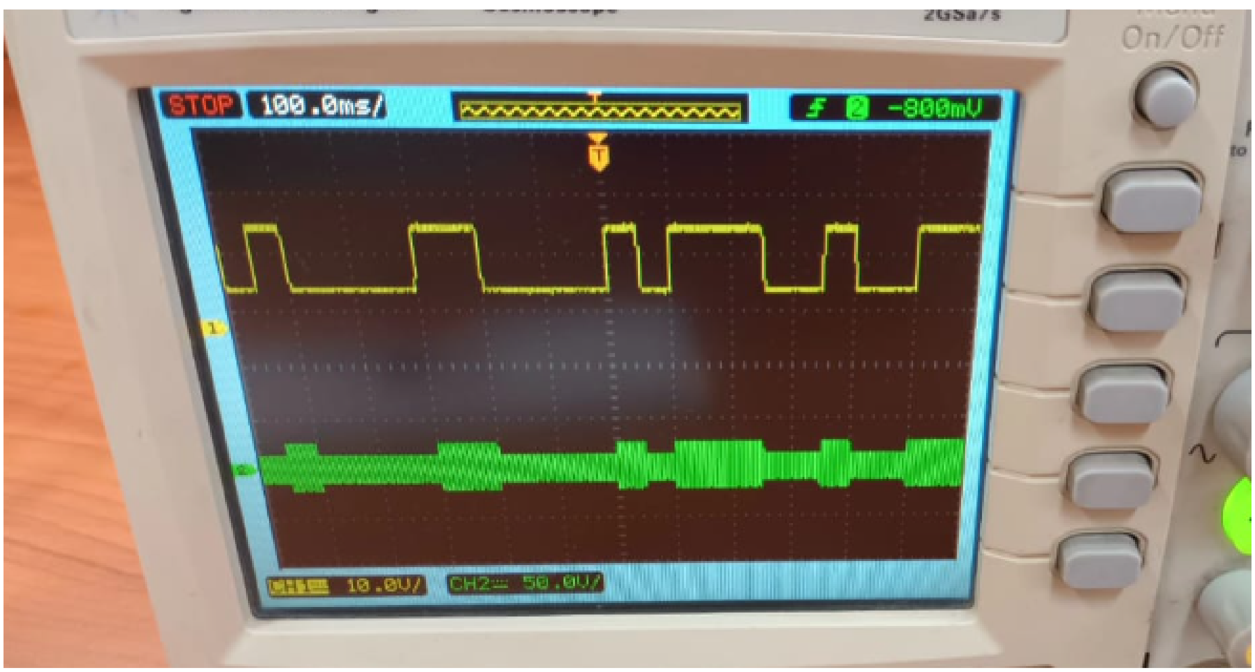
Function generator with carrier waveform



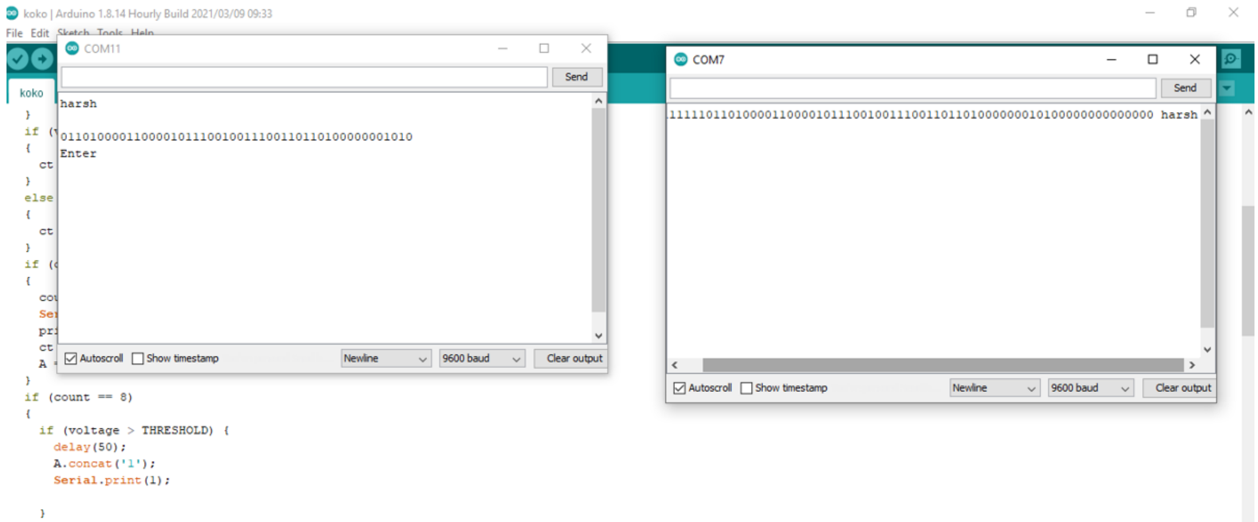
Modulated (green) and Demodulated (yellow) waveforms



Modulated (green) and Demodulated (yellow) waveforms when text data is transferred in the form of bits



Transmitting and Receiving Text signal



Discussion

In amplitude shift keying modulation, the wave signal is transmitted by modulating the amplitude of a digital signal.It is used for transmitting a message signal through a carrier wave. Retrieving the message signal from the modulated signal is called demodulation .

In the circuit values of L and C should be selected on the basis of carrier signal frequency.

$F_c = 1/(2 * \pi * \sqrt{LC})$

We are using a Low pass filter at the demodulation side to reconstruct our message signal.

Conclusions

We were able to receive our text data and also observed the modulated and demodulated waveforms in the Oscilloscope.

References

- Haykin, S. and Moher, M. (2009), Communication Systems, 5th Edition, Wiley Press
- Amplitude modulation and demodulation experiment_Part1_ # Dr. Ravi Dwivedi#VIT Chennai.

Pulse width Modulation using Basic Components

Abstract: PWM stands for Pulse Width Modulation, a technique widely used in electronic circuits to control the power delivered to a load. PWM is a way of encoding a signal by modulating the duty cycle of a pulse train. The duty cycle is the ratio of the pulse duration to the total period of the pulse train. By varying the duty cycle, the average power delivered to a load can be controlled without changing the amplitude of the signal.

Theory

PWM is often used in applications such as motor control, lighting control, and power regulation. In motor control, for example, PWM is used to adjust the speed of a motor by controlling the average voltage applied to the motor. Similarly, in lighting control, PWM can be used to adjust the brightness of an LED by controlling the average current through the LED.

PWM signals can be generated using a variety of electronic components such as 555 timer IC, operational amplifiers, and microcontrollers. Microcontrollers are particularly well-suited for generating PWM signals because they can easily generate precise and complex waveforms with a high degree of flexibility and programmability.

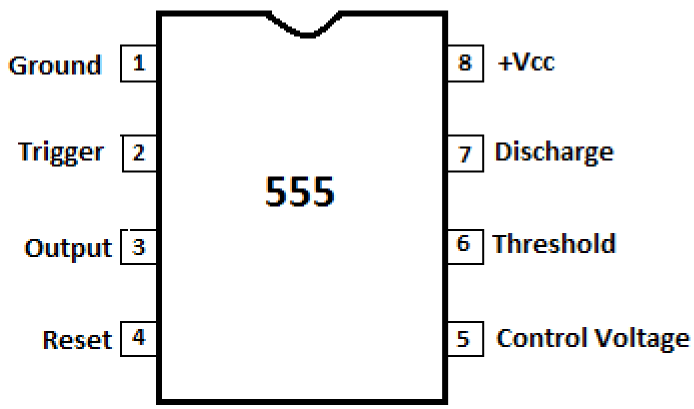
Overall, PWM is a powerful and versatile technique that is widely used in electronics to control power delivery to a load. It offers a simple and efficient way to adjust the average power delivered to a load without changing the amplitude of the signal.

Equipment Used

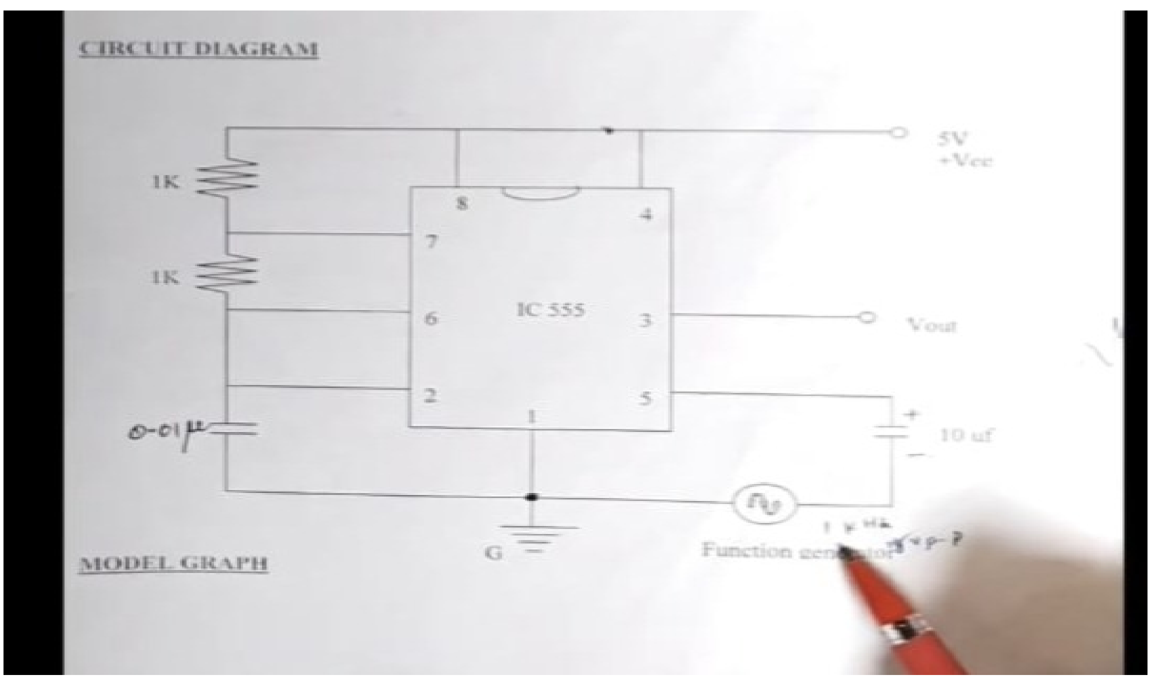
1. 1K ohm resistor x2
2. 0.01 uF capacitor x1
3. IC 555 x1
4. 5 V power supply
5. 10 uF capacitor x1
6. Function Generator for message signal

Circuit Diagram and Output Waveform

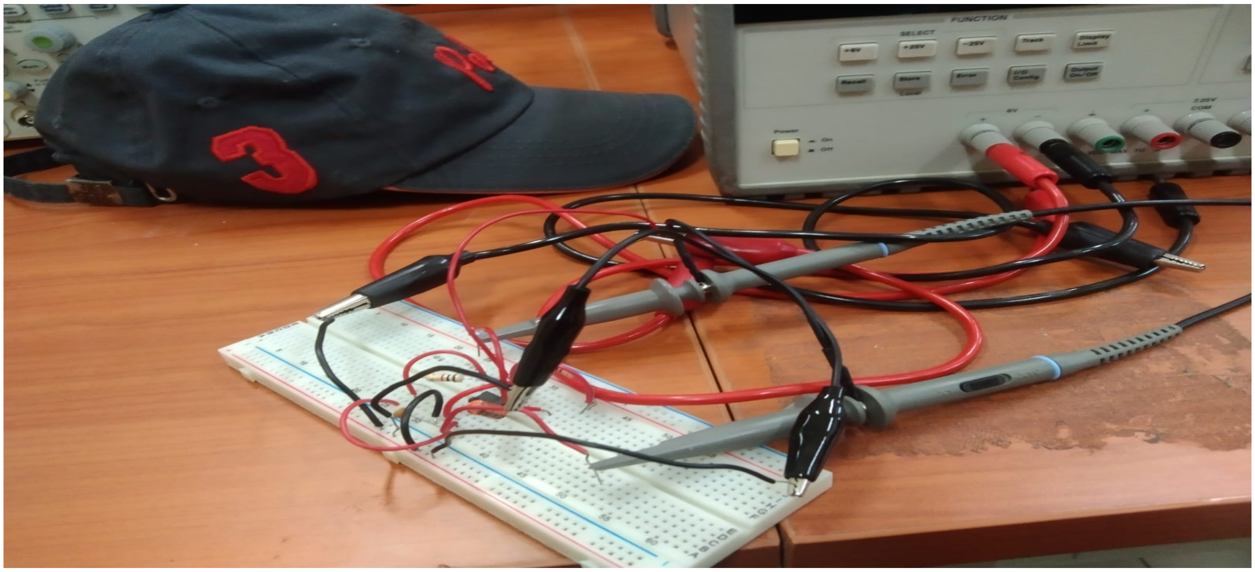
IC Pin Configuration



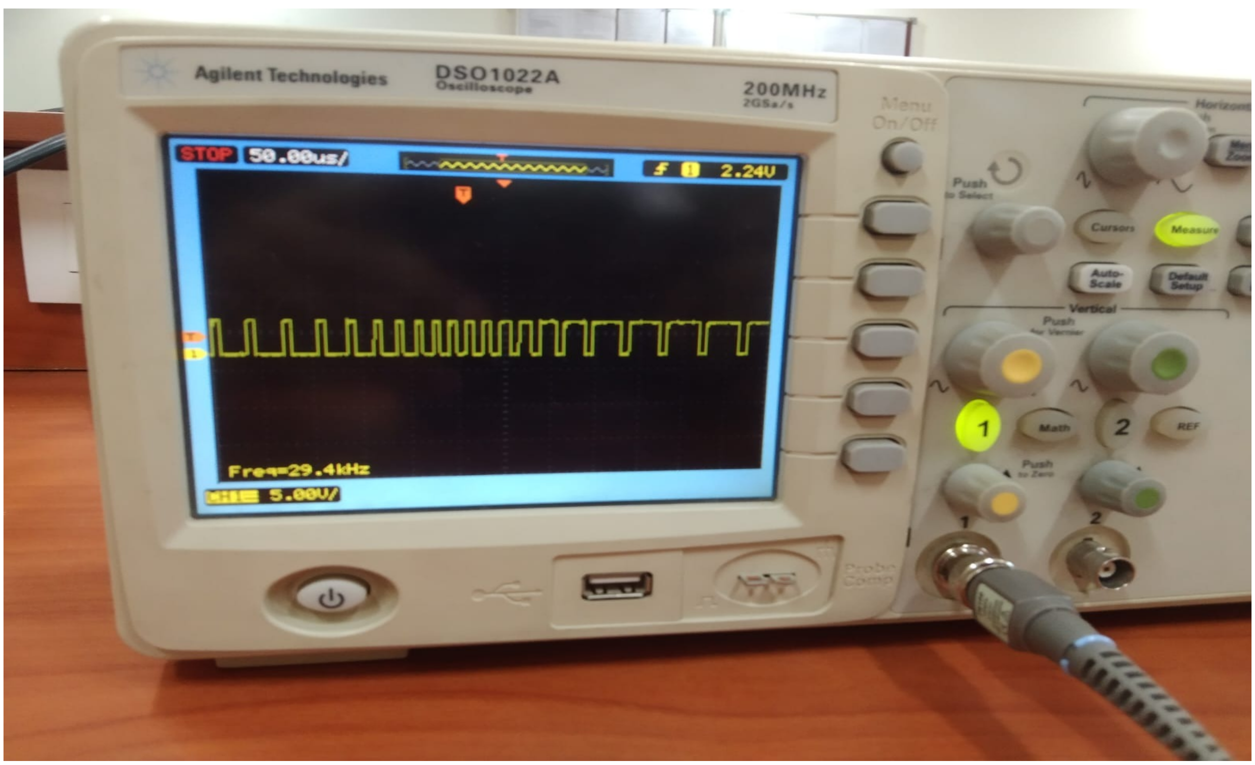
Circuit Diagram Configuration



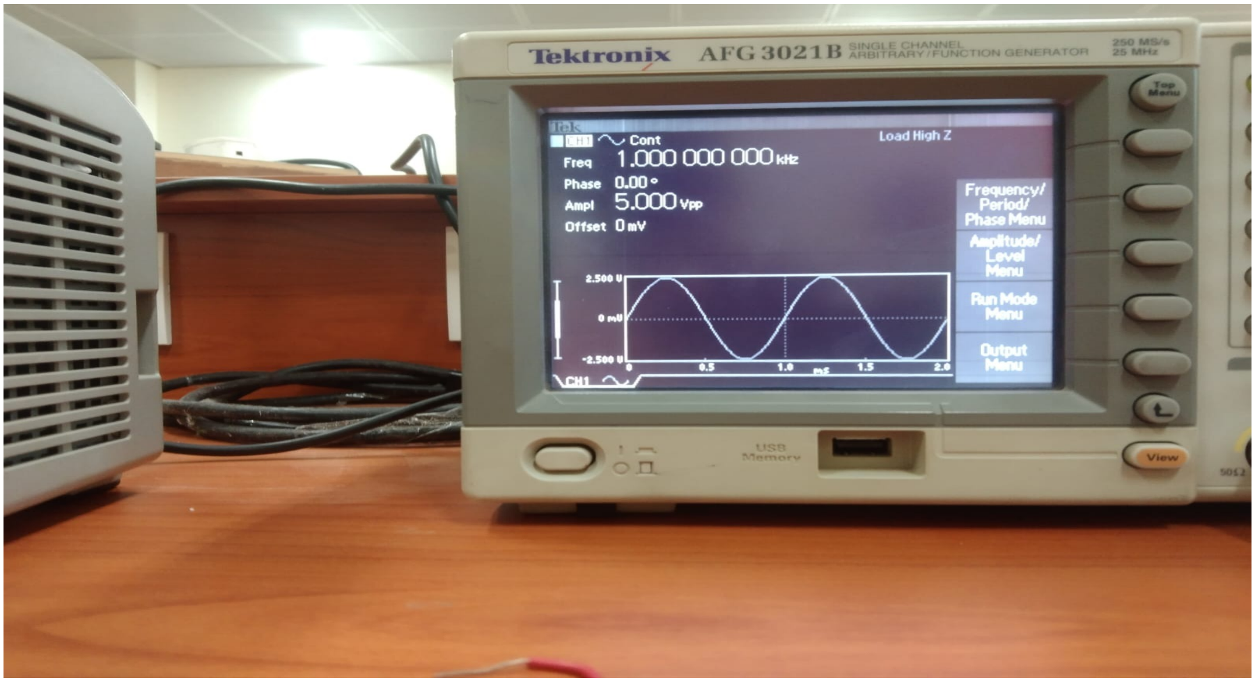
Circuit Diagram



Output PWM WAVEFORM



Function Generator– Input Waveform



DC SUPPLY TO IC

Conclusion: In the Obtained PWM wave we can see that the PWM waveform width is changing as per the amplitude of the Input signal from the signal generator and giving us our desired output.

Challenges: I have tried to implement the PWM demodulation but not able to succeed in it.

References :

a. Communication Systems Engineering Book by John G. Proakis.
b. Lecture by Dr. Aarthi G, PWM modulation using timer 555.

Frequency modulation using basic components

Abstract: In frequency modulation, a signal's frequency is modulated and then transmitted over the transmission line. In the experiment, we are generating a message and carrier signal in the time and frequency domain using the Function Generator and then modulating this signal using basic components.

Objective: To study frequency modulation using basic components eg. Resistor, inductor, capacitor, diode and IC-Timer 555.

Theory: Frequency modulation (FM) is a type of angle modulation in which the frequency of a sinusoidal carrier wave deviates from a center frequency by an amount proportional to the instantaneous value of the message signal.

We calculate some parameters given below in frequency modulation:

Occupied bandwidth: $2(fm + \Delta f)$

$$\beta = \Delta f \,/\, fm$$

Equipment Used

1. 1.5 K ohm resistor x2
2. 10 K ohm resistor x1
3. Diode 1N4007 x1
4. 0.1 uF capacitor x1
5. IC 555 x1
6. 5 V power supply
7. 10 uF capacitor x1
8. Function Generator for message signal

Experimental Methodology:

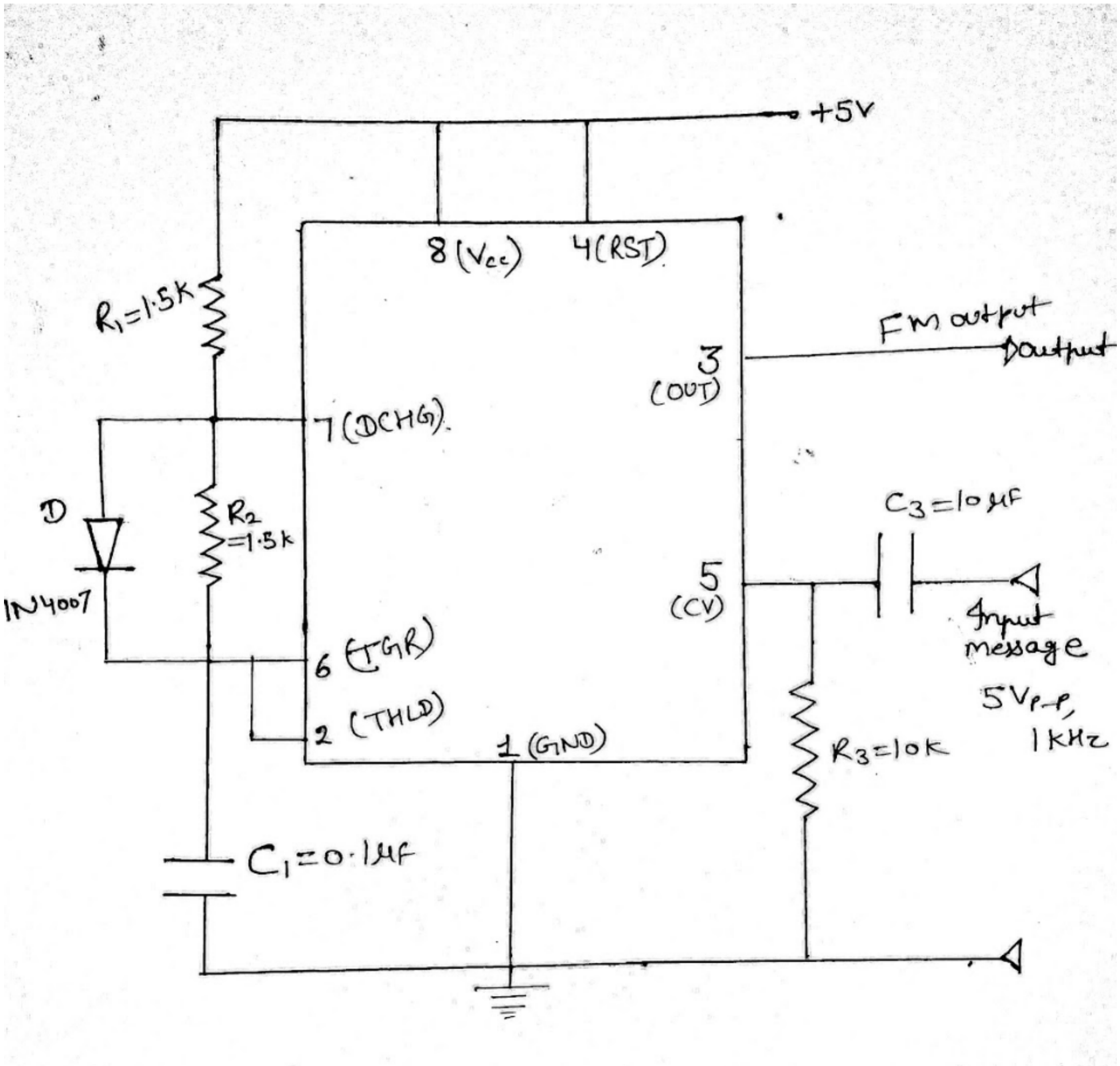
➔ In frequency modulation, Frequency of carrier signal is varied according to the amplitude of message signal.

➔ Here we have used IC 555 Timer in astable mode. In astable mode, output waveform is produced based on external resistor and capacitor.

➔ When Output is high, the capacitor will charge Vcc through resistor R1 and diode D.

➔ When Output is low then the capacitor will discharge through resistor R2 and pin number 7. In this way Output is generated by IC555 based on charging and discharging of capacitor.

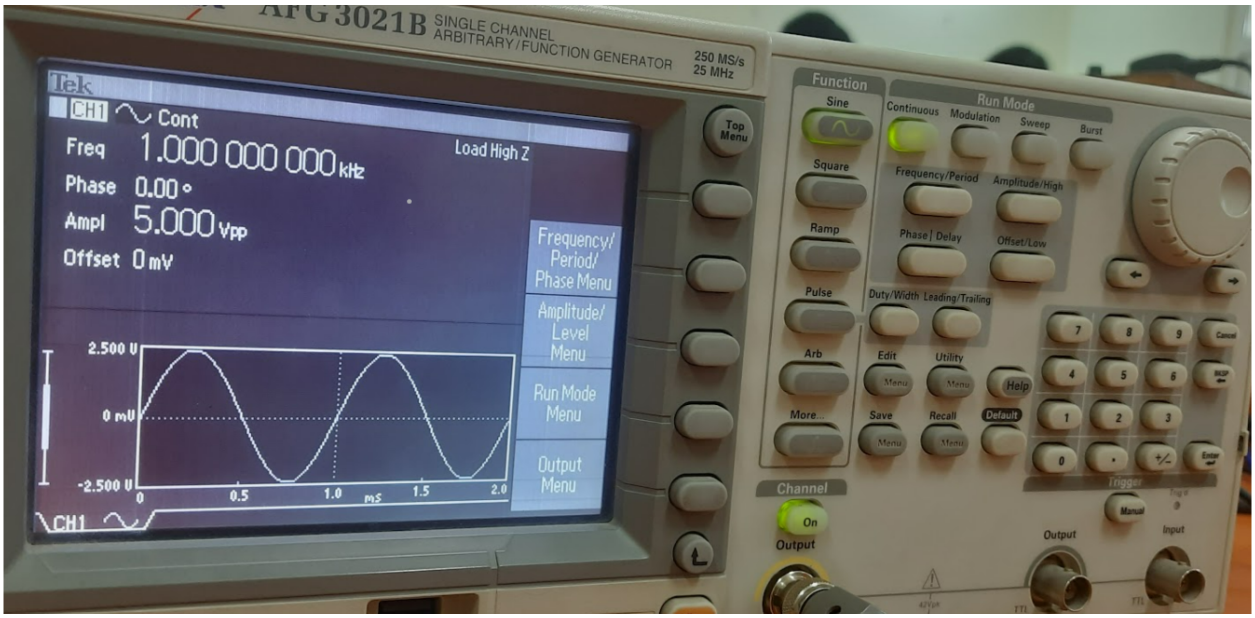
➔ Carrier signal is produced by IC 555 Timer.



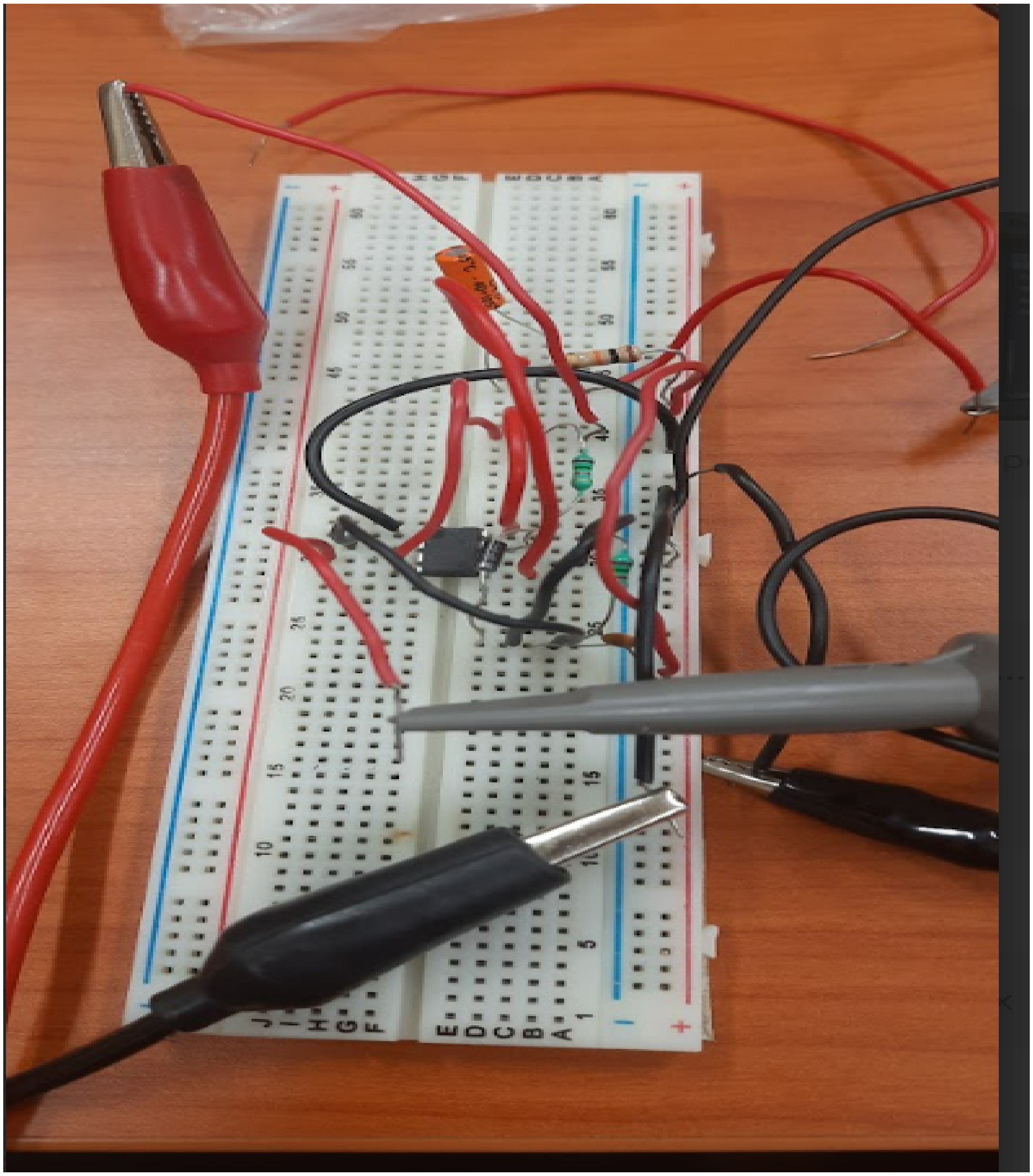
Frequency Modulation using IC555 Timer.

Observation and Calculations:

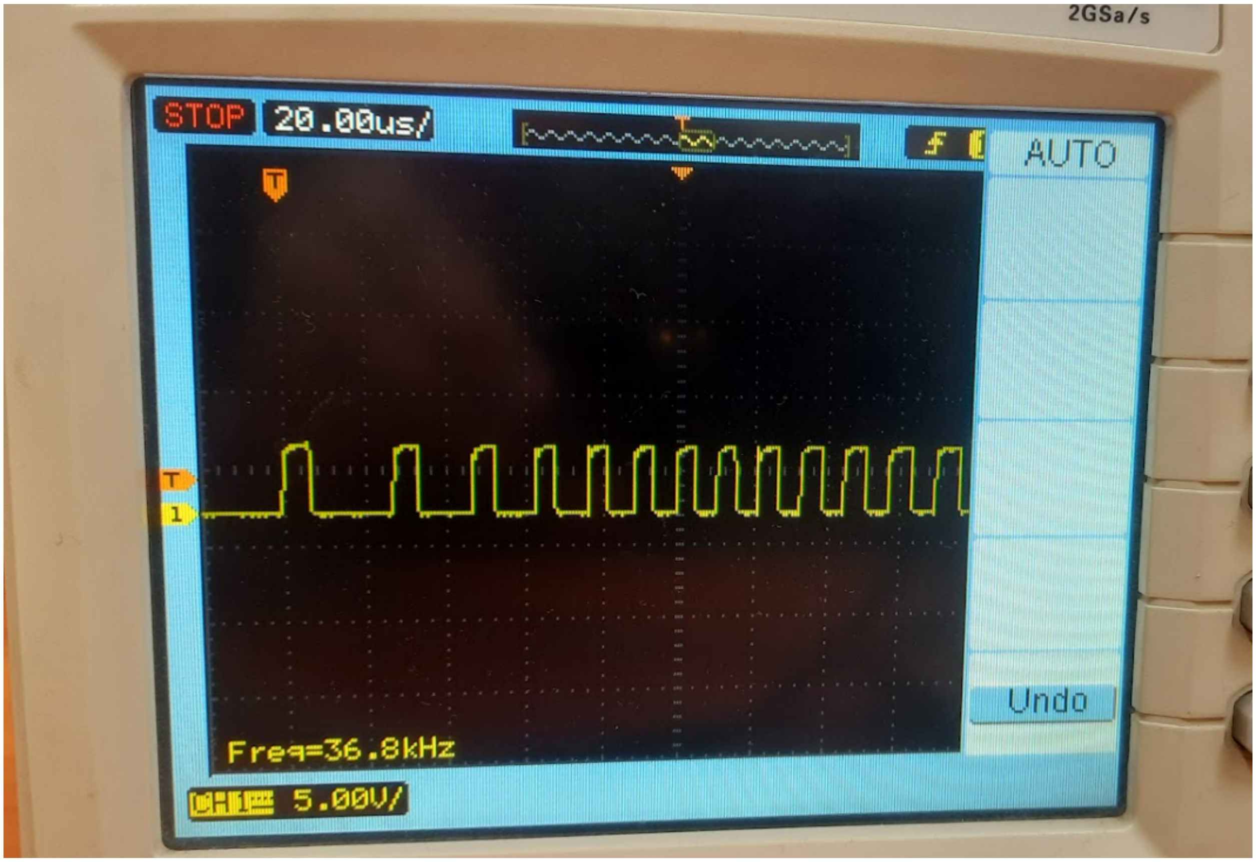
a. Message Signal:



b. Circuit on breadboard



c. Modulated Signal:



Discussion on results: Here IC 555 is generating a square wave which is acting as carrier wave and Input pulse is 1Khz sine wave which is modulating on square wave's frequency.
Modulating wave is shown as in the above figure.

Challenges faced: We were not able to generate sine waves as carrier waves through IC 555 timer.

Calculations:

$$Modulation\ Index(\beta)\ =\ \frac{\delta f}{f_m}$$

fm = 1KHz

$$\delta f\ = f_{max} - f_{min}$$
$$=\ 40.2Khz\ -\ 32.8Khz$$
$$=\ 7.4\ KHz$$

$$\beta\ = \frac{7.4KHz}{1KHz}$$

$$\beta\ =\ 7.4$$

Conclusion: In this experiment, we have studied the waveforms obtained for frequency modulation using IC555 Timer.

References :

c. Communication Systems Engineering Book by John G. Proakis.
d. Lecture by Dr. Aarthi G, Frequency modulation using timer 555.

Work Done by each team member

As we have decided to work on the Different modulation techniques, so we divided the work accordingly and implemented 3 modulation techniques:-

1. Harsh worked on the Amplitude Shift Keying modulation and Demodulation and transmitted text data with the help of designed circuit and arduino UNO.
2. Hemant worked on the Pulse Width Modulation and Transmitted the modulated message signal which was generated using the function generator.
3. Jatin worked on the frequency modulation and using the function generator was able to transmit the frequency modulated wave successfully.

Remarks :

In our Preliminary Report, we mentioned that Hemant is going to work on amplitude modulation but later the plan was changed because Hemant was busy in the Design Credit project so Harsh competed the amplitude shift keying modulation and demodulation and transmitted text data and Jatin completed the Frequency modulation. So later Hemant worked on the

Pulse Width Modulation on his own. We completed the project with Three modulation techniques.